Academic Council Meeting No. and Date : 08 / 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 Code: BPIT

Programme :Master of Science

Specific Programme : Information Technology

[M.Sc. (I.T.) Part I (Semester I and II)]

Level 6.0

CHOICE BASED GRADING SYSTEM

Revised under NEP

From academic year 2023-24

B. N. Bandodkar College of Science (Autonomous), Thane											
Master Program in Information Technology											
Year (2 Yrs)	**LEVEL**	**SEMESTER**	**Major**				**Research Methodology**	**On Job Training / Field project**	**Research project**	**Cum Credits**	**Degrees**
			Mandatory			**Electives anyone**					
I	**6.0**	SEM-I	**3*4 + 2 = 14**			Credits 4	**Credits 4**	NA	NA	22	PG Diploma in Information Technology (After 3 Yrs. degree UG)
			Course 1	Credits 4		Course 1= Credits 4					
			Course 2	Credits 4		**OR**					
			Course 3	Credits 4		Course 2 = Credits 4					
			Course 4	Credits 2							
		SEM-II	Course 1	Credits 4		Course 1 = Credits 4	NA	**Credits 4**	NA	**22**	
			Course 2	Credits 4		**OR**					
			Course 3	Credits 4		Course 2 = Credits 4					
			Course 4	Credits 2							
Cum Cr. for 1 Yr. PG Diploma			**28**			8	4	4		44	
II	**6.5**	SEM- III	Course 1	Credits 4	Course 1	Credits 4	NA	NA	**Credits 4**	22	Master Program in Information Technology (After 3 Yrs. degree UG)
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2	Credits 4					
			Course 4	Credits 2							
		SEM IV	Course 1	Credits 4	Course 1	Credits 4	NA	NA	**Credits 6**	**22**	
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2	Credits 4					
Cum Cr. for integrated 1 Yr. PG Degree			**26**		**8**				**10**	**44**	
Cum Cr. for 2 Yr. PG Degree			**44**		**16**		**4**	**4**	**10**	**88**	

B. N. Bandodkar College of Science (Autonomous), Thane

Master of Science

Information Technology

(To be implemented from the academic year 2023-2024)

SEMESTER I and SEMESTER II

Sr. No.	Heading	Particulars
1.	Title of the Course	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)	Existing ordinances and regulations.
5.	Number of years / Semesters	Two years – Four Semesters
6.	Level	PG
7.	Pattern	Semester
8.	To be implemented from Academic year	2023 – 2024
9.	Mode of conduct	Offline / Online Lectures / Practicals

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

Abhijeet A. Kale

BOS Chairperson

PROGRAMME OUTCOMES (POs) OF MASTERS IN SCIENCE (M.Sc.)

The Postgraduate Programmes of Science are intended to cater quality education and attain holistic development of learners through the following programme outcomes:

PO1 – Domain Knowledge

Comprehend and demonstrate domain knowledge in specialized branch of science. Instil ability to apply it in upgrading professional, social and personal life.

PO2 – Development of Research Competence

Imbibe skills related to identification of research problem, formulating hypothesis, execution of research process, analysing data, interpreting the data, drawing conclusion and presenting research work. Encourage learners for doctoral studies.

PO3 - Digital Literacy

Enhance ability to access, select and use a variety of relevant information e-resources for creating new knowledge resources.

PO4 - Sensitization towards Environment

Build cohesive bond with nature by respecting natural resources, encouraging eco-friendly practices and creating awareness about sustainable development.

PO5 - Individuality and Team work

Encourage learner to work independently or in collaboration for achieving effective results through practical experiments, project work and research activities.

PO6 – Competence for Employment

Promote field work, internships, industrial training, research projects, research paper presentations and publications to develop competence for adapting towards dynamic socio-economic changes and make learner employable.

Program Specific Outcome : On completion of the M.Sc. (Information Technology) degree the learners will be able to

1. Analyze and evaluate algorithms to solve complex computational problems effectively. (Level 4)
2. Demonstrate advanced knowledge and understanding of Data Analytics, Cloud Computing, Machine Learning, Artificial Intelligence, and Digital Forensics to analyze, design, and evaluate complex IT solutions. (Level 3)
3. Understand and manage IT systems, networks, and security. (Level 2)
4. Apply research methods to interpret data and make informed decisions. (Level 3)
5. Develop skills for continuous self-practice and adapting to new technologies. (Level 6)
6. Evaluate emerging industry trends to assess their impact on future IT requirements. (Level 5)

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="7">1</td><td rowspan="7">6.0</td><td rowspan="5">Sem I</td><td colspan="3">3*4+1*2</td><td>4</td><td>4</td><td rowspan="5">-</td><td rowspan="5">-</td><td rowspan="5">22</td><td rowspan="12">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 in I.T.</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="6">Sem II</td><td colspan="3">3*4+1*2</td><td>4</td><td rowspan="6">-</td><td rowspan="6">4</td><td rowspan="6">-</td><td rowspan="6">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>
</table>

Semester I

VPM's B. N. Bandodkar College of Science (Autonomous), Thane

M.Sc. Information Technology

Structure of Programme

SEMESTER I

Course Code	Course Title	No. of Lectures	Credits
MANDATORY PAPERS			
23BPIT1T01	Data Science	**60**	**4**
23BPIT1T02	Cloud Computing	**60**	**4**
23BPIT1T03	Soft Computing Techniques	**60**	**4**
23BPIT1P01	Practicals Based on 23BPIT1T01 and 23BPIT1T03	**60**	**2**
Electives			
23BPIT1T04	Security Breaches and Countermeasures	**30**	**2**
23BPIT1P02	Practicals Based on 23BPIT1T04	**60**	**2**
OR			
23BPIT1T05	Data Center Virtualization	**30**	**2**
23BPIT1P03	Practicals Based on 23BPIT1T05	**60**	**2**
OR			
23BPIT1T06	Image Processing	**30**	**2**
23BPIT1P04	Practicals Based on 23BPIT1T06	**60**	**2**
23BPRM1T04	Research Methodology in I.T.	**60**	**4**
	Total Credits		**22**

Course Code	Course Title	Credits	No. of lectures
23BPIT1T01	**Data Science**	**04**	**60**

CO1	Explain the fundamental concepts of Data Science, including the data science technology and the roles of business, utility, and management layers in real-world data-driven systems.	L5
CO2	Apply statistical methods, data visualization techniques to retrieve, assess, process, and transform structured and unstructured data from data sources to generate business insights.	L3
CO3	Analyze and evaluate datasets using machine learning and data mining techniques such as regression, clustering, classification, PCA, hypothesis testing, and model validation methods to assess model performance and data quality issues.	L4
CO4	Design and develop end-to-end data science solutions by integrating data engineering, machine learning, and reporting super steps, and communicate findings effectively through visualizations, reports, and decision-support artifacts using modern tools and frameworks.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	2
CO2	3	3	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

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 [CO1, CO2]
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 [CO2, CO3]
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 [CO3, CO4]

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 [CO2, CO3, CO4]

References:

1. Practical Data Science by Andreas François Vermeulen, APress, 2018
2. Principles of Data Science by Sinan Ozdemir, PACKT 2016
3. Data Science from Scratch by Joel Grus, O'Reilly, 2015
4. Data Science from Scratch first Principle in python by Joel Grus, Shroff Publishers 2017
5. Experimental Design in Data science with Least Resources by N C Das, Shroff Publishers, 2018

Course Code	Course Title	Credits	No. of lectures
23BPIT1T02	**Cloud Computing**	**04**	**60**

CO1	Describe and explain the fundamental concepts of cloud computing, including its historical evolution, principles of parallel and distributed computing, virtualization concepts, and core cloud characteristics.	L1
CO2	Apply cloud computing models and virtualization techniques to build and configure basic cloud environments using logical network perimeters, virtual servers, cloud storage devices, and ready-made cloud platforms.	L3
CO3	Analyze and evaluate cloud architectures, deployment models, and delivery models, considering performance, scalability, economics, and security threats in real-world cloud-based systems.	L4
CO4	Design a secure and scalable cloud computing solution by integrating appropriate cloud services and industrial platforms (AWS, Google App Engine, Microsoft Azure), while addressing security challenges and emerging trends in cloud computing.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	2
CO2	3	2	3	1	3	3
CO3	3	3	3	2	2	3
CO4	3	3	3	2	3	3

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 [CO1, CO2]
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 [CO1, CO3]
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 [CO2, CO4]
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 [CO3, CO4]

Reference:

1. Mastering Cloud Computing Foundations and Applications Programming, Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Elsevier, 2013
2. Cloud Computing Concepts, Technology & Architecture by Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, Prentice Hall, 2013
3. Distributed and Cloud Computing, From Parallel Processing to the Internet of Things by Kai Hwang, Jack Dongarra, Geoffrey Fox, MK Publishers, 2012

Course Code 23BPIT1T03	Course Title **Soft Computing Techniques**	Credits 04	No. of lectures 60

CO1	Explain the fundamental concepts of soft computing, including fuzzy logic, artificial neural networks, genetic algorithms, probabilistic reasoning, and their differences from hard computing, along with real-world applications.	L5
CO2	Apply supervised, unsupervised, and associative neural network models (Perceptron, ADALINE, Back propagation, Hopfield, SOM, ART, CNNs) to solve classification, clustering, and pattern recognition problems.	L3
CO3	Analyze and evaluate fuzzy systems and evolutionary algorithms, including membership functions, fuzzification–defuzzification methods, fuzzy inference systems, genetic and differential evolution algorithms, for handling uncertainty and optimization problems.	L4
CO4	Design and develop hybrid soft computing solutions (neuro-fuzzy, genetic-fuzzy, genetic-neural systems) by integrating advanced neural networks and evolutionary techniques to address complex real-world decision-making and control problems.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	2
CO2	3	3	3	1	3	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

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 [CO1, CO2]
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 [CO1, CO2, CO3]
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.	15 [CO2, CO4]

	e) Fuzzy Arithmetic and Fuzzy measures - fuzzy arithmetic, fuzzy measures, measures of fuzziness, fuzzy integrals.	
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 [CO2, CO3, CO4]

References:

1. Artificial Intelligence and Soft Computing by Anandita Das Battacharya SPD 3rd Edition 2018
2. Principles of Soft computing by S.N.Sivanandam S.N.Deepa, Wiley, 3rd Edition 2019
3. Neuro-Fuzzy and Soft Computing by 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 by S.Rajasekaran, G. A. Vijayalakshami Prentice Hall of India 2004
5. Fuzzy Logic with Engineering Applications by Timothy J.Ross McGraw-Hill 1997
6. Genetic Algorithms: Search, Optimization and Machine Learning by Davis E.Goldberg Addison Wesley 1989
7. Introduction to AI and Expert System by Dan W. Patterson Prentice Hall of India 2009

Course Code	Course Title	Credits	No. of lectures
23BPIT1P01	**Practicals Based on 23BPIT1T01 and 23BPIT1T03**	**02**	**60**

CO1	Explain the fundamentals of data representation, preprocessing, and neural computation, including data formats, basic statistical operations, and foundational neural network models.	L5
CO2	Apply Python/R programming techniques to perform data conversion, preprocessing, error handling, and exploratory analysis, including binning, averaging, outlier detection, and attribute extraction from real-world datasets.	L3
CO3	Analyze and evaluate neural network learning algorithms and models, such as McCulloch–Pitts neurons, Hebbian learning, Delta rule, Backpropagation, Hopfield networks, RBF, SOM, and ART, by computing outputs and assessing learning performance.	L4
CO4	Design and implement integrated data-driven and neural network solutions, including acyclic graph construction, associative memory systems, linear separability testing, and simple neural models to solve classification and pattern recognition problems.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	2	2
CO2	3	3	3	1	3	3
CO3	3	3	3	1	2	3
CO4	3	3	3	2	3	3

Practical 1	Creating and using database in Cassandra
Practical 2	Write the programs for the following:
Practical 3	Text Delimited CSV to HORUS format
Practical 4	XML to HORUS format
Practical 5	JSON to HORUS format
Practical 6	Picture(JPEG) to HORUS format
Practical 7	Data Binning or Bucketing
Practical 8	Averaging of data
Practical 9	Outlier Detection
Practical 10	Perform following data processing using R
Practical 11	Program retrieve different attributes of data
Practical 12	Data pattern
Practical 13	Loading IP_DATA_ALL
Practical 14	Perform error management on the given data using pandas package
Practical 15	Write a python/R program to build acyclic graph
Practical 16	Design a simple linear neural network model.
Practical 17	Calculate the output of neural net using both binary and bipolar sigmoidal function.
Practical 18	Generate AND/NOT function using McCulloch-Pitts neural net.
Practical 19	Generate XOR function using McCulloch-Pitts neural net.
Practical 20	Write a program to implement Hebb's rule.
Practical 21	Write a program to implement of delta rule.
Practical 22	Write a program for Back Propagation Algorithm
Practical 23	Write a program for error Backpropagation algorithm.
Practical 24	Write a program for Hopfield Network.
Practical 25	Write a program for Radial Basis function
Practical 26	Kohonen Self organizing map
Practical 27	Adaptive resonance theory
Practical 28	Write a program for Linear separation.
Practical 29	Write a program for Hopfield network model for associative memory
Practical 30	Membership and Identity Operators | in, not in, is, is not

Course Code 23BPIT1T04	Course Title **Elective I: Security Breaches and Countermeasures**	Credits 02	No. of lectures 30

CO1	Explain the concepts, objectives of foot printing, reconnaissance, enumeration, vulnerability assessment, system hacking, the functioning of commonly used security tools.	L5
CO2	Apply information-gathering and enumeration tools such as Recon-ng, Nmap, Whois, Wireshark, HTTrack, network scanners to collect, analyze system, network, domain-related information.	L3
CO3	Analyze security vulnerabilities and network weaknesses using tools like Nessus, OpenVAS, and Wireshark, and interpret scan results to assess risk levels and potential attack vectors.	L4
CO4	Design and demonstrate controlled security testing scenarios, password cracking, MAC spoofing, steganography, log clearing and prepare structured security assessment reports	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	2
CO2	3	3	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

Unit I	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 [CO1, CO2]
Unit II	Perform Enumeration using the following tools: Nmap, NetBIOS Enumeration Tool, SuperScan Software, Hyena, SoftPerfect Network Scanner Tool, OpUtils, SolarWinds Engineer's Toolset, Wireshark 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 [CO2, CO3, CO4]

Course Code 23BPIT1P02	Course Title Elective I: Practicals based on 23BPIT1T04	Credits 02	No. of lectures 60

CO1	Apply network foot printing and reconnaissance techniques using Reconfiguring tools, FOCA, Windows Command Line Utilities, Advanced IP Scanner to gather network information.	L3
CO2	Analyze network traffic, open ports, running services, and data flow using tools like CurrPorts, Colasoft Packet Builder, The Dude, Proxy Workbench, Wireshark to identify network behavior	L4
CO3	Evaluate network topology and infrastructure by performing network discovery using SolarWinds Network Topology Mapper and LANState Pro to assess connectivity, performance	L5
CO4	Apply and Analyze information hiding and data protection techniques by performing steganography operations using S-Tools to understand secure data transmission methods.	L3

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	3
CO2	3	2	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	2	3

Practical 1	Use of Reconfiguring, FOCA, Windows Command Line Utilities tools to perform foot printing and reconnaissance
Practical 2	Scan the network using Advanced IP Scanner
Practical 3	Scan the network using CurrPorts
Practical 4	Scan the network using Colasoft Packet Builder
Practical 5	Scan the network using the Dude
Practical 6	Use Proxy Workbench to see the data passing through it and save the data to file
Practical 7	Perform Network Discovery using Solar Wind Network Topology Mapper
Practical 8	LANState Pro
Practical 9	Perform network discovery using Wireshark
Practical 10	Perform stegnography operations using S Tools

Course Code	Course Title	Credits	No. of lectures
23BPIT1T05	**Elective II: Data Center Virtualization**	**02**	**30**

CO1	Understand the evolution, concepts, and definitions of virtualization, including server, network, and storage virtualization and their roles in modern data center architectures.	L2
CO2	Analyze virtualization and network technologies such as virtual contexts, virtual device contexts, and virtualized chassis concepts to configure and manage virtualized server, storage, and network environments.	L4
CO3	Analyze and evaluate virtual data center architectures, including SAN virtualization, end-to-end virtualization, and fabric-based networking, in terms of scalability, performance, and resource optimization.	L4
CO4	Design a virtual data center or cloud computing environment by integrating server, storage, and network virtualization technologies to support flexible, scalable, and resilient enterprise computing needs.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	2
CO2	3	3	3	1	3	3
CO3	3	3	3	2	2	3
CO4	3	3	3	2	3	3

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
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

References:

1. Data Center Virtualization Fundamentals, Gustavo Alessandro Andrade Santana, Cisco Press, 1st 2014

Course Code	Course Title	Credits	No. of lectures
23BPIT1P03	**Elective II: Practicals based on 23BPIT1T05**	**02**	**60**

CO1	Apply server virtualization technologies by implementing and configuring VMware ESXi, XEN, and Hyper-V environments for effective resource utilization.	L3
CO2	Analyze and manage virtualized infrastructures using tools such as vCenter Server and Xen Center, and evaluate blade server architectures using Cisco UCS/HP EVA simulators.	L4
CO3	Analyze system reliability and availability by implementing Windows Server 2012, configuring failover clustering, and assessing fault-tolerance mechanisms.	L4
CO4	Evaluate and implement distributed computing solutions by developing web services and applying RMI, RPC, and socket programming for efficient network-based communication.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	-	1	3
CO2	3	2	2	-	1	3
CO3	3	2	1	-	1	3
CO4	3	2	2	-	2	3

Practical 1	Implement vmware ESXi,for server virtualization
Practical 2	Implement XEN for server virtualization
Practical 3	Implement Hyper-V server virtualization using Windows Server 2k12
Practical 4	Manage vmware ESXi with vCentre server
Practical 5	Manage Xen server Xen center
Practical 6	Understanding blade server with cisco UCS/HP eva simulator
Practical 7	Installation of Windows Server 2k12
Practical 8	Implement Failover cluster using Windows Server 2k12
Practical 9	Show the implementation of web services
Practical 10	Implementation of RMI, RPC and Socket Programming

Course Code	Course Title	Credits	No. of lectures
23BPIT1T06	**Elective III: Image Processing**	**02**	**30**

CO1	Understand the fundamental concepts of digital image processing, including image acquisition, sampling and quantization, human visual perception, pixel relationships, and mathematical tools used in image processing systems	L2
CO2	Apply intensity transformation, histogram processing, spatial filtering, and frequency-domain techniques to enhance and restore digital images, including noise reduction and fuzzy-based enhancement methods.	L3
CO3	Analyze and evaluate image restoration, color image processing, and compression techniques, including Wiener filtering, color models, segmentation, and coding methods, based on performance, quality, and application requirements.	L4
CO4	Design and implement advanced image processing solutions using morphological operations, image reconstruction, compression, and digital watermarking techniques for real-world image analysis applications.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	2	2
CO2	3	3	3	1	3	3
CO3	3	3	3	1	2	3
CO4	3	3	3	2	3	3

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 [CO1, CO2]
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 [CO3, CO4]

Course Code	Course Title	Credits	No. of lectures
23BPIT1P04	**Practicals based on 23BPIT1T06**	**02**	**60**

CO1	Apply Python programming techniques to analyze the effects of quantization and spatial resolution on digital images.	L3
CO2	Analyze and implement image enhancement techniques such as thresholding, contrast adjustment, brightness adjustment, and gray-level slicing to improve image quality.	L4
CO3	Analyze the impact of intensity transformation methods including log transformation, power-law transformation, and image negation on visual interpretation of images.	L4
CO4	Evaluate image characteristics using masking operations and histogram analysis to assess image enhancement and transformation results.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	1	2
CO2	3	2	2	1	1	2
CO3	3	2	2	1	1	2
CO4	3	3	2	1	2	3

Practical 1	Write a Python program to study effects of reducing quantization values & spatial resolution
Practical 2	Write a Python program for Image enhancement: Thresholding
Practical 3	Write a Python program for Image enhancement: Contrast adjustment
Practical 4	Write a Python program for Image enhancement: Brightness adjustment
Practical 5	Write a Python program for Image enhancement: Gray level slicing
Practical 6	Write a program to demonstrate Log Transformation
Practical 7	Write a program to demonstrate Power Law Transformation
Practical 8	Write a program to demonstrate Negation
Practical 9	Write a program to apply a mask on the image
Practical 10	Write a program to plot a Histogram

Course Code	Course Title	Credits	No. of lectures
23BPRM1T04	**Research Methodology in I.T.**	04	60

CO1	Explain the role and importance of business research, information systems, knowledge management, theory building, and ethical considerations in organizational decision-making.	L5
CO2	Apply research methods and data collection techniques such as qualitative tools, surveys, observation, and experimental research to define research problems and collect relevant primary and secondary data.	L3
CO3	Analyze and evaluate research data using univariate, bivariate, and multivariate statistical techniques, and assess differences and relationships between variables for informed business decisions.	L4
CO4	Design and present a complete business research study, including questionnaire design, sampling plan, data analysis, interpretation of results, and ethical reporting of findings.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	2	2
CO2	3	3	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

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 [CO1, CO2]
Unit II	**Research Methods and Data Collection:** Survey research, communicating with respondents, Observation methods, Experimental research	15 [CO1, CO3]
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 [CO2, CO3]
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 [CO3, CO4]

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				

Semester II

SEMESTER II

Course Code	Course Title	No. of Lectures	Credits
MANDATORY PAPERS			
23BPIT2T01	Big Data Analytics	60	4
23BPIT2T02	Micro services Architecture	60	4
23BPIT2T03	Modern Networking	60	4
23BPIT2P01	Practicals Based on 23BPIT2T01 and 23BPIT2T03	60	2
Electives			
23BPIT2T04	Embedded Systems	30	2
23BPIT2P02	Practicals Based on 23BPIT2T04	60	2
OR			
23BPIT2T05	Computer Vision	30	2
23BPIT2P03	Practicals Based on 23BPIT2T05	60	2
23BPIT2P04	On Job Training / Research Project in I.T.	120	4
Total Credits			**22**
Total Semester I & Semester II Credits			**44**

Course Code	Course Title	Credits	No. of lectures
23BPIT2T01	**Big Data Analytics**	**04**	**60**

CO1	Understand the concepts of Big Data and analytics, characteristics, evolution, challenges, Big Data ecosystems, data analytics life cycle, and differences between traditional BI and Big Data analytics.	L2
CO2	Apply Big Data technologies and frameworks such as Hadoop, HDFS, MapReduce and Python-based APIs to ingest, process, and analyze large-scale structured and unstructured datasets	L3
CO3	Analyze analytical methods and machine learning models including clustering, association rules, regression, classification, time series analysis	L4
CO4	Develop scalable data products and analytics pipelines by integrating Big Data processing distributed computing patterns, advanced analytics to support real-world applications.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	2
CO2	3	3	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

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** **[CO1, CO2]**
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** **[CO2, CO3]**
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** **[CO2, CO4]**

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** **[CO3, CO4]**

References:

1. Big Data and Analytics by Subhashini Chellappan Seema Acharya Wiley First
2. Data Analytics with Hadoop An Introduction for Data Scientists by Benjamin Bengfort and Jenny Kim O'Reilly 2016
3. Big Data and Hadoop by V.K Jain Khanna Publishing First 2018

Course Code	Course Title	Credits	No. of lectures
23BPIT2T02	**Microservices Architecture**	**04**	**60**

CO1	Apply microservices principles and design approaches to decompose a monolithic application into goal-oriented, layered microservices aligned with business value.	L3
CO2	Analyze microservices system designs by examining service boundaries, API design, data management strategies, communication patterns (synchronous/asynchronous), and dependency management in distributed environments.	L4
CO3	Evaluate microservices architectures and operational strategies with respect to scalability, independent deployability, fault tolerance, service discovery, API gateways, monitoring, and containerization using Docker.	L5
CO4	Design and develop complete microservices-based solution architecture, incorporating organizational, cultural, tooling, and process considerations to successfully adopt microservices in real-world enterprise systems.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	3
CO2	3	3	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	2	3	3

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 [CO1, CO2]**
Unit II	• **Designing Microservice Systems:** The Systems Approach to Microservices, A Microservices Design Process, Establishing a Foundation**:** Goals and Principles, Platforms, Culture	**15 [CO1, CO2]**
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 [CO1, CO3]**
Unit IV	• **Adopting Microservices in Practice:** Solution Architecture Guidance, Organizational Guidance, Culture Guidance, Tools and Process Guidance, Services Guidance.	**15 [CO3, CO4]**

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 Code	Course Title	Credits	No. of lectures
23BPIT2T03	**Modern Networking**	**04**	**60**

CO1	Analyze modern network architectures and traffic characteristics by examining Ethernet, Wi-Fi, cellular (4G/5G), cloud, IoT, SDN, and NFV environments, including routing behavior, congestion mechanisms, and traffic demands.	L4
CO2	Analyze SDN and NFV architectures by interpreting data plane, control plane, and application plane interactions, OpenFlow operations, virtualization mechanisms, and orchestration workflows in software-defined infrastructures.	L4
CO3	Evaluate network performance, scalability, and service quality using QoS and QoE frameworks, including DiffServ, queuing disciplines, traffic engineering policies, and QoS/QoE mapping models for multimedia and real-time services.	L5
CO4	Design a scalable, software-defined network solution integrating SDN, NFV, network virtualization, and QoE-aware management strategies to support cloud, big data, mobility, and real-time applications.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	3
CO2	3	3	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

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 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 Traffic Big 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 [CO1, CO2]
Unit II	Software-Defined Networks SDN: Background and Motivation, Evolving Network Requirements Demand Is Increasing, Supply Is Increasing Traffic Patterns Are More Complex Traditional Network Architectures are Inadequate, The SDN Approach Requirements SDN Architecture Characteristics of Software-Defined Networking, SDN- and NFV-Related Standards Standards-Developing Organizations Industry Consortia Open Development Initiatives, 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 Open Flow Protocol, SDN Control Plane SDN Control Plane Architecture Control Plane Functions, Southbound Interface Northbound Interface Routing, ITU-T Model, Open Day light Open Day light	15 [CO1, CO3]

	Architecture Open Daylight Helium, RESTREST Constraints Example REST API, Cooperation and Coordination Among Controllers, Centralized Versus Distributed Controllers, High-Availability Clusters Federated SDN Networks, Border Gateway Protocol Routing and QoS Between Domains, Using BGP for QoS Management IETF SDNi Open Daylight SNDiSDN 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 Open Daylight DDoS Application Data Center Networking, Big Data over SDN Cloud Networking over SDN Mobility and Wireless Information-Centric Networking CCNx, Use of an Abstraction Layer	
Unit 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, Compute Domain, Hypervisor Domain, Infrastructure Network Domain, Virtualized Network Functions, VNF Interfaces, VNFC to VNFC Communication, VNF Scaling, NFV Management and Orchestration, Virtualized Infrastructure Manager, Virtual Network Function Manager, NFV Orchestrator, Repositories, Element Management, OSS/BSS, NFV Use Cases Architectural Use Cases, Service-Oriented Use Cases, SDN and NFV 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 [CO2, CO3, CO4]
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 QoE Network Design Implications of QoS and QoE Classification 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-	15 CO2, CO3, CO4]

	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	

References:

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
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 Code	Course Title	Credits	No. of lectures
23BPIT2P01	**Practicals Based on 23BPIT2T01 and 23BPIT2T03**	**02**	**60**

CO1	Apply Big Data frameworks and tools such as Hadoop, HDFS, MapReduce, Hive, Pig, and Jaql to store, process, and analyze large-scale datasets efficiently.	L3
CO2	Analyze real-world datasets using machine learning techniques including decision trees, SVM, regression models, and clustering algorithms to identify patterns, relationships, and trends.	L4
CO3	Evaluate the performance and suitability of classification, regression, and clustering models by applying statistical measures, visualization techniques, and model-fitness testing using R/Python.	L5
CO4	Design and implement integrated data analytics and networking solutions by configuring advanced network technologies such as BGP, MPLS, VRF, SDN controllers, and network emulators to support scalable and intelligent data-driven systems.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	3
CO2	3	3	2	1	3	3
CO3	2	3	2	1	3	3
CO4	3	2	3	1	3	3

Practical 1	Install, configure and run Hadoop and HDFS ad explore HDFS.
Practical 2	Implement word count / frequency programs using MapReduce
Practical 3	Implement an MapReduce program that processes a weather dataset.
Practical 4	Implement an application that stores big data in Hbase / MongoDB & manipulate it using R/Python
Practical 5	Implement the program in practical 4 using Pig.
Practical 6	Configure the Hive and implement the application in Hive.
Practical 7	Write a program to illustrate the working of Jaql.
Practical 8	Implement Decision tree classification techniques
Practical 9	Implement SVM classification techniques
Practical 10	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).
Practical 11	MULTIPLE REGRESSION MODEL Apply multiple regressions, if data have a continuous independent variable. Apply on above dataset.
Practical 12	CLASSIFICATION MODEL a. Install relevant package for classification. b. Choose classifier for classification problem. c. Evaluate the performance of classifier.
Practical 13	CLUSTERING MODEL a. Clustering algorithms for unsupervised classification. b.Plot the cluster data using R visualizations.
Practical 14	Configure IP SLA Tracking and Path ControlTopology
Practical 15	Using the AS_PATH Attribute
Practical 16	Configuring IBGP and EBGP Sessions, Local Preference, and MED
Practical 17	Secure the Management Plane
Practical 18	Configure and Verify Path Control Using PBR
Practical 19	IP Service Level Agreements and Remote SPAN in a Campus Environment
Practical 20	Inter-VLAN Routing
Practical 21	Simulating MPLS environment and Simulating VRF
Practical 22	Simulating SDN with OpenDaylight SDN Controller with the Mininet Network Emulator
Practical 23	Simulating SDN with OFNet SDN network emulator

Course Code 23BPIT2T04	Course Title **Elective I: Embedded Systems**	Credits 02	No. of lectures 30

CO1	Explain the fundamental concepts of embedded systems, including system components, quality attributes, and differences between embedded systems and general-purpose computing systems.	L2
CO2	Apply the Embedded Development Life Cycle (EDLC) and hardware–software co-design principles to model embedded systems using UML and make informed hardware–software trade-off decisions.	L3
CO3	Evaluate embedded hardware and firmware design choices, including component selection, PCB design considerations, firmware development approaches, and RTOS selection	L5
CO4	Design and develop a complete embedded system solution, integrating hardware, firmware, device drivers, and an appropriate RTOS to meet specified functional and real-time requirements.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	2	2
CO2	3	3	3	1	3	3
CO3	3	3	3	1	2	3
CO4	3	3	3	2	3	3

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** **[CO1, CO2, CO3]**
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 **[CO3, CO4]**

References: 1. Introduction to embedded systems by Shibu K. V Tata McGraw-Hill 2nd
2. Embedded Systems Architecture, Programming and Design by Raj Kamal, Tata McGraw-Hill 2nd
3. Embedded Systems: A Contemporary Design Tool, James K. Peckol, Wiley Edition, 1st Edition

Course Code 23BPIT2P02	Course Title **Practical Based on 23BPIT2T04**	Credits 02	No. of lectures 30

CO1	Explain the functions and operating principles of 8051 microcontroller hardware components, including resistors, capacitors, diodes, transistors, operational amplifiers, crystal oscillators, relays, sensors, and actuators.	L2
CO2	Apply 8051 assembly programming concepts using the EdSim simulator to implement basic programs such as LED blinking, LED pattern generation, and data block transfer operations.	L3
CO3	Analyze serial communication and display interfacing techniques by developing and testing 8051 programs for serial data transmission and reception, seven-segment display control, and keypad scanning.	L4
CO4	Analyze real-time control and interfacing applications by designing 8051-based programs for ADC-to-DAC conversion and motor control using simulation tools.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	-	-	1
CO2	3	2	2	-	1	3
CO3	3	2	2	-	1	3
CO4	3	2	2	1	1	3

Practical 1	Study of hardware components 8051 Microcontroller, Resistors (color code, types), Capacitors, Operational Amplifiers, Transistors, Diode, Crystal Oscillator, Types of Relays, Sensors, Actuator
Practical 2	Write an 8051 program using Edsim simulator to blink an LED
Practical 3	Write an 8051 program using Edsim simulator block transfer of data
Practical 4	Write an 8051 program using Edsim simulator serial receive
Practical 5	Write an 8051 program using Edsim simulator serial transmit
Practical 6	Write an 8051 program using Edsim simulator for LED patterns
Practical 7	Write an 8051 program using Edsim simulator for 7 segment display
Practical 8	Write an 8051 program using Edsim simulator for ADC to DAC conversion
Practical 9	Write an 8051 program using Edsim simulator to scan keypad
Practical 10	Write an 8051 program using Edsim simulator to rotate motor

Course Code 23BPIT2T05	Course Title **Elective II: Computer Vision**	Credits 02	No. of lectures

CO1	Analyze image formation models and vision primitives by examining geometric and photometric transformations, point and neighborhood operators, filtering techniques, Fourier transforms, pyramids, and wavelet representations.	L4
CO2	Evaluate feature extraction and segmentation techniques such as edge detection, line detection, active contours, region-based methods, mean shift, normalized cuts, and graph-cut–based energy optimization methods for different vision tasks.	L5
CO3	Design and implement a computer vision solution that integrates geometric transformations, feature detection, and global optimization techniques to solve real-world image analysis problems.	L6
CO4	Develop a complete vision pipeline combining preprocessing, feature extraction, segmentation, and optimization techniques, and justify design choices based on performance and application constraints.	L6

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1	2	3
CO2	3	3	3	1	2	3
CO3	3	3	3	1	3	3
CO4	3	3	3	1	3	3

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 [CO1-CO2]
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 [CO3, CO4]

References:

1. Computer Vision: Algorithms and Applications by Richard Szeliski, Springer, 1st edition, 2010

Course Code	Course Title	Credits	No. of lectures
23BPIT2P03	**Practical Based on 23BPIT2T05**	**02**	

CO1	Recall and explain fundamental image processing concepts, including image representation, image formats, color space conversion, and basic image operations such as reading, writing, and complementing images using Python/MATLAB/OpenCV.	L1
CO2	Apply image enhancement and filtering techniques such as contrast adjustment, histogram processing and equalization, low-pass and high-pass filtering, and Fourier transform–based filtering to improve image quality.	L3
CO3	Analyze images using advanced feature extraction and motion analysis techniques, including SIFT, HOG, image segmentation, and optical flow computation, to interpret structural and motion-based information in images.	L4
CO4	Evaluate and implement object detection, recognition, and classification systems (character, digit, or face recognition) using suitable image processing and machine learning techniques on real-world image datasets.	L5

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	-	-	1
CO2	3	2	3	-	1	2
CO3	3	3	2	-	1	2
CO4	3	3	3	-	2	3

Practical 1	Implementing various basic image processing operations in python/matlab/open-CV: Reading image, writing image, conversion of images, and complement of an image
Practical 2	Implement contrast adjustment of an image. Implement Histogram processing and equalization.
Practical 3	Implement the various low pass and high pass filtering mechanisms.
Practical 4	Use of Fourier transform for filtering the image.
Practical 5	Utilization of SIFT and HOG features for image analysis.
Practical 6	Performing/Implementing image segmentation
Practical 7	Implement optical flow computation algorithm.
Practical 8	Demonstrate the use of optical flow in any image processing application
Practical 9	Object detection and Recognition on available online image datasets
Practical 10	Character or digit or face classification project

Course Code	Course Title	Credits	No. of hours
23BPIT2P04	**ON-JOB TRAINING / FIELD PROJECT (FP) in Data Science**	**04**	**120**

CO1	Apply theoretical knowledge in real workplace situations	
CO2	Demonstrate professional workplace skills and ethics	
CO3	Use industry tools, technologies, and procedures competently	
CO4	Evaluate work performance and identify areas for improvement	

Grading will be as 3: High(>60%), 2: Moderate(40%-60%), 1: Low(<40%), 0: No mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	3	3
CO2	2	1	2	2	3	3
CO3	3	2	3	1	2	3
CO4	2	3	2	1	3	3

General Guidelines:

- The OJT/FP topic may be undertaken from any topic relevant to course
- Each of the learners must undertake an OJT/FP individually based on field-work/field-survey/laboratory work.
- Learners must remain presented at the time of review meeting scheduled by research guide.
- Structure of report should contain the following chapter: Title; Abstract; Aim, Objectives, and Rationale; Introduction and Review of Literature; Materials and Methodology; Observation and Result; Discussion and Conclusion; References.
- Learners should prepare a PowerPoint presentation (PPT) of research project and it should be presented in front of external examiner.
- Duly signed hard copy of report and PPT should be submitted to the Department
- In case of OJT, detail report of attendance, record and acknowledgement /certificate issued from the organization to be submitted in college.

Evaluation and Examination Scheme

Evaluation Scheme 60:40
Internals Based on Unit 1 / Unit 2 / Unit 3/ Unit 4

Assignments/ Tutorials/Class Test	Seminar or any other activities	Active Participation & Leadership qualities	Total
30	05	05	40

Theory Examinations: For Paper 1, Paper 2, Paper 3and Elective

Suggested Format for Mandatory Question paper

Duration: 2 hr. 30 min **Total Marks: 60**

N.B.

1. **All questions are compulsory**
2. **Draw neat labeled diagram wherever necessary**
3. **All questions carry equal marks**

Q.1.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.1.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
Q.2.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.2.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
Q.3.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.3.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
Q.4.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.4.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
			**********	

Suggested Format for Elective Question paper:

23BPEV_T0_/0_/20_

Duration: 1 hr. 30 min **Total Marks: 30**

N.B.

1. **All questions are compulsory**
2. **Draw neat labeled diagram wherever necessary**
3. **All questions carry equal marks**

Q.1.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.1.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		
Q.2.	**(A)**		**Attempt any one**	**8**
		(I)		
		(II)		
Q.2.	**(B)**		**Attempt any one**	**7**
		(I)		
		(II)		

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Semester End Practical Examination:

Practical examination of each paper for 50 marks will be held for 4 hours.

Marks Distribution and Passing Criterion for Each Semester

Semester - I

Theory						Practical		
Course Code	**Internal**	**Min marks for passing**	**Theory Examination**	**Min marks for passing**	**Total**	**Course Code**	**Practical Examination**	**Min marks for passing**
23BPIT1T01	40	16	60	24	100	23BPIT1P01	**50**	**20**
23BPIT1T02	40	16	60	24	100			
23BPIT1T03	40	16	60	24	100			
E-I 23BPIT1T04	40	16	60	24	100	23BPIT1P02	**50**	**20**
E-II 23BPIT1T05	40	16	60	24	100	23BPIT1P03	**50**	**20**
E-III 23BPIT1T06	40	16	60	24	100	23BPIT1P04	**50**	**20**
23BPRM1T04	40	16	60	24	100			

Semester - II

Theory						Practical		
Course Code	**Internal**	**Min marks for passing**	**Theory Examination**	**Min marks for passing**	**Total**	**Course Code**	**Practical Examination**	**Min marks for passing**
23BPIT2T01	40	16	60	24	100	23BPIT2P01	**50**	**20**
23BPIT2T02	40	16	60	24	100			
23BPIT2T03	40	16	60	24	100			
E-I 23BPIT2T04	40	16	60	24	100	23BPIT2P02	**50**	**20**
E-II 23BPIT2T05	40	16	60	24	100	23BPIT2P03	**50**	**20**
ON-JOB TRAINING/RESEARCH PROJECT IN I.T.						23BPIT2P04	**50**	**20**

VPM's B. N. Bandodkar College of Science (Autonomous), Thane
Curriculum Structure for the Post Graduate Degree Programme M.Sc. Information Technology

	SEMESTER–I	**Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)**			**Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)**			
Course Code	**Mandatory Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BPIT1T01	Data Science	✓	✓	✓	-	-	-	-
23BPIT1T02	Cloud Computing	✓	✓	✓	-	-	-	-
23BPIT1T03	Soft Computing Techniques	✓	✓	✓	-	-	-	-
23BPIT1P01	Practicals Based on 23BPIT1T01 and 23BPIT1T03	✓	✓	✓	-	-	-	-
	Elective Course Title							
23BPIT1T04	Security Breaches and Countermeasures	✓	✓	✓	-	-	-	-
23BPIT1P02	Practicals Based on 23BPIT1T04	✓	✓	✓	-	-	-	-
	OR							
23BPIT1T05	Data Center Virtualization	✓	✓	✓	-	-	-	-
23BPIT1P03	Practicals Based on 23BPIT1T05	✓	✓	✓	-	-	-	-
	OR							
23BPIT1T06	Image Processing	✓	✓	✓	-	-	-	-
23BPIT1P04	Practicals Based on 23BPIT1T06	✓	✓	✓	-	-	-	-
	Research Methodology							
23BPRM1T04	Research Methodology for IT	✓	✓	✓	✓	✓	-	-

	SEMESTER–II	Course imparts Employability (EM), Entrepreneurship (EN), Skill Development (SD)			Course integrates with Professional Ethics (PE), Gender Equity (GE), Human Value (HV), Environmental Sustainability (ES)			
Course Code	**Mandatory Course Title**	**EM**	**EN**	**SD**	**PE**	**GE**	**HV**	**ES**
23BPIT2T01	Big Data Analytics	✓	✓	✓	-	-	-	-
23BPIT2T02	Micro services Architecture	✓	✓	✓	-	-	-	-
23BPIT2T03	Modern Networking	✓	✓	✓	-	-	-	-
23BPIT2P01	Practicals Based on 23BPIT2T01 and 23BPIT2T03				-	-	-	-
	Elective Course Title							
23BPIT2T04	Embedded Systems	✓	✓	✓	-	-	-	-
23BPIT2P02	Practicals Based on 23BPIT2T05	✓	✓	✓	-	-	-	-
	OR							
23BPIT2T05	Computer Vision	✓	✓	✓	-	-	-	-
23BPIT2P03	Practicals Based on 23BPIT2T06	✓	✓	✓	-	-	-	-
	Internship / On Job Training / Field Project							
23BPIT2P04	On Job Training / Research Project in I.T.	✓	✓	✓	✓	--	✓	✓

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