Academic Council Meeting No. and Date: 9 / July 02, 2024

Agenda Number: 3 Resolution Number: 41, 42 / 3.13 & 3.33

Syllabus for

Programme Code : BPIT

Programme: Master of Science

Specific Programme: Information Technology

[M.Sc.(Semester III and IV)]

Level 6.5

CHOICE BASED GRADING SYSTEM

Revised under NEP 2020

From academic year 2024-25

Year (2 Yrs)	LEVEL	SEMESTER	Major				Research Methodo-logy	On Job Training / Field project	Research project	Cum Credits	Degrees
			Mandatory		Electives anyone						
I	6.0	SEM-I	**3*4 + 2 = 14**		Credits 4						
			Course 1	Credits 4	Course 1= Credits 4		Credits 4	NA	NA	22	PG Diploma 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-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**	

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

Mr. 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)

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

(To be implemented from the academic year 2024-2025)
SEMESTER III and SEMESTER IV

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. / ~~U.G.~~ / ~~Diploma~~ / ~~Certificate~~ (Strike out which is not applicable)
7.	Pattern	~~Yearly~~ / Semester Choice Based under NEP 2020 (Strike out which is not applicable)
8.	Status	New under NEP 2020/ ~~Revised~~
9.	To be implemented from Academic year	**2024 – 2025**

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

<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="11">2</td><td rowspan="11">6.5</td><td rowspan="6">Sem III</td><td colspan="2">3*4+1*2</td><td>4</td><td>4</td><td rowspan="6">-</td><td rowspan="6">-</td><td rowspan="6">4</td><td rowspan="6">22</td><td rowspan="16">PG Degree after 3-yr UG or PG Degree after 4-yr UG</td></tr>
<tr><td>Advanced Artificial Intelligence</td><td>TH</td><td>4</td><td rowspan="5">Natural Language Processing
(OR)
Cloud Application Development</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>Advanced Artificial Intelligence Practical</td></tr>
<tr><td rowspan="5">Sem IV</td><td colspan="2">3*4</td><td>4</td><td>4</td><td rowspan="5">-</td><td rowspan="5">-</td><td rowspan="5">6</td><td rowspan="5">22</td></tr>
<tr><td>Blockchain</td><td>TH</td><td>4</td><td rowspan="4">Computer Forensics
(OR)
Advanced IoT</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>Deep Learning Practical</td></tr>
<tr><td colspan="3">Cum. Cr. For 1 Yr PG Degree</td><td colspan="3">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="3">54</td><td>16</td><td>4</td><td>4</td><td>10</td><td>88</td></tr>
</table>

SEMESTER III

VPM's B. N. Bandodkar College of Science (Autonomous), Thane
M.Sc. Information Technology
Structure of Programme

SEMESTER III

Course Code	Course Title	No. of Lectures	Credits
MANDATORY PAPERS			
24BPIT3T01	Advanced Artificial Intelligence	60	4
24BPIT3T02	Storage as a Service	60	4
24BPIT3T03	Machine Learning	60	4
24BPIT3P01	Practical Based on 24BPIT3T01 and 24BPIT3T03	60	2
ELECTIVE PAPERS			
24BPIT3T04	Natural Language Processing	30	2
24BPIT3P02	Practicals Based on 24BPDS3T04	60	2
OR			
24BPIT3T05	Cloud Application Development	30	2
24BPIT3P03	Practicals Based on 24BPDS3T05	60	2
RESEARCH PROJECT (RP)			
24BPIT3RP7	Research Project in I.T. - I	120	4
	Total Credits		22

Course Code	Course Title	Credits	No. of lectures
24BPIT3T01	**Advanced Artificial Intelligence**	**04**	**60**

CO1	Apply problem-solving techniques using intelligent agents, search algorithms, and basic knowledge representation methods to solve well-defined AI problems.	L3
CO2	Analyze advanced AI models such as deep learning, neural networks, reinforcement learning, and natural language processing to understand their working principles and domain-specific applications.	L4
CO3	Evaluate the effectiveness of cutting-edge AI techniques including artificial neural networks, evolutionary computation, swarm intelligence, and optimization algorithms for real-world problem domains.	L5
CO4	Design intelligent AI-based systems by integrating intelligent agents, advanced knowledge representation techniques, and natural language processing components to address complex 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	3
CO2	3	3	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

Unit I	**Foundations of Artificial Intelligence and Expert Systems** Introduction to Artificial IntelligenceIntelligent Agents, Problem-solving using search algorithms, Knowledge Representation	15 [CO1, CO2]
Unit II	**Advanced Artificial Intelligence:** Introduction to advanced AI concepts, Deep learning and neural networks, Natural language processing and understanding, Reinforcement learning, AI applications in various domains such as healthcare, finance, and robotics	15 [CO1, CO3]
Unit III	**Cutting-edge Techniques in AI: Artificial Neural Networks:** Artificial Neural Networks, Single-Layer feedforward networks, multi-layer feed-forward networks, radial basis function networks, design issues of artificial neural networks and recurrent networks **Evolutionary Computation:** Soft computing, genetic algorithms, genetic programming concepts, evolutionary programming, swarm intelligence, ant colony paradigm, particle swarm optimization, evolutionary algorithms.	15 [CO2, CO3]
Unit IV	**Exploring Intelligent Agents, Knowledge Representation, and Natural Language Processing in Advanced AI Systems** a. **Intelligent Agents:** Agents vs software programs, classification of agents, working of an agent, single agent and multiagent systems, performance evaluation, architecture, agent communication language, applications b. **Advanced Knowledge Representation Techniques:**Conceptual dependency theory, script structures, CYC theory, script structure, CYC theory, case grammars, semantic web. c. **Natural Language Processing:**Sentence Analysis phases, grammars and parsers, types of parsers, semantic analysis, universal networking language, dictionary	15 [CO2, CO3, CO4]

References: 1. Deep Learning Ian Goodfellow, Yoshua Bengio, and Aaron Courville MIT Pres 2020
2. Artificial Intelligence: A Modern Approach Stuart Russell and Peter Norvig Prentice Hall 2020
3. Reinforcement Learning: An Introduction Richard S. Sutton and Andrew G. Barto MIT Press 2023
4. Python Machine Learning Sebastian Raschka and Vahid Mirjalili Packt Publication 2021
5. Artificial Intelligence Saroj Kaushik, Cengage Cngage Publication 2019

Course Code	Course Title	Credits	No. of lectures
24BPIT3T02	Storage as a Service	04	60

CO1	Recall fundamental concepts of information storage, data center infrastructure, storage architectures, disk and flash technologies, RAID levels, and storage networking components	L1
CO2	Explain the working principles of intelligent storage systems, SAN, NAS, IP-SAN, object-based storage, virtualization, cloud computing models, and business continuity concepts.	L2
CO3	Analyze storage system performance, availability, and reliability by examining RAID configurations, storage provisioning methods, replication techniques, backup strategies, and SAN/NAS architectures.	L4
CO4	Evaluate storage infrastructure solutions with respect to security, scalability, performance, business continuity, and cloud integration to recommend suitable storage strategies for enterprise environments.	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	3	1	2	2
CO2	3	3	3	1	2	3
CO3	3	3	3	1	3	3
CO4	3	3	3	2	3	3

Unit I	**Foundations of Information Storage** Introduction to Information Storage, Information Storage Data Types of Data Big Data, Information Storage Evolution of Storage Architecture, Data Center Infrastructure Core Elements of a Data Center Key Characteristics of a Data Center Managing a Data Center Virtualization and Cloud Computing, Data Center Environment Application Database Management System (DBMS), Host (Compute) Operating System Memory Virtualization Device Driver 20, Volume Manager File System Compute Virtualization, Connectivity Physical Components of Connectivity, Interface Protocols IDE/ATA and Serial ATA 28, SCSI and Serial SCSI Fiber Channel, Internet Protocol (IP) Storage, Disk Drive Components Platter Spindle Read/Write Head Actuator Arm Assembly Drive Controller Board Physical Disk Structure Zoned Bit Recording Logical Block Addressing Disk Drive Performance Disk Service Time Seek Time Rotational Latency Data Transfer Rate Disk I/O Controller Utilization Host Access to Data Direct-Attached Storage DAS Benefit and Limitations Storage Design Based on Application Requirements and Disk Performance Disk Native Command Queuing Introduction to Flash Drives Components and Architecture of Flash Drives Features of Enterprise Flash Drives Concept in Practice: VMware ESXi Data Protection: RAID, RAID Implementation Methods Software RAID Hardware RAID Array Components RAID Techniques Striping Mirroring Parity RAID Levels RAID 0 RAID 1 Nested RAID RAID 3 RAID 4 RAID 5 RAID 6 RAID Impact on Disk Performance Application IOPS and RAID Configurations RAID Comparison Hot Spares	15 [CO1, CO2, CO3]
Unit II	**Understanding Intelligent Storage Systems and Fiber Channel Storage Area Networks** **Intelligent Storage Systems** Components of an Intelligent Storage System Front End Cache Structure of Cache Read Operation with Cache Write Operation with Cache Implementation Cache Management Cache Data Protection Back End Physical Disk Storage	15 [CO1, CO2, CO3]

	Provisioning Traditional Storage Provisioning LUN Expansion: MetaLUN Virtual Storage Provisioning 82 Comparison between Virtual and Traditional Storage Provisioning Use Cases for Thin and Traditional LUNs LUN Masking Types of Intelligent Storage Systems High-End Storage Systems Midrange Storage Systems **Fiber Channel Storage Area Networks** Fiber Channel: Overview The SAN and Its Evolution Components of FC SAN Node Ports Cables and Connectors Contents Interconnect Devices SAN Management Software FC Connectivity Point-to-Point Fiber Channel Arbitrated Loop Fiber Channel Switched Fabric FC-SW Transmission Switched Fabric Ports Fiber Channel Architecture Fiber Channel Protocol Stack FC-4 Layer FC-2 Layer FC-1 Layer FC-0 Layer Fiber Channel Addressing World Wide Names FC Frame 110. Structure and Organization of FC Data Flow Control BB_CreditEE_Credit Classes of Service Fabric Services Switched Fabric Login Types Zoning: Types of Zoning FC SAN Topologies Mesh Topology Core-Edge Fabric Benefits and Limitations of Core-Edge Fabric Virtualization in SAN Block-level Storage Virtualization Virtual SAN (VSAN) **IP SAN and FCoE**iSCSI Components of iSCSI Iscsi Host Connectivity iSCSI Topologies Native iSCSI Connectivity Bridged iSCSI Connectivity Combining FC and Native iSCSI Connectivity iSCSI Protocol Stack iSCSI PDU 6 iSCSI Discovery iSCSI Names iSCSI Session iSCSI Command Sequencing FCIP FCIP Protocol Stack FCIP Topology FCIP Performance and Security FCoE I/O Consolidation Using FCoE Components of an FCoE Network Converged Network Adapter Cables FCoE Switches FCoE Frame Structure FCoE Frame Mapping FCoE Enabling Technologies Priority-Based Flow Control (PFC) Enhanced Transmission Selection (ETS Congestion Notification (CN) Data Center Bridging Exchange Protocol (DCBX) **Network-Attached Storage** General-Purpose Servers versus NAS Devices Benefits of NAS File Systems and Network File Sharing Accessing a File System Network File Sharing Components of NAS NAS I/O Operation NAS Implementations Unifi ed NAS Unifi ed NAS Connectivity 164 Gateway NAS Gateway NAS Connectivity Scale-Out NAS Scale-Out NAS Connectivity NAS File-Sharing Protocols NFS CIFS Factors Affecting NAS Performance File-Level Virtualization Object-Based and Unified Storage Object-Based Storage Devices Object-Based Storage Architecture Components of OSD Object Storage and Retrieval in OSD Benefits of Object-Based Storage Common Use Cases for Object-Based Storage Content- Addressed Storage CAS Use Cases Healthcare Solution: Storing Patient Studies Finance Solution: Storing Financial Records Unified Storage Components of Unifi ed Storage Data Access from Unified Storage Introduction to Business Continuity Information Availability Causes of Information Unavailability Consequences of Downtime Measuring Information Availability BC Terminology BC Planning Life Cycle Failure Analysis Single Point of Failure Resolving Single Points of Failure Multipathing Software Business Impact Analysis BC Technology Solutions I/O Operation without PowerPath I/O Operation with PowerPath Automatic Path Failover Path Failure without PowerPath Path Failover with PowerPath: Active-Active Array Path Failover with PowerPath: Active-Passive Array Backup and Archive Backup Purpose Disaster Recovery Operational Recovery Archival Backup Considerations Backup Granularity Recovery Considerations Backup Methods 6 Backup Architecture Backup and Restore	

	Operations Backup Topologies Backup in NAS Environments Server-Based and Serverless Backup NDMP-Based Backup Backup Targets Backup to Tape Physical Tape Library Limitations of Tape 2 Backup to Disk Backup to Virtual Tape Virtual Tape Library Data Deduplication for Backup Data Deduplication Methods Data Deduplication Implementation Source-Based Data Deduplication Target-Based Data Deduplication Backup in Virtualized Environments Data Archive Archiving Solution Architecture Use Case: E-mail Archiving Use Case: File Archiving	
Unit III	**Exploring Network-Attached Storage (NAS) and Business Continuity** Local Replication Replication Terminology Uses of Local Replicas Replica Consistency Consistency of a Replicated File System Consistency of a Replicated Database Local Replication Technologies Host-Based Local Replication LVM-Based Replication Advantages of LVM-Based Replication Limitations of LVM-Based Replication File System Snapshot Storage Array-Based Local Replication Full-Volume Mirroring Pointer-Based, Full-Volume Replication Pointer-Based Virtual Replication Network-Based Local Replication Continuous Data Protection CDP Local Replication Operation Tracking Changes to Source and Replica Restore and Restart Considerations Creating Multiple Replicas Local Replication in a Virtualized Environment Remote Replication Modes of Remote Replication Remote Replication Technologies Host-Based Remote Replication LVM-Based Remote Replication Host-Based Log Shipping Storage Array-Based Remote Replication Synchronous Replication Mode Asynchronous Replication Mode Disk-Buffered Replication Mode Network-Based Remote Replication CDP Remote Replication Three-Site Replication Three-Site Replication-Cascade / Multihop Synchronous + Asynchronous Synchronous + Disk Buffered Three-Site Replication — Triangle/Multitarget Data Migration Solutions Remote Replication and Migration in aVirtualized Environment Cloud Computing Cloud Enabling Technologies Characteristics of Cloud Computing Benefits of Cloud Computing Cloud Service Models Infrastructure-as-a-Service Platform-as-a-Service Software-as-a-Service Cloud Deployment Models Public Cloud Private Cloud Community Cloud Hybrid Cloud Cloud Computing Infrastructure Physical Infrastructure Virtual Infrastructure Applications and Platform Software Cloud Management and Service Creation Tools Cloud Challenges Challenges for Consumers Challenges for Providers Cloud Adoption Considerations	15 [CO2, CO3, CO4]
Unit IV	**Securing the Storage Infrastructure** Securing the Storage Infrastructure Information Security Framework Risk Triad Assets Threats Vulnerability Storage Security Domains Securing the Application Access Domain Controlling User Access to Data Protecting the Storage Infrastructure 341 Data Encryption Securing the Management Access Domain Controlling Administrative Access Protecting the Management Infrastructure Securing Backup, Replication, and Archive Security Implementations in Storage Networking FC SAN FC SAN Security Architecture Basic SAN Security Mechanisms LUN Masking and Zoning Securing Switch Ports Switch-Wide and Fabric-Wide Access Control Logical Partitioning of a Fabric: Virtual SAN NAS NAS File Sharing: Windows ACLs NAS File Sharing: UNIX Permissions NAS File Sharing: Authentication and Authorization Kerberos Network-Layer Firewalls IP SAN Securing Storage Infrastructure in Virtualized and Cloud Environments Security Concerns Security Measures Security at the Compute Level Security at the Network Level Security at the Storage Level Concepts in Practice: RSA and VMware Security Products RSA Secure ID RSA Identity and Access Management RSA Data Protection Manager VMware vShield Managing the Storage Infrastructure Monitoring the Storage Infrastructure Monitoring	15 [CO3, CO4]

	Parameters Components Monitored Hosts Storage Network Storage Monitoring Examples Accessibility Monitoring Capacity Monitoring Performance Monitoring Security Monitoring Alerts Storage Infrastructure Management Activities Availability Management Capacity Management Performance Management Security Management Reporting Storage Infrastructure Management in a Virtualized Environment Storage Management Examples Storage Allocation to a New Server/Host File System Space Management Chargeback Report Storage Infrastructure Management Challenges Developing an Ideal Solution 384Storage Management Initiative Enterprise Management Platform Information Lifecycle Management Storage Tiering Intra-Array Storage Tiering Inter-Array Storage Tiering	
References: Information Storage and Management: Storing, Managing, and Protecting Digital Information in Classic, Virtualized, and Cloud Environments, EMC, John Wiley & Sons, 2nd Edition 2012		

Course Code	Course Title	Credits	No. of lectures
24BPIT3T03	Machine Learning	04	60

CO1	Explain core machine learning concepts, learning paradigms, general principles, and mathematical foundations including probability, statistics, information theory, and optimization.	L2
CO2	Analyze discriminative and generative models, including mixture models, Bayesian learning, and graphical models, to understand their assumptions, strengths, and limitations.	L4
CO3	Evaluate advanced machine learning approaches such as reinforcement learning, meta-learning, causal inference, and deep generative models for suitability across different problem domains.	L5
CO4	Design machine learning solutions for domain-specific applications by integrating appropriate models, mathematical principles, and ethical considerations.	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	2	3
CO3	3	3	2	1	2	3
CO4	3	3	3	2	3	3

Unit I	**Foundations and Advanced Topics in Machine Learning** Introduction: What Is Machine Learning? Basic Concepts in Machine Learning - Classification versus Regression, Supervised versus Unsupervised Learning Simple versus Complex Models, Parametric versus Nonparametric Models Overfitting versus Underfitting, Bias–Variance Trade-Off General Principles in Machine Learning: Occam's Razor, No-Free-Lunch Theorem, Law of the Smooth World, Curse of Dimensionality. Advanced Topics in Machine Learning: Reinforcement Learning, Meta-Learning, Causal Inference, and Other Advanced topics **Mathematical Foundation** Probability and Statistics: Random Variables and Distributions, Expectation: Mean, Variance, and Moments, Joint, Marginal, and Conditional Distributions, Common Probability Distributions, Transformation of Random Variables Information Theory: Information and Entropy, Mutual Information, KL Divergence Mathematical Optimization: General Formulation, Optimality Conditions, Numerical Optimization Methods	15 [CO1, CO2]
Unit II	**Advanced Classification Algorithms and Feature Extraction Techniques in Machine Learning** Classification Algorithms: Introduction, Decision-based methods: Nonlinear Instance-based methods, Decision Tree algorithm, Use Cases Feature Extraction: Feature Extraction: Concepts,Linear Dimension Reduction, Nonlinear Dimension Reduction (I): Manifold Learning,Nonlinear Dimension Reduction (II): Neural Networks	15 [CO1, CO2, CO3]
Unit III	**In-Depth Study of Discriminative and Generative Models in Machine Learning** Discriminative Models: Statistical Learning Theory, Linear Models, Learning Discriminative Models in General, Neural Networks, Ensemble Learning Generative Models: Overview of Generative Models, Formulation of Generative Models, Bayesian Decision Theory, Statistical Data Modeling, Density Estimation, Maximum-Likelihood Estimation, Maximum-Likelihood Classifier, Generative Models (in a Nutshell) Generative versus Discriminative Models	15 [CO2, CO3, CO4]

	Unimodal Models: Gaussian Models, Multinomial Models, Markov Chain Models, Generalized Linear Models Mixture Models: Formulation of Mixture Models, Expectation-Maximization Method, Expectation-Maximization Method, Gaussian Mixture Models, Hidden Markov Models Entangled Models: Formulationof Entangled Models, Linear Gaussian Models, Non-Gaussian Models, Deep Generative Models Bayesian Learning: Formulation of Bayesian Learning, Conjugate Priors, Approximate Inference, Gaussian Processes Graphical Models: Concepts of Graphical Models, Bayesian Networks, Markov Random Fields	
Unit IV	**Domain-Specific Applications and Ethical Considerations in Machine Learning** Domain-Based Machine Learning Applications, Ethical Aspects of Machine Learning	15 [CO3, CO4]

References:

1. Machine Learning Fundamentals: A Concise Introduction Hui Jiang Cambridge University Press 2021
2. Machine Learning Concepts, Techniques and Applications T V Geetha, SSendhilkumar CRC Press Taylor & Francis Group First 2023
3. Mastering Classification Algorithms for Machine Learning Partha Majumdar BPB First 2023
4. Machine Learning for Absolute Beginners Oliver Theobald Scatterplot Press Third 2021
5. Machine Learning: The Art and Science of Algorithms that Make Sense of Data Peter Flach Cambridge University Press First 2012
6. **Online Resources :** Instructor slides https://github.com/iNCML/MachineLearningBook

Course Code	Course Title	Credits	No. of lectures
24BPIT3P01	Practical Based on 24BPIT3T01 and 24BPIT3T03	02	60

CO1	Apply data pre-processing, exploration, hypothesis testing, and machine learning algorithms, including linear models, discriminative, generative, probabilistic, and deep generative models, to build and evaluate predictive models using real and synthetic datasets.	L3
CO2	Evaluate and optimize machine learning models by applying appropriate performance metrics, cross-validation techniques, hyper parameter tuning methods, and deployment strategies to select suitable models for practical applications.	L5
CO3	Design and implement advanced deep learning and AI solutions—including CNNs, RNNs, transformers, GANs, reinforcement learning models, recommendation systems, computer vision, NLP, and time-series models—using Python frameworks such as TensorFlow and PyTorch to solve complex real-world problems.	L6
CO4	Evaluate, optimize, and deploy machine learning and deep learning models by applying transfer learning, advanced hyperparameter optimization techniques, automated ML pipelines, and cloud-based deployment strategies to ensure scalable and production-ready solutions	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	3	3	0	2	3
CO2	3	3	3	0	2	3
CO3	3	3	3	0	2	3
CO4	3	3	3	0	2	3

Machine Learning Practical	
1.	**Data Pre-processing and Exploration**
a.	Load a CSV dataset. Handle missing values, inconsistent formatting, and outliers.
b.	Load a dataset, calculate descriptive summary statistics, create visualizations using different graphs, and identify potential features and target variables **Note**: Explore Univariate and Bivariate graphs (Matplotlib) and Seaborn for visualization.
c.	Create or Explore datasets to use all pre-processing routines like label encoding, scaling, and binarization.
2.	**Testing Hypothesis**
a.	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a. CSV file and generate the final specific hypothesis. (Create your dataset)
3	**Linear Models**
a.	**Simple Linear Regression** Fit a linear regression model on a dataset. Interpret coefficients, make predictions, and evaluate performance using metrics like R-squared and MSE
b.	**Multiple Linear Regression** Extend linear regression to multiple features. Handle feature selection and potential multicollinearity.
c.	**Regularized Linear Models** (Ridge, Lasso, ElasticNet)
	Implement regression variants like LASSO and Ridge on any generated dataset.
4	**Discriminative Models**
a	**Logistic Regression** Perform binary classification using logistic regression. Calculate accuracy, precision, recall, and understand the ROC curve**.**

b.	Implement and demonstrate k-nearest Neighbor algorithm. Read the training data from a .CSV file and build the model to classify a test sample. Print both correct and wrong predictions.
c.	Build a decision tree classifier or regressor. Control hyperparameters like tree depth to avoid overfitting. Visualize the tree.
d.	Implement a Support Vector Machine for any relevant dataset.
e.	Train a random forest ensemble. Experiment with the number of trees and feature sampling. Compare performance to a single decision tree.
f.	Implement a gradient boosting machine (e.g., XGBoost). Tune hyperparameters and explore feature importance.
5.	**Generative Models**
a.	Implement and demonstrate the working of a Naive Bayesian classifier using a sample data set. Build the model to classify a test sample.
b.	Implement Hidden Markov Models using hmmlearn
6.	**Probabilistic Models**
a.	Implement Bayesian Linear Regression to explore prior and posterior distribution.
b.	Implement Gaussian Mixture Models for density estimation and unsupervised clustering
7.	**Model Evaluation and Hyperparameter Tuning**
a.	Implement cross-validation techniques (k-fold, stratified, etc.) for robust model evaluation
b.	Systematically explore combinations of hyperparameters to optimize model performance.(use grid and randomized search)
8.	**Bayesian Learning**
a.	Implement Bayesian Learning using inferences
9.	**Deep Generative Models**
a.	Set up a generator network to produce samples and a discriminator network to distinguish between real and generated data. (Use a simple small dataset)
10.	Develop an API to deploy your model and perform predictions
Advanced Artificial Intelligence Practical	
1a	Implementing advanced deep learning algorithms such as convolutional neural networks (CNNs) or recurrent neural networks (RNNs) using Python libraries like TensorFlow or PyTorch.
1b	.Building a natural language processing (NLP) model for sentiment analysis or text classification.
2a	Creating a chatbot using advanced techniques like transformer models.
2b	Developing a recommendation system using collaborative filtering or deep learning approaches.
3	Implementing a computer vision project, such as object detection or image segmentation.
4	Training a generative adversarial network (GAN) for generating realistic images.
5	Applying reinforcement learning algorithms to solve complex decision-making problems.
6a	Utilizing transfer learning to improve model performance on limited datasets.
6b	Building a deep learning model for time series forecasting or anomaly detection.
7	Implementing a machine learning pipeline for automated feature engineering and model selection.
8	Using advanced optimization techniques like evolutionary algorithms or Bayesian optimization for hyperparameter tuning.
9	Deploying a machine learning model in a production environment using containerization and cloud services.
10a	Use Python libraries such as GPT-2 or textgenrnn to train generative models on a corpus of text data and generate new text based on the patterns it has learned.
10b	Experiment with neural networks like GANs (Generative Adversarial Networks) using Python libraries like TensorFlow or PyTorch to generate new images based on a dataset of images.

Course Code	Course Title	Credits	No. of lectures

24BPIT3T04	Elective I: Natural Language Processing	02	30

CO1	Apply NLP techniques using Python to preprocess text, access corpora and lexical resources, perform tokenization, tagging, parsing, and basic text classification tasks.	L3
CO2	Analyze linguistic patterns, sentence structures, and semantic representations using grammatical models, feature-based grammars, statistical methods, and topic modeling techniques.	L4
CO3	Evaluate NLP models and algorithms such as supervised classifiers, information extraction systems, named entity recognition, and semantic analysis methods using appropriate metrics and real-world datasets.	L5
CO4	Design and implement end-to-end NLP applications—including chatbots, topic modeling systems, question answering, and information extraction pipelines—by integrating syntactic, semantic, and statistical approaches.	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	2	3
CO3	2	3	2	1	2	3
CO4	3	3	3	1	3	3

Unit I	**Introduction:** Natural language vs. programming language, The magic, Practical applications, Language through a computer's "eyes", word order and grammar, A chatbot natural language pipeline **Language Processing and Python:** Computing with Language, Closer Look at Python: Texts as Lists of Words, Computing with Language: Simple Statistics, Automatic Natural Language Understanding **Accessing Text Corpora and Lexical Resources:** Accessing Text Corpora, Conditional Frequency Distributions, Reusing Code, Lexical Resources, WordNet **Processing Raw Text:** Accessing Text from the Web and from Disk, Strings: Text Processing at the Lowest Level, Text Processing with Unicode, Regular Expressions for Detecting Word Patterns, Useful Applications of Regular Expressions, Normalizing Text, Regular Expressions for Tokenizing Text, Segmentation Formatting: From Lists to Strings	15 [CO1, CO2]
Unit II	**Categorizing and Tagging Words:** Using a Tagger, Tagged Corpora, Mapping Words to Properties Using Python Dictionaries, Automatic Tagging, N-Gram Tagging, Transformation-Based Tagging, How to Determine the Category of a Word **Learning to Classify Text:** Supervised Classification, Further Examples of Supervised Classification, Evaluation, Decision Trees, Naive Bayes Classifiers, Maximum Entropy Classifiers , Modelling Linguistic Patterns, **Extracting Information from Text:** Information Extraction,Chunking, Developing and Evaluating Chunkers, Recursion in Linguistic Structure, Named Entity Recognition, Relation Extraction	15 [CO2, CO3]

References:

1. Natural Language Processing With Python Steven Bird, Edward Loper O'Reilly Media 2nd 2016
2. Applied Text Analysis with Python Benjamin Bengfort, Rebecca Bilbro, and Tony Ojeda O'Reilly 1st 2018
3. Natural Language Processing in Action Understanding, analyzing, and generating text with Python Hobson Lane, Cole Howard, Hannes Max Hapke Manning Publications 2019
4. Speech and Language Processing Martin, J. H., &Jurafsky, D. Pearson Education India 2nd 2013
5. Foundations of Statistical Natural Language Processing Manning, Christopher and Heinrich, Schutze MIT Press 1st 1997

Course Code	Course Title	Credits	No. of lectures
24BPIT3P02	Practical Based on 24BPIT3T04	02	60

CO1	Identify and recall fundamental NLP concepts, NLTK components, corpus types, tagging methods, and WordNet terminologies such as synsets, lemmas, hyponyms, and hypernyms.	L1
CO2	Analyze textual and speech data using NLTK by studying different corpora, conditional frequency distributions, tagged corpora, noun tag frequencies, and word–property mappings.	L4
CO3	Evaluate NLP techniques and tagging approaches such as Default Tagger, Regular Expression Tagger, and Unigram Tagger, and assess word similarity, synonym–antonym relationships, and noun comparisons using WordNet.	L5
CO4	Design and implement Python programs to perform text-to-speech, speech-to-text conversion, custom corpus creation, word segmentation and scoring, and semantic analysis using WordNet for real-world language processing tasks.	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	1	2	-	-	2
CO2	2	3	3	-	2	3
CO3	2	3	2	-	2	3
CO4	2	3	3	-	3	3

Practical 1	a. Install NLTK b. Convert the given text to speech
Practical 2	Convert audio file Speech to Text.
Practical 3	Study of various Corpus – Brown, Inaugural, Reuters, udhr with various methods like fields, raw, words, sents, categories,
Practical 4	a. Create and use your own corpora(plaintext, categorical) b. Study Conditional frequency distributions
Practical 5	Study of tagged corpora with methods like tagged_sents, tagged_words.
Practical 6	Write a program to find the most frequent noun tags.
Practical 7	Map Words to Properties Using Python Dictionaries
Practical 8	Study DefaultTagger, Regular expression tagger, UnigramTagger
Practical 9	Find different words from a given plain text without any space by comparing this text with a given corpus of words. Also find the score of words.
Practical 10	Study of Wordnet Dictionary with methods as synsets, definitions, examples, antonyms.
Practical 11	Study lemmas, hyponyms, hypernyms, entailments,
Practical 12	a. Write a program using python to find synonym and antonym of word "active" using Wordnet b. Compare two nouns

Course Code	Course Title	Credits	No. of lectures
24BPIT3T05	Elective II : Cloud Application Development	02	30

CO1	Apply microservices principles to design, develop, deploy, and monitor cloud-native applications using Azure Service Fabric, Azure Kubernetes Service (AKS), and API gateways.	L3
CO2	Analyze microservices architectures with respect to interservice communication, data management, security, scalability, monitoring, and deployment strategies in cloud and hybrid environments.	L4
CO3	Evaluate DevOps pipelines, CI/CD workflows, monitoring solutions, and API management platforms to ensure reliability, security, observability, and continuous delivery of microservices-based systems.	L5
CO4	Design and implement a professional-grade microservices ecosystem by integrating cloud infrastructure, container orchestration, secure APIs, automated DevOps pipelines, and monitoring solutions on Azure platforms.	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	2	3	3	1	2	3
CO4	3	3	3	1	3	3

Unit I	**Implementing Microservices:** Client to microservices communication, Interservice communication, data considerations, security, monitoring, microservices hosting platform options. **Azure Service Fabric:** Introduction, core concepts, supported programming models, service fabric clusters, develop and deploy applications of service fabric. **Monitoring Azure Service Fabric Clusters:** Azure application, resource manager template, Adding Application Monitoring to a Stateless Service Using Application Insights, Cluster monitoring, Infrastructure monitoring. **Azure Kubernetes Service (AKS):** Introduction to kubernetes and AKS, AKS development tools, Deploy applications on AKS. **Monitoring AKS:** Monitoring, Azure monitor and analytics, monitoring AKS clusters, native kubernetesdashboard, Prometheus and Grafana.	15 [CO1, CO2]
Unit II	**Securing Microservices:** Authentication in microservices, Implenting security using API gateway pattern, Creating application using Ocrlot and securing APIs with Azure AD. **Database Design for Microservices:** Data stores, monolithic approach, Microservices approach, harnessing cloud computing, dataase options on MS Azure, overcoming application development challenges. **Building Microservices on Azure Stack:** Azure stack, Offering IaaS, PaaS on-premises simplified, SaaS on Azure stack..**NET DevOps for Azure:** DevOps introduction, Problem and solution. **Professional Grade DevOps Environment:** The state of DevOps,professional grade DevOps vision, DevOps architecture, tools for professional DevOps environment, DevOps centered application.	15 [CO2, CO3]

References:

1. Building Microservices Applications on Microsoft Azure- Designing, Developing, Deploying, and Monitoring Harsh Chawla Hemant Kathuria Apress – 2019
2. .NET DevOps for Azure A Developer's Guide to DevOps Architecture the Right Way Jeffrey Palermo Apress – 2019
3. Practical API Architecture and Development with Azure and AWS - Design and Implementation of APIs for the Cloud Thurupathan Vijayakumar Apress -- 2018

Course Code	Course Title	Credits	No. of lectures
24BPIT3P03	Practical Based on 24BPIT3T05	02	60

CO1	Explain the architecture and working principles of stateless web applications, RESTful APIs, microservices, Kubernetes, and Azure Kubernetes Service (AKS).	L2
CO2	Develop and deploy web applications and APIs using ASP.NET Core MVC, ASP.NET Core Web API, Spring Boot, and Node.js, and configure them on Azure Kubernetes Service using Visual Studio, Visual Studio Code, and Azure CLI.	L3
CO3	Analyze deployment, monitoring, and routing requirements of microservices-based applications by configuring AKS clusters, enabling Azure Dev Spaces, implementing API gateways using Ocelot, and securing APIs with Azure Active Directory.	L4
CO4	Evaluate design choices for scalable cloud-native applications by assessing Kubernetes deployment strategies, application gateway configurations, monitoring mechanisms, and database designs for microservices architectures.	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	-	-	2
CO2	3	2	3	-	3	3
CO3	3	3	3	-	2	3
CO4	3	3	2	-	2	3

Practical 1	Develop an ASP.NET Core MVC based Stateless Web App.
Practical 2	Develop a Spring Boot API.
Practical 3	Create an ASP.NET Core Web API and configure monitoring.
Practical 4	a. Create an Azure Kubernetes Service Cluster b. Enable Azure Dev Spaces on an AKS Cluster
Practical 5	Configure Visual Studio to Work with an Azure Kubernetes Service Cluster
Practical 6	Configure Visual Studio Code to Work with an Azure Kubernetes Service Cluster
Practical 7	Deploy Application on AKS i. Core Web API ii. Node.js API
Practical 8	Create an AKS cluster a. from the portal b. with Azure CLI
Practical 9	Create an Application Gateway Using Ocelot and Securing APIs with Azure AD.
Practical 10	Create a database design for Microservices an application using the database.

Course Code	Course Title	Credits	No. of Hours
24BPIT3RP7	Research Project in I.T. – I	04	120

CO1	Identifying problems, designing experiments, and executing research independently.	L4
CO2	Applying advanced concepts, interpreting complex data, and developing creative solutions.	L3
CO3	Demonstrate research clearly through papers, posters, or oral presentations to diverse audiences.	L3
CO4	Understand IPR, ethical issues, and responsible conduct in research.	L2

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	3	2	1	3	3
CO2	3	3	3	1	2	3
CO3	2	3	3	1	3	3
CO4	2	3	2	1	2	2

For details of Research Project Guidelines refer following link
https://drive.google.com/file/d/1l9hsRma6hrq6DxJ6yi-bnN9iZJNkGm-6/view?usp=sharing

Semester IV

SEMESTER IV

Course Code	Course Title	No. of Lectures	Credits
MANDATORY PAPERS			
24BPIT4T01	Blockchain	**60**	**4**
24BPIT4T02	Deep Learning	**60**	**4**
24BPIT4P01	Practicals Based on 24BPDS4T01 and 24BPIT4T02	**60**	**4**
ELECTIVE PAPERS			
24BPIT4T03	Cyber Forensics	**30**	**2**
24BPIT4P02	Practicals Based on 24BPIT4T03	**60**	**2**
OR			
24BPIT4T04	Advanced IoT	**30**	**2**
24BPIT4P03	Practicals Based on 24BPIT4T04	**60**	**2**
RESEARCH PROJECT (RP)			
24BPIT4RP7	Research Project in I.T. - II	**180 Hours**	**6**
	Total Credits		**22**
	Total Semester III & Semester IV Credits		**44**

Course Code	Course Title	Credits	No. of lectures
24BPIT4T01	Blockchain	04	60

CO1	Explain the fundamental concepts of blockchain technology, including decentralized systems, blockchain architecture, consensus mechanisms, cryptography, and major blockchain platforms.	L5
CO2	Apply blockchain principles to interact with public and permissioned blockchains by executing transactions, using wallets, and developing basic smart contracts using Solidity and Ethereum tools.	L3
CO3	Analyze blockchain platforms such as Bitcoin, Ethereum, and Hyperledger with respect to scalability, security, cryptoeconomics, consensus models, and attack scenarios.	L4
CO4	Develop decentralized applications (DApps), smart contracts, and NFT-based solutions by leveraging Ethereum, Solidity, and blockchain deployment 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	2	1	1	2
CO2	3	2	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

Unit I	**Blockchain** – Introduction, History, Centralised versus Decentralised systems, Layers of blockchain, Importance of blockchain, Blockchain uses and use cases. **Working of Blockchain** – Blockchain foundation, Cryptography, Game Theory, Computer Science Engineering, Properties of blockchain solutions, blockchain transactions, distributed consensus mechanisms, Blockchain mechanisms, Scaling blockchain.	15 [CO1, CO2]
Unit II	**A Working of Bitcoin:** Money, Bitcoin, Bitcoin blockchain, bitcoin network, bitcoin scripts, Full Nodes and SVPs, Bitcoin wallets, Interacting with the Bitcoin Blockchain **Ethereum**- Ethereum as a Next-Gen Blockchain, Design Philosophy of Ethereum, Ethereum Blockchain, Ethereum Accounts, Advantages of Accounts, Account State, Merkle Patricia Tree, Ethereum Transaction and Message Structure, Ethereum State Transaction Function, Gas and Transaction Cost, Ethereum Smart Contracts, Contract Creation, Ethereum Virtual Machine. **Mining Ether**: Difficulty, Factors Required for Block Validation, How Proof of Work Helps Regulate Block Time, Faster Blocks, How Ethereum Uses Stale Blocks, Forking	15 [CO2, CO3]
Unit III	**Smart Contracts and Solidity:** Basic of Solidity Programming:- writing loops in solidity, statement and expressions in solidity, Value types, Global special variables, Units and Functions **Behind Dapp Deployment**-Seven Ways to Think About Smart Contracts, Smart Contract Deployment- EVM as Back End: Introduction to Truffle, Use of Remix and test networks for deployment, Dapp deployment. **Blockchain Application Development** -Decentralized Applications, , Interacting Programmatically with Ethereum—Sending Transactions, Creating a Smart Contract, Executing Smart Contract Functions	15 [CO1, CO3]
Unit IV	**Permissioned Blockchain**-, Public vs. Private Blockchains, Decentralized Application Architecture, Hyperledger concept, Exploring Hyperledger fabric project, Iroha project **Cryptoeconomics**- Why Is Cryptoeconomicsuseful?, Understanding Hashing vs.encryption,Speed of blocks, Ether Issuance scheme, Common Attack Scenarios **NFT**- What are NFTs?NFTMarketplaces,Creating and Minting NFTs,Legal Aspects of NFTs, The Future of NFTS	15 [CO3, CO4]

References:

1. Introducing Ethereum and Solidity Chris Dannen Apress 2017
2. Beginning Blockchain: A Beginner's Guide to Building Blockchain Solutions Bikramaditya Singhal , Gautam Dhameja ,Priyansu Sekhar Panda Apress 2018
3. Blockchain for dummies Tiana Laurence Wiley 2017
4. The Blockchain Developer Elad Elrom Apress 2019
5. Mastering Ethereum Andreas M. Antonopoulos Dr. Gavin Wood O'Reilly First 2018
6. The NFT Handbook Matt Fortnow,Terry Wiley 2022

Online References:	1. NPTEL courses: a. Blockchain and its Applications, b. Blockchain Architecture Design and Use Cases 2. www.swayam.gov.in/ 3. www.coursera.org 4. https://ethereum.org/en/ 5. https://www.trufflesuite.com/tutorials 6. https://hyperledger-fabric.readthedocs.io/en/release-2.2/whatis.h 7. Blockchain demo: https://andersbrownworth.com/blockchain/ 8.BlockchainDemo:Public/PrivateKeys&signing: https://andersbrownworth.com/blockchain/public-private-keys/ 9.https://www.javatpoint.com/blockchain-tutorial 10. https://www.tutorialspoint.com/blockchain/index.htm

Course Code	Course Title	Credits	No. of lectures
24BPIT4T02	**Deep Learning**	**04**	**60**

CO1	Recall fundamental mathematical concepts used in machine learning, including linear algebra elements, numerical computation issues, and basic optimization terminology.	L1
CO2	Explain the working principles of deep learning architectures such as deep feedforward networks, convolutional networks, sequence models, autoencoders, and generative models.	L2
CO3	Apply mathematical foundations and optimization techniques to train deep learning models, including regularization methods and gradient-based optimization algorithms.	L3
CO4	Analyze the behavior and performance of deep learning and generative models by examining representations, training dynamics, and applications such as transformers and advanced GANs.	L4

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	3	1	2	3
CO3	3	3	3	1	2	3
CO4	3	3	3	1	3	3

Unit I	**Applied Math and Machine Learning Basics:** Linear Algebra: Scalars, Vectors, Matrices and Tensors, Multiplying Matrices and Vectors , Identity and Inverse Matrices, Linear Dependence and Span , norms, special matrices and vectors, Eigen decompositions. **Numerical Computation:** Overflow and under flow, poor conditioning, Gradient Based Optimization, Constraint optimization.	15 [CO1, CO2]
Unit II	**Deep Networks:** Deep feed forward network, regularization for deep learning, Optimization for Training deep models.	15 [CO1, CO3]
Unit III	**Convolution Applications:** Convolutional Networks, Sequence Modelling, Applications **Deep Learning Research:** Linear Factor Models, Auto encoders, representation learning	15 [CO2, CO4]
Unit IV	**Generative Models:** Approximate Inference, Deep Generative Models **Discussion Models** **Applications:** Transformers, Advance GANs	15 [CO3, CO4]

References:

1. Deep Learning Ian Goodfellow, Yoshua Bengio, Aaron An MIT Press book 1st 2016
2. Fundamentals of Deep Learning Nikhil Buduma O'Reilly 1st 2017
3. Generative Deep Learning David Foster O'Reilly 2nd 2023
4. Deep Learning: Methods and Applications Deng & Yu Now Publishers 1st 2013
5. Deep Learning CookBook Douwe Osinga O'Reilly 1st 2017

Course Code	Course Title	Credits	No. of lectures
24BPIT4P01	Practicals based on 24BPIT4T01 and 24BPIT4T02	04	120

CO1	Analyze blockchain networks, cryptocurrency transactions, and smart contract functionalities using Python, Solidity, and blockchain frameworks to identify transaction flows, mining processes, and potential security issues.	L4
CO2	Examine deep learning models including CNNs, RNNs, LSTMs, and Autoencoders to understand data flow, feature extraction, and model performance on classification, regression, and sequence tasks.	L4
CO3	Evaluate the effectiveness of decentralized applications, smart contracts, and deep learning models by testing, debugging, and comparing alternative implementations for accuracy, efficiency, and security.	L5
CO4	Design and implement secure blockchain applications, DApps, and deep learning solutions—such as secure messaging systems, NFT interactions, image generation with GANs, and predictive models for real-world data integrating multiple technologies into cohesive 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	3	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

Blockchain Practical	
1	Develop a secure messaging application where users can exchange messages securely using RSA encryption. Implement a mechanism for generating RSA key pairs and encrypting/decrypting messages.
2	Allow users to create multiple transactions and display them in an organised format.
3	Create a Python class named Transaction with attributes for sender, receiver, and amount. Implement a method within the class to transfer money from the sender's account to the receiver's account..
4a	Implement a function to add new blocks to the miner and dump the blockchain.
4b	Write a python program to demonstrate mining.
5a	Demonstrate the use of the Bitcoin Core API to interact with a Bitcoin Core node.
5b	Demonstrating the process of running a blockchain node on your local machine.
6	Demonstrate mining using geth on your private network.
7	Write a Solidity program that demonstrates various types of functions including regular functions, view functions, pure functions, and the fallback function.
8a	Write a Solidity program that demonstrates function overloading, mathematical functions, and cryptographic functions.
8b	Write a Solidity program that demonstrates various features including contracts, inheritance, constructors, abstract contracts, interfaces.
9a	Write a Solidity program that demonstrates use of libraries, assembly, events, and error handling.
9b	Build a decentralized application (DApp) using Angular for the front end and Truffle along with Ganache CLI for the back end.
10a	Install and demonstrate use of hyperledger-Irhoa
10b	Demonstration on interacting with NFT
Deep Learning Practical	
1.	Introduction to TensorFlow

a.	• Create tensors with different shapes and data types. • Perform basic operations like addition, subtraction, multiplication, and division on tensors. • Reshape, slice, and index tensors to extract specific elements or sections. Performing matrix multiplication and finding eigenvectors and eigenvalues using TensorFlow
b.	Program to solve the XOR problem.
2.	Linear Regression
a.	• Implement a simple linear regression model using TensorFlow's low-level API (or tf. keras). • Train the model on a toy dataset (e.g., housing prices vs. square footage). • Visualize the loss function and the learned linear relationship. Make predictions on new data points.
3	Convolutional Neural Networks (Classification)
a.	Implementing deep neural network for performing binary classification task
b.	Using a deep feed-forward network with two hidden layers for performing multiclass classification and predicting the class.
4	Write a program to implement deep learning Techniques for image segmentation.
5	Write a program to predict a caption for a sample image using LSTM.
6	Applying the Autoencoder algorithms for encoding real-world data
7.	Write a program for character recognition using RNN and compare it with CNN.
8.	Write a program to develop Autoencoders using MNIST Handwritten Digits
9.	Demonstrate recurrent neural network that learns to perform sequence analysis for stock price.(google stock price)
10.	Applying Generative Adversarial Networks for image generation and unsupervised tasks.

Course Code	Course Title	Credits	No. of lectures
24BPIT4T03	Computer Forensic	02	30

CO1	Apply forensic techniques and software tools to acquire, preserve, and recover digital evidence from computer systems, networks, and mobile devices while maintaining data integrity.	L3
CO2	Analyze digital artifacts such as logs, disk images, network traffic, emails, browser data, and internet activity to reconstruct events related to cyber incidents.	L4
CO3	Evaluate digital evidence, forensic findings, and investigation methodologies for reliability, admissibility, and compliance with legal and ethical standards.	L5
CO4	Develop comprehensive forensic investigation reports and present digital evidence effectively for legal proceedings, including case documentation and expert testimony	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	2	3	2	1	2	3
CO4	2	3	2	1	3	3

Unit I	**Computer Forensics :** Introduction to Computer Forensics and standard procedure, Incident Verification and System Identification ,Recovery of Erased and damaged data, Disk Imaging and Preservation, Data Encryption and Compression, Automated Search Techniques, Forensics Software **Network Forensic :** Introduction to Network Forensics and tracking network traffic, Reviewing Network Logs, Network Forensics Tools, Performing Live Acquisitions, Order of Volatility, Standard Procedure **Cell Phone and Mobile Device Forensics:** Overview, Acquisition Procedures for Cell Phones and Mobile Devices	15 [CO1, CO2]
Unit II	**Internet Forensic :** **Introduction** to Internet Forensics, World Wide Web Threats, Hacking and Illegal access, Obscene and Incident transmission, Domain Name Ownership Investigation, Reconstructing past internet activities and events **E-mail Forensics :**e-mail analysis, e-mail headers and spoofing, Laws against e-mail Crime, **Browser Forensics:** Cookie Storage and Analysis, Analyzing Cache and temporary internet files, Web browsing activity reconstruction **Introduction to Legal aspects of Digital Forensics:** Laws & regulations, Information Technology Act, Giving Evidence in court, Case Study – Cyber Crime cases, Case Study – Cyber Crime cases	15 [CO3, CO4]

References:

1. Guide to computer forensics and investigations, Bill Nelson, Amelia Philips and Christopher Steuart, course technology,5th Edition,2015
2. Incident Response and computer forensics, Kevin Mandia, Chris Prosise, Tata McGrawHill,2nd Edition,2003

Course Code	Course Title	Credits	No. of lectures
24BPIT4P02	Practicals Based on 24BPIT4T03	02	30

CO1	Analyze forensic images, acquired data, and captured network packets using tools like FTK Imager, EnCase, Autopsy, and Wireshark to identify relevant artifacts and reconstruct events.	L3
CO2	Examine email and web browser data, including headers, cache, and cookies, to determine evidence of user actions and cyber incidents.	L4
CO3	Evaluate the integrity, authenticity, and reliability of digital evidence collected from computers, storage devices, network captures, and memory forensics using write blockers and monitoring tools.	L5
CO4	Develop comprehensive forensic investigation reports, synthesize evidence from multiple sources, and propose solutions or findings for cybercrime case studies and real-world forensic scenarios.	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	2	3	1	2	3
CO3	3	3	2	1	2	3
CO4	2	3	2	1	3	3

Practical 1	Creating a Forensic Image using FTK Imager/Encase Imager : - Creating Forensic Image - Check Integrity of Data - Analyze Forensic Image
Practical 2	Data Acquisition: - Perform data acquisition using: - USB Write Blocker + Encase Imager - SATA Write Blocker + Encase Imager - Falcon Imaging Device
Practical 3	Forensics Case Study: - Solve the Case study (image file) provide in lab using Encase Investigator or Autopsy
Practical 4	Capturing and analyzing network packets using Wireshark (Fundamentals) : - Identification the live network - Capture Packets
Practical 5	Using Sysinternals tools for Network Tracking and Process Monitoring : - Check Sysinternals tools - Monitor Live Processes - Capture RAM - Capture TCP/UDP packets - Monitor Hard Disk - Monitor Virtual Memory - Monitor Cache Memory
Practical 6	Email Forensics - Mail Service Providers - Email protocols - Recovering emails - Analyzing email header
Practical 7	Web Browser Forensics - Web Browser working - Forensics activities on browser - Cache / Cookies analysis - Last Internet activity

Course Code	Course Title	Credits	No. of lectures
24BPIT4T04	**Elective II: Advanced IoT**	**02**	**30**

CO1	Explain the concepts of Artificial Intelligence 2.0, IoT architectures, Azure IoT Suite, Cognitive APIs, blockchain as a service, and microservices-based IoT platforms.	L2
CO2	Apply Azure IoT services, Cognitive APIs, and machine learning techniques to capture, analyze, visualize real-time data, and build smart IoT applications.	L3
CO3	Develop IoT solutions by configuring cloud infrastructure, implementing message brokers, integrating Node.js and Node-RED, and enabling secure device-to-cloud communication.	L3
CO4	Analyze smart IoT platforms and microservices architectures in terms of scalability, security, data flow, and performance for real-world IoT applications.	L4

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	1	2
CO2	3	3	3	1	2	3
CO3	3	3	3	1	3	3
CO4	3	3	2	1	2	3

Unit I	The Artificial Intelligence 2.0, IoT and Azure IoT Suite, Creating Smart IoT Application, Cognitive APIs, Consuming Microsoft Cognitive APIs, Building Smarter Application using Cognitive APIs. Implementing Blockchain as a service, Capturing, Analysing and Visualizing real-time data, Making prediction with machine learning.	15 [CO1, CO2, CO3]
Unit II	IoT and Microservices, Service Fabric, Build your own IoT platform: Introduction, Building blocks for IoT solution, Essentials for building your own platform, Platform requirements, building the platform by initializing cloud instance, installing basic software stacks, securing instance and software, installing node.js and Node-RED, Message broker	15 [CO3, CO4]

References:

1. IoT, AI, and Blockchain for .NET- Building a Next-Generation Application from the Ground Up Nishith Pathak Anurag Bhandari Apress – 2018
2. Microservices, IoT and Azure Bob Familiar Apress -- 2015
3. Build your own IoT Platform Anand Tamboli Apress -- 2019
4. Internet of Things Architectures, Protocols and Standards Simone Cirani Gianluigi Ferrari Marco Picone Luca Veltri Wiley 1st 2019

Course Code	Course Title	Credits	No. of lectures
24BPIT4P03	Practicals Based on 24BPIT4T04	02	30

CO1	Recall the basic concepts, components, operating systems, and cloud services used in IoT systems, including Raspberry Pi, IoT protocols, Azure IoT Hub, AWS IoT, and cognitive services.	L1
CO2	Understand fundamental security, communication, and architectural elements involved in IoT platforms, blockchain-enabled IoT, and microservices-based IoT systems.	L2
CO3	Apply IoT development skills to install operating systems, develop applications using Python and Node.js, configure cloud IoT services, and transmit telemetry data between devices and cloud platforms.	L3
CO4	Develop and deploy practical IoT solutions such as home automation systems, face detection applications, blockchain-enabled IoT authentication, and microservices-based IoT platforms.	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	1	3	1	1	2
CO2	3	2	3	1	2	2
CO3	3	3	3	1	3	3
CO4	3	3	3	1	3	3

Practical 1	Loading Raspbian and Windows IoT Core on Raspberry Pi and executing applications on it using Python and node.js
Practical 2	Create a home automation system and control the devices remotely
Practical 3	Create the programs using the Microsoft Cognitive APIs for IoT
Practical 4	Create blockchain on Raspberry Pi and implement and test it. Authenticate IoT with blockchain.
Practical 5	Implement Microservices on IoT device.
Practical 6	Build your own IoT platform
Practical 7	Use IoT device with AWS.
Practical 8	Send telemetry from a device to an IoT hub and read it with a service application
Practical 9	Use the Azure CLI and Azure portal to configure IoT Hub message routing
Practical 10	Face Detection using IoT device. (Pi Camera or anything else).

Course Code	Course Title	Credits	No. of Hours
24BPIT4RP7	Research Project in I.T. - II	06	180

CO1	Identifying problems, designing experiments, and executing research independently.	L4
CO2	Applying advanced concepts, interpreting complex data, and developing creative solutions.	L3
CO3	Demonstrate research clearly through papers, posters, or oral presentations to diverse audiences.	L3
CO4	Understand IPR, ethical issues, and responsible conduct in research.	L2

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	3	2	1	3	3
CO2	3	3	3	1	2	3
CO3	2	3	3	1	3	3
CO4	2	3	2	1	2	2

For details of Research Project Guidelines refer following link
https://drive.google.com/file/d/1l9hsRma6hrq6DxJ6yi-bnN9iZJNkGm-6/view?usp=sharing

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 - III

Theory						Practical		
Course Code	**Internal**	**Min marks for passing**	**Theory Examination**	**Min marks for passing**	**Total**	**Course Code**	**Practical Examination**	**Min marks for passing**
24BPIT3T01	40	16	60	24	100	24BPIT3P01	**50**	**20**
24BPIT3T02	40	16	60	24	100			
24BPIT3T03	40	16	60	24	100			
E-I 24BPIT3T04	40	16	60	24	100	24BPIT3P02	**50**	**20**
E-II 24BPIT3T05	40	16	60	24	100	24BPIT3P03	**50**	**20**
24BPIT3RP7	Research Project in I.T. - I					**100**		**40**

Semester - IV

Theory						Practical		
Course Code	**Internal**	**Min marks for passing**	**Theory Examination**	**Min marks for passing**	**Total**	**Course Code**	**Practical Examination**	**Min marks for passing**
24BPIT4T01	40	16	60	24	100	23BPIT2P01	**50**	**20**
24BPIT4T02	40	16	60	24	100			
E-I 24BPIT4T03	40	16	60	24	100	24BPIT4P02	**50**	**20**
E-II 24BPIT4T04	40	16	60	24	100	24BPIT4P03	**50**	**20**
24BPIT4RP7	Research Project in I.T. - II					**150**		**60**

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

Curriculum Structure for the Post Graduate Degree Programme M.Sc. Information Technology

	SEMESTER–III	**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**
24BPIT3T01	Advanced Artificial Intelligence	✓	✓	✓	-	-	-	-
24BPIT3T02	Storage as a Service	✓	✓	✓	-	-	-	-
24BPIT3T03	Machine Learning	✓	✓	✓	-	-	-	-
24BPIT3P01	Practical Based on 24BPIT3T01 and 24BPIT3T03	✓	✓	✓	-	-	-	-
	Elective Course Title							
24BPIT3T04	Natural Language Processing	✓	✓	✓	-	-	-	-
24BPIT3P02	Practicals Based on 24BPDS3T04	✓	✓	✓	-	-	-	-
	OR							
24BPIT3T05	Cloud Application Development	✓	✓	✓	-	-	-	-
24BPIT3P03	Practicals Based on 24BPDS3T05	✓	✓	✓	-	-	-	-
	Research Project							
24BPIT3RP7	Research Project in I.T. - I	✓	✓	✓	✓	-	-	-

	SEMESTER–IV	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**
24BPIT4T01	Blockchain	✓	✓	✓	-	-	-	-
24BPIT4T02	Deep Learning	✓	✓	✓	-	-	-	-
24BPIT4P01	Practicals Based on 24BPDS4T01 and 24BPIT4T02	✓	✓	✓	-	-	-	-
	Elective Course Title							
24BPIT4T03	Computer Forensics	✓	✓	✓	-	-	-	-
24BPIT4P02	Practicals Based on 24BPIT4T03	✓	✓	✓	-	-	-	-
	OR							
24BPIT4T04	Advanced IoT	✓	✓	✓	-	-	-	-
24BPIT4P03	Practicals Based on 24BPIT4T04	✓	✓	✓	-	-	-	-
	Research Project							
24BPIT4RP7	Research Project in I.T. - II	✓	✓	✓	✓	-	-	-

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