AC – 25/03/2026
Item No. 6.18 (N) (9)

As Per NEP 2020

1.

University of Mumbai

Syllabus for Minor (Scheme - I) Vertical 2	
Faculty of Science & Technology	
Board of Studies in Information Technology	
Third Year Programme in Minor B.Sc. (Information Technology)	
Semester	**V**
Title of Papers	**1. Linux Operating System** **2. Linux Operating System Practical** **OR** **3. Mobile Programming Practical** **4. IT 2000 and Subsequent Amendments**
Semester	**VI**
Title of Papers	**1. Cloud Computing Fundamentals** **2. Digital Forensics Practical** **OR** **3. AI Ethics** **4. Green IT Practices and Sustainability**
Credits	**2**
From the Academic Year	**2026-27**

Sem. - V

Syllabus
B.Sc. (Information Technology)
(Sem.- V)

Name of the Course: Linux Operating System

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	Linux Administration Theory is a rigorous, practice-oriented theory course that develops students' mastery of Red Hat Enterprise Linux 8 (RHEL 8) system administration. Aligned with the National Education Policy (NEP) 2020, the course is outcome-based, career-ready, and skill-focused, preparing students for one of the most in-demand roles in the IT industry — the Linux / RHEL System Administrator. It simultaneously serves as a strong conceptual foundation for students aspiring to the Red Hat Certified System Administrator (RHCSA) and Red Hat Certified Administrator (RHCA) industry certifications. The course is built around Red Hat Enterprise Linux 8 — the enterprise standard for mission-critical servers in banking, telecoms, defence, healthcare, and cloud infrastructure worldwide. Students learn the complete life cycle of Linux system administration: from installation and day-to-day command-line operations, shell scripting, and software management, through to user/group/permission security, network configuration, SSH-based remote administration, firewall management with firewalld, SELinux mandatory access control, local and advanced storage management (LVM, Stratis, VDO), and a thorough understanding of the Linux boot process.
2	**Vertical :**	Minor
3	**Type :**	Theory
4	**Credits :**	2 credits (1 credit = 15 Hours for Theory in a semester)
5	**Hours Allotted :**	30 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO1. Introduce the RHEL 8 ecosystem CO2. Develop proficiency in essential Linux command-line operations and Bash shell scripting CO3. Equip students with skills to use common Linux system administration tools CO4. Enable students to manage Linux users, groups, and permissions (	

	CO5. Configure and manage network connectivity on RHEL 8 CO6. Administer software packages and repositories CO7. Implement secure remote system administration using OpenSSH CO8. Understand and enforce SELinux . CO9. Manage local disk storage and filesystems CO10. Implement advanced storage solutions using LVM CO11. Analyse the complete Linux boot process — BIOS/UEFI,
8	**Course Outcomes (OC):** OC1 Install and configure RHEL 8 in both standard and automated OC2 Execute core Linux administrative tasks OC3 Utilise Linux tools for regular operations OC4 Create and manage Linux user accounts and groups OC5 Configure network interfaces, IP addresses OC6 Manage software installation, updates, and OC7 Implement and verify SSH key-based remote access,Configure and troubleshoot SELinux OC8 Partition disks (MBR and GPT), Design and implement LVM storage solutions OC9 Trace and explain each stage of the RHEL 8 boot process
9	**Modules:-**
	Module 1:
	1. Systems Administration – Software, User, Network, and Services Management Installing RHEL8, a. Advanced Installation Options, b. Basic Commands and Simple Shell Scripts, c. Tools for Regular Operations d. Securing Systems with Users, Groups, and Permissions e. Enabling Network Connectivity Adding, Patching, and Managing Software f. Adding, Patching, and Managing Software
	Module 2: 1. Security with SSH, SE Linux, a Firewall, and System Permissions a. Administering Systems Remotely b. Securing Network Connectivity with firewall 2. Resource Administration a. Managing Local Storage and Filesystems b. Flexible Storage Management with LVM c. Advanced Storage Management with Stratis and VDO d. Understanding the Boot Process

10	**Text Books**
11	**Reference Books** 1. Red Hat Enterprise Linux 8 Administration - Master Linux Administration Skills and Prepare for the RHCSA Certification Exam (Packt, 2021,) 2. RHCSA_Red_Hat_Enterprise_Linux_8_Training_and_Exam_Preparation_Guide 3. Red Hat RHCA 8 Cert Guide by Sander van Vugt
12	**Internal Continuous Assessment: 40%**
	Continuous Evaluation through: 1. Class test of 1 of 15 marks 2. Class test of 2 of 15 marks Average of the two: 15 marks 3. Quizzes/ Presentations/ Assignments: 5 marks **4.** Total: 20 marks
13	**Semester End Examination: 60%**
	30 marks Semester End Examination
14	**Format of Question Paper: (Semester End Examination : 30 Marks. Duration:)** Q1: Attempt any three (out of five) from Module 1 (15 marks) Q2: Attempt any three (out of five) from Module 2 (15 marks)

Syllabus
B.Sc. (Information Technology)
(Sem.- V)

Name of the Course: Linux Operating System Practical

Sr.No.	Heading	Particulars
1	**Description the course :** **Including but Not limited to:**	This course introduces learners to the fundamental and applied concepts of Linux system administration through extensive hands-on laboratory practice. Students will install, configure, secure, and manage a Linux operating system environment using virtualization platforms. The course focuses on developing practical abilities required for entry-level roles such as System Administrator The laboratory-oriented pedagogy enables learners to work in real-world computing
2	**Vertical :**	Minor
3	**Type :**	Practical
4	**Credits :**	2 credits (1 credit = 30 Hours of Practical work in a semester)
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO1. Understand the architecture, features, and working environment of the Linux operating system and perform installation using virtualization tools. CO2. Use Linux command-line interface effectively to manage files, directories, text processing, permissions, and software packages. CO3. Administer users, groups, file systems, and storage devices while applying appropriate access control and security practices. CO4. Configure essential networking services including IP addressing, SSH remote access, web server, and network file sharing. CO5. Monitor system performance, manage processes, implement firewall rules, and troubleshoot common system issues. CO6. Automate administrative tasks using shell scripting and scheduling tools such as cron and at.	
8	**Course Outcomes (OC):** OC 1. Install and configure a Linux operating system and work in graphical and command-line environments. OC 2. Perform file handling, text processing, and package management using standard Linux utilities and commands. OC 3. Create and manage users, groups, permissions, and access control lists to secure system resources.	

	OC 4. Configure networking, remote login (SSH), and basic server services such as Apache web server and network storage. OC 5. Analyse and manage processes, partitions, logical volumes, and system performance. OC 6. Write basic shell scripts and schedule automated tasks to manage and monitor system operations.
9	**Modules:-**
	Module 1:
	2. a. Installing Red Hat Enterprise Linux (Virtual Box/ VmWare) b. Linux Graphical Environment i. Display/Login Manager ii. Desktop Environment iii. Linux Directory Structure and File Systems 3. Basic System Commands a. Use input-output redirection (>, >>, |, 2>, etc) b. Use grep and regular expressions to analyse text c. Log in and switch users in multi-user targets d. Working with Text Files cat,cut,less,hesd,tail,sort,wc,grep, awk 4. Essential File Management Tools a. Managing Files ,Using Links b. Working with Archives and Compressed Files c. Create, delete, copy, and move files and directories d. Archive, compress, unpack, and uncompress files using tar, star, gzip, and bzip2 e. Create hard and soft links f. Managing File Ownership, Managing Basic Permissions g. Managing Advanced Permissions, Managing ACLs h. Setting Default Permissions with umask i. Working with User-Extended Attributes j. List, set, and change standard ugo/rwx permissions k. Create and configure set-GID directories for collaboration l. Create and manage access control lists 5. Working with Users, Groups, and Permissions a. Creating and Managing Users b. Creating and Managing Groups c. Using Permissions and Advanced Permissions d. Change passwords and adjust password aging for local user accounts e. Configure superuser access -> su,sudo,root 6. Managing Software a. Managing Software Packages with YUM b. Using yum c. Managing Software Packages with RPM d. Install and update software packages repository from the local file system

	Module 2: 7. Managing Processes a. Introduction to Process Management b. Managing Shell Jobs c. Using Common Command-Line Tools for Process Management d. Using top to Manage Processes e. Using tuned to Optimize Performance f. Identify CPU/memory-intensive processes and kill processes 8. Managing Storage a. Understanding MBR and GPT Partitions b. Managing Partitions and File Systems c. Mounting File Systems d. List, create, delete partitions on MBR and GPT disks e. Configure systems to mount file systems at boot by universally unique ID (UUID) or label f. Add new partitions and logical volumes, and swap to a system non-destructively g. Create, mount, unmount, and use vfat, ext4, and xfs file systems 9. Configuring Networking a. Managing Network Addresses and Interfaces b. Validating Network Configuration c. Managing Network Configuration with nmtui and nmcli d. Configure IPv4 and IPv6 addresses e. Configure DNS-hostname resolution 10. Configuring SSH a. Using SSH and Related Utilities b. Access remote systems using SSH c. Configuring Key-Based Authentication with Passphrases d. Configure key-based authentication for SSH 11. Configuring web server a. Configuring a Basic Apache Server b. Understanding Apache Configuration Files c. Creating Apache Virtual Host 12. Configure Firewall a. Linux Firewall with iptables b. Working with Firewalld 13. Accessing Network Storage a. Using NFS Services b. Using CIFS Services c. Mounting Remote File Systems Through fstab d. Using Automount to Mount Remote File Systems 14. Creating Shell scripts a. automate or monitor tasks/processes b. Getting and setting system information 15. Scheduling Tasks

	a. Configuring Cron to Automate Recurring Tasks b. Configuring At to Schedule Future Tasks c. Schedule tasks using at and cron
10 **11**	**Text Books** **Reference Books** 4. Red Hat RHCA 8 Cert Guide by Sander van Vugt 5. RHCSA Red Hat Enterprise Linux 8 Training and Exam Preparation Guide (EX200) by Asghar Ghori 6. Red Hat Enterprise Linux 8 Administration - Master Linux Administration Skills and Prepare for the RHCSA Certification Exam (Packt, 2021)
12	**Internal Continuous Assessment: 40%**
	Continuous Evaluation through: Students are expected to attend each practical and submit the written practical of the previous session. Performing practical and writeup submission will be continuous internal evaluation. 2.5 marks can be awarded for each practical performance and writeup submission totalling to 50 marks and can be converted to 20 marks.
13	**Semester End Examination: 60%**
	30 marks Semester End Examination
14	**Format of Question Paper: (Semester End Examination : 30 Marks. Duration: 2Hr)** **Certified copy of Journal is compulsory to appear for the practical examination Practical Slip:** Q1. From Module 1 13 marks Q2. From Module 2 12marks Q3. Journal and Viva 05 marks

Syllabus
B.Sc. (Information Technology)
(Sem.- V)

Name of the Course: Mobile Programming Practical

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	This course introduces students to cross-platform mobile application development using Flutter and Dart. It focuses on UI design, navigation, data handling, networking, asynchronous programming, and integration of essential mobile features to build interactive and data-driven applications.
2	**Vertical :**	Minor
3	**Type :**	Practical
4	**Credits :**	2 credits (1 credit = 30 Hours of Practical work in a semester)
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** **CO1:** To understand the fundamentals of Flutter framework and Dart programming for cross-platform mobile application development. **CO2:** To design and implement user interfaces using Flutter widgets, layouts, and theming techniques. **CO3:** To develop multi-screen applications using navigation, routing, and state management concepts. **CO4:** To implement interactive applications using events, dialogs, menus, and dynamic UI components. **CO5:** To integrate data handling mechanisms including SQLite database operations and JSON-based network communication. **CO6:** To develop advanced mobile features using asynchronous programming, background processing, media handling, and secure data management.	
8	**Course Outcomes (OC):** **OC1:** Develop basic Flutter applications using Dart and demonstrate understanding of project structure and widget hierarchy. **OC2:** Design responsive and structured user interfaces using Flutter layout widgets and UI components. **OC3:** Implement navigation, routing, and state management in multi-screen Flutter applications. **OC4:** Build interactive applications incorporating event handling, dialogs, and dynamic data rendering.	

	OC5: Create data-driven applications integrating SQLite databases and RESTful APIs using JSON. **OC6:** Apply asynchronous programming, media APIs, and runtime permission handling to develop secure and efficient mobile applications.
9	**Modules**
	Module I: Android Fundamentals & UI Design
	Android Basics and Resources (Flutter Basics & Project Setup) 1. Develop a simple "Hello World" Flutter application demonstrating project creation, Flutter SDK setup, widget structure, emulator setup, and application execution. 2. Develop a Flutter application demonstrating the use of assets and resources (themes, colors, strings, images, fonts) and apply them in UI components. 3. Develop a Flutter application demonstrating StatefulWidget lifecycle methods and analyze state changes using debug tools. **Fragments and Activity Interaction (Flutter Navigation & State Management)** 4. Develop a Flutter application implementing navigation between multiple screens using Navigator. 5. Develop a Flutter application demonstrating named routes and passing data between screens. 6. Develop a Flutter application demonstrating state management between parent and child widgets. **Basic Layout Management** 7. Develop a Flutter application using Row and Column widgets to design structured UI layouts. 8. Develop a Flutter application using Stack and Positioned widgets to align UI components dynamically. 9. Develop a Flutter application using Form, TextFormField, and validation to design a structured Login/Registration Form. **Advanced Layout and View Handling** 10. Develop a Flutter application using SingleChildScrollView and ListView to display scrollable content. 11. Develop a Flutter application using Expanded and Flexible widgets for responsive layout design. 12. Develop a Flutter application using Stack to overlay UI elements. **Adapter Based Views (List & Grid Widgets)** 13. Develop a Flutter application using ListView.builder and implement item click handling. 14. Develop a Flutter application using GridView to display items in grid format. 15. Develop a Flutter application implementing ListView with custom widgets for dynamic data rendering.
	Module 2: Android System Components & Data Handling
	Menus, Dialogs and UI Interaction

	1. Develop a Flutter application using ListView.builder and implement item click handling. 2. Develop a Flutter application using GridView to display items in grid format. 3. Develop a Flutter application implementing ListView with custom widgets for dynamic data rendering. **Intents, Events and Listeners (Navigation & Interaction in Flutter)** 4. Develop a Flutter application demonstrating navigation using Navigator.push and Navigator.pop. 5. Develop a Flutter application demonstrating event handling using GestureDetector and button callbacks. 6. Develop a Flutter application using DropdownButton or ListView to populate dynamic data. **Services, Notifications and Background Tasks** 7. Develop a Flutter application implementing background services using Dart async features. 8. Develop a Flutter application implementing local notifications using Flutter plugins. 9. Develop a Flutter application implementing state updates using Stream or Future. **Database and Networking** 10. Develop a Flutter application implementing SQLite database CRUD operations using sqflite package. 11. Develop a Flutter application integrating SQLite data with ListView or GridView. 12. Develop a Flutter application to fetch and parse JSON data from a web API using http package and display it in UI components. **Concurrency, Media and Security** 13. Develop a Flutter application demonstrating asynchronous programming using Future and async/await. 14. Develop a Flutter application implementing media playback using Flutter plugins (audio/video). 15. Develop a Flutter application implementing runtime permissions and secure data handling using appropriate Flutter packages.
10	**Text Books** 1. **Davies, Matt**, Flutter Apprentice (Third Edition): Beginning Flutter Development with Dart, Razeware LLC, 3rd Edition, 2023. 2. **Serrano, Eric Windmill**, Flutter in Action, Manning Publications, 1st Edition, 2020. 3. **Payne, Richard**, Beginning Flutter: A Hands-On Guide to App Development, Wrox Publishing, 1st Edition, 2019. 4. **Jain, Saurabh**, Flutter for Beginners, Packt Publishing, 2nd Edition, 2022. 5. **Hunt, John**, Dart Programming for Flutter: The Complete Guide, Springer, 1st Edition, 2021.
11	**Reference Books**

	1. **Rippel, Simone; and Tayar, Peter**, Flutter Cookbook: Over 100 Recipes to Build Mobile Applications, Packt Publishing, 2nd Edition, 2021. 2. **Khadka, Sanjib Sinha**, Google Flutter by Example, BPB Publications, 1st Edition, 2020. 3. **Biessek, Marco L.**, Flutter and Dart Cookbook, Packt Publishing, 1st Edition, 2019. 4. **Google Flutter Team**, Flutter Documentation and API Guide, Google Developers, 2024 (Online Reference). 5. **JetBrains Team**, Dart Official Documentation, Dart.dev, 2024 (Online Reference).
12	**Internal Continuous Assessment: 40%**
	Continuous Evaluation through: Students are expected to attend each practical and submit the written practical of the previous session. Performing Practical and writeup submission will be continuous internal evaluation. 2.5 marks can be awarded for each practical performance and writeup submission totaling to 50 marks and can be converted to 20 marks.
13	**Semester End Examination: 60%**
	30 marks Semester End Examination
14	**Format of Question Paper: (Semester End Examination : 30 Marks. Duration: 2 hrs)** **Certified copy of Journal is compulsory to appear for the practical examination** **Practical Slip:** Q1. From Module 1 13 marks Q2. From Module 2 12marks Q3. Journal and Viva 05 marks

Syllabus
B.Sc. (Information Technology)
(Sem.- V)

Name of the Course: IT Act 2000 and subsequent amendments

Sr.No.	Heading	Particulars
1	**Description the course :** **Including but Not limited to:**	This course helps students understand the laws that apply to their daily use of the internet, social media, emails, online payments, and cloud platforms. It explains what actions are legally safe or unsafe in the digital world and how cybercrimes like hacking, identity theft, and online fraud are handled under Indian law. The course empowers students to use technology responsibly, protect their data, and stay legally aware in their academic and professional lives.
2	**Vertical :**	Minor
3	**Type :**	Theory
4	**Credits :**	2 credits (1 credit = 15 Hours for Theory in a semester)
5	**Hours Allotted :**	30 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. To introduce students to the legal framework governing information technology and cyberspace in India. CO 2. To familiarize learners with the provisions of the Information Technology Act, 2000 and its subsequent amendments , to create awareness about cybercrimes, penalties, and adjudication mechanisms. CO3. To develop an understanding of data protection, privacy, and cyber security issues in the digital era. CO4. To enable students to apply cyber laws responsibly in academic, professional, and personal digital environments.	
8	**Course Outcomes (OC):** OC 1. Explain the objectives, scope, and key provisions of the Information Technology Act, 2000. OC 2. Identify cyber offences and corresponding penalties under the IT Act and related laws. OC 3. Interpret amendments to the IT Act with respect to electronic governance, digital signatures, and cyber security. OC 4. Analyze real-world cybercrime cases and apply relevant legal provisions. OC 5. Demonstrate awareness of ethical, legal, and security issues in the use of information technology.	
9	**Modules:-**	
	Module 1:Information Technology Act, 2000 – Foundations	
	● Evolution of Cyber Laws in India ● Objectives, Scope, and Importance of the Information Technology Act, 2000	

	● Definitions and Key Concepts under the IT Act ● Legal Recognition of Electronic Records and Digital Signatures ● Electronic Governance ● Electronic filing ● Issue of licenses and permits ● Certifying Authorities and Digital Signature Certificates ● Duties of Subscribers ● Offences and Penalties under IT Act, 2000 ● Adjudication and Appellate Authorities ● Powers of Controller and Adjudicating Officers
	Module 2: Amendments, Cyber Crimes, and Emerging Issues
	● Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Amendment Rules, 2022 ● Cyber Offences and Crimes: o Hacking and identity theft o Phishing, spoofing, and cyber fraud o Cyber stalking and online harassment ● Data Protection and Privacy Provisions ● Intermediary Liability and Safe Harbour Provisions ● Cyber Security and Critical Information Infrastructure ● Role of CERT-In ● Cyber Terrorism and National Security ● Case Studies on Cyber Law Violations ● Emerging Trends: o Social media misuse o Cloud computing and legal challenges o Artificial Intelligence and cyber law concerns
10	**Text Books** ● Cyber Law in India – Farooq Ahmad, Oxford University Press ● Information Technology Law and Practice – Vakul Sharma, Universal Law Publishing
11	**Reference Books** ● Cyber Laws – Justice Yatindra Singh, Universal Law Publishing ● Bare Act: Information Technology Act, 2000 (as amended)
12	**Internal Continuous Assessment: 40%**
	Continuous Evaluation through: 1. Class test of 1 of 15 marks 2. Class test of 2 of 15 marks Average of the two: 15 marks 3. Quizzes/ Presentations/ Assignments: 5 marks **4.** Total: 20 marks
13	**Semester End Examination: 60%**
	30 marks Semester End Examination

14	**Format of Question Paper: (Semester End Examination : 30 Marks. Duration:)** Q1: Attempt any three (out of five) from Module 1 (15 marks) Q2: Attempt any three (out of five) from Module 2 (15 marks)

Sem. - VI

Syllabus
B.Sc. (Information Technology)
(Sem.- VI)

Name of the Course: Cloud Computing Fundamentals

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	Cloud Computing Theory is a foundational course that introduces students to the principles, architectures, and paradigms of cloud computing. The course develops a thorough understanding of how cloud environments operate, how services are delivered and consumed, and how organizations leverage cloud platforms for scalable, cost-effective, and resilient IT infrastructure.
2	**Vertical :**	Minor
3	**Type :**	Theory
4	**Credits :**	2 credits (1 credit = 15 Hours for Theory in a semester)
5	**Hours Allotted :**	30 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1 To understand the fundamental concepts, characteristics, and historical evolution of cloud computing. CO 2 To distinguish between cloud service models (IaaS, PaaS, SaaS) and deployment models (Public, Private, Hybrid, Community). CO 3 To comprehend virtualization and containerization as the backbone of cloud infrastructure. CO 4 To analyze cloud architecture components including scalability, elasticity, multi-tenancy, fault tolerance, and load balancing. CO 5 To evaluate cloud security frameworks, compliance requirements, and the shared responsibility model. CO 6 To compare major cloud providers (AWS, Azure, GCP) and understand cloud cost management and governance.	
8	**Course Outcomes (OC):** OC1. Define cloud computing and articulate its essential characteristics, benefits, and limitations in real-world contexts. OC2. Identify and explain the differences between IaaS, PaaS, and SaaS with appropriate use-case examples. OC3. Describe virtualization technologies (hypervisors, VMs, Docker containers) and their role in cloud infrastructure.	

	OC4. Analyse cloud architectures for performance, availability, scalability, and cost-efficiency. OC5. Apply knowledge of cloud security best practices and compliance standards to evaluate cloud deployments. OC6. Select and justify the choice of cloud service provider and deployment model for given organizational requirements. OC7. Demonstrate awareness of emerging cloud trends including serverless, edge computing, and AI/ML cloud services
9	**Modules:-**
	Module 1:
	16. ▸ The vision of cloud computing — computing as a utility (analogous to water, electricity, gas, telephony); dynamic provisioning model ▸ Defining a cloud: the XaaS (Everything as a Service) paradigm; Buyya's formal definition — 'a type of parallel and distributed system consisting of a collection of interconnected and virtualised computers...' ▸ The Cloud Computing Reference Model: IaaS (virtualised servers, storage, networking), PaaS (runtime environments, development platforms), SaaS (end-user applications, CRM, social networking) ▸ Characteristics and benefits of cloud computing — elasticity, pay-per-use billing, multi-tenancy, on-demand provisioning ▸ Challenges ahead: interoperability, scalability, fault tolerance, security, trust, and privacy ▸ Historical developments: evolution from distributed systems → virtualisation → Web 2.0 → service-oriented computing → utility-oriented computing → cloud ▸ Building cloud computing environments: application development, infrastructure development, computing platforms and technologies ▸ Eras of computing: mainframe era, client-server era, internet era, cloud era ▸ Parallel vs. distributed computing — definitions, distinctions, and complementary roles ▸ Elements of parallel computing: parallel processing, hardware architectures (SIMD/MIMD), levels of parallelism, Amdahl's Law and Gustafson's Law ▸ Elements of distributed computing: general concepts, components of a distributed system, architectural styles (client-server, peer-to-peer, three-tier, n-tier) ▸ Models for interprocess communication: message passing, shared memory, remote procedure call (RPC) ▸ Technologies for distributed computing: RPC mechanisms, distributed object frameworks (CORBA, Java RMI), service-oriented computing (SOAP, WSDL, REST, web services)

	▸ Introduction to virtualisation: why it is the backbone of cloud computing infrastructure ▸ Characteristics of virtualised environments: increased security, managed execution, portability ▸ Taxonomy of virtualisation techniques: execution virtualisation (full virtualisation, para-virtualisation, hardware-assisted), and other types (OS-level, application-level, storage, network) ▸ Virtualisation and cloud computing: the relationship between VM lifecycle management and cloud elasticity ▸ Pros and cons of virtualisation: resource consolidation, isolation, overhead, complexity ▸ Technology examples: Xen (para-virtualisation), VMware (full virtualisation — vSphere, ESX, Workstation), Microsoft Hyper-V Unit 1.4 — Cloud Computing Architecture [Chapter 4] ▸ The cloud reference model in depth: layered architecture and service stack ▸ Infrastructure- and Hardware-as-a-Service (IaaS/HaaS): virtual servers, storage provisioning, networking — example: Amazon EC2, Rightscale, vCloud ▸ Platform-as-a-Service (PaaS): runtime environments, development and data processing platforms — example: Windows Azure, Hadoop, Google AppEngine, Aneka ▸ Software-as-a-Service (SaaS): end-user applications, office automation, CRM, social networking — example: Google Docs, Facebook, Flickr, Salesforce ▸ Types of clouds: Public Clouds (third-party, multi-tenant, subscription), Private/Enterprise Clouds (internal data center, high security), Hybrid Clouds (mixed use), Community Clouds ▸ Economics of the cloud: pay-per-use model, capital expenditure vs. operational expenditure (CapEx vs. OpEx), pricing strategies, billing models ▸ Open challenges: cloud definition ambiguity, interoperability and standards, scalability and fault tolerance, security/trust/privacy, and organisational aspects
	Module 2: ▸ What is data-intensive computing? Characteristics of data-intensive workloads; historical perspective (from data warehousing to Big Data) ▸ Challenges in data-intensive computing: data volume, velocity, variety, veracity — the 4Vs of Big Data in cloud context ▸ Technologies for data-intensive computing — Storage Systems: distributed file systems (GFS/HDFS), key-value stores, NoSQL databases, object storage ▸ Programming platforms for data-intensive computing: Google File System, Bigtable, Hadoop HDFS; conceptual overview

	▸ The MapReduce programming model: principles, Map and Reduce phases, shuffling and sorting, fault tolerance in distributed MapReduce ▸ Conceptual walkthrough of a MapReduce application — word count and similar examples Cloud Platforms in Industry: AWS, Google AppEngine, Microsoft Azure ▸ Amazon Web Services (AWS): Compute Services (EC2 — instance types, AMIs, Auto Scaling, Elastic Load Balancer), Storage Services (S3 — buckets and objects, EBS, Glacier), Communication Services (SQS, SNS, SES), Additional Services overview ▸ Google AppEngine: architecture and core concepts (sandbox model, datastore, memcache), application life cycle, cost model and scaling behaviour, observations and limitations ▸ Microsoft Azure: Azure core concepts (compute, storage, fabric controller), SQL Azure (relational DB as a service), Windows Azure Platform Appliance, observations ▸ Comparative analysis of the three platforms: pricing models, geographic availability, service depth, developer experience, and appropriate use cases ▸ Energy efficiency in clouds: motivations (rising data center energy costs, carbon emissions), energy-efficient and green cloud computing architecture, dynamic voltage and frequency scaling (DVFS), VM consolidation strategies ▸ Market-based management of clouds: market-oriented cloud computing (MOCC) — why market mechanisms?, a reference model for MOCC, technologies and initiatives supporting MOCC, observations ▸ Federated clouds / InterCloud: characterisation and definition of cloud federation, cloud federation stack (Service Layer, Resource Layer, Network Layer), aspects of interest (interoperability, SLA negotiation, portability), technologies for cloud federations ▸ Third-party cloud services: MetaCDN (content delivery as a third-party cloud service), SpotCloud (spot market for excess cloud capacity) ▸ Future directions: trends in cloud research — autonomic cloud management, cloud standards, hybrid and multi-cloud strategies
10	**Text Books**
11	**Reference Books** 7. Mastering Cloud Computing Foundations and Applications Programming- Rajkumar Buyya 8. CLOUD COMPUTING Principles and Paradigms-Rajkumar Buyya **9.** Cloud Computing Concepts, Technology & Architecture Thomas Erl
12	**Internal Continuous Assessment: 40%**
	Continuous Evaluation through: 1. Class test of 1 of 15 marks 2. Class test of 2 of 15 marks Average of the two: 15 marks

	3. Quizzes/ Presentations/ Assignments: 5 marks **4.** Total: 20 marks
13	**Semester End Examination: 60%**
	30 marks Semester End Examination
14	**Format of Question Paper: (Semester End Examination : 30 Marks. Duration: 1Hr)** Q1: Attempt any three (out of five) from Module 1 (15 marks) Q2: Attempt any three (out of five) from Module 2 (15 marks)

Syllabus
B.Sc. (Information Technology)
(Sem.- VI)

Name of the Course: Digital Forensics Practical

Sr.No.	Heading	Particulars
1	**Description the course :** **Including but Not limited to:**	Digital Forensics Practical is the hands-on laboratory component offered provides students with direct, tool-based experience in the discipline of cyber forensics — the science of collecting, preserving, examining, and presenting digital evidence from computers, storage media, networks, and mobile devices in a manner that is legally sound and forensically reliable. Graduates with these skills are equipped for roles such as Digital Forensic Analyst, Cyber Crime Investigator, Incident Responder, SOC Analyst, and Information Security Auditor. Students begin with a survey of the cyber forensics landscape — covering the investigation lifecycle (identification, collection, preservation, examination, analysis, and presentation), chain of custody principles, and a comparative study
2	**Vertical :**	Minor
3	**Type :**	Practical
4	**Credits :**	2 credits (1 credit = 30 Hours of Practical work in a semester)
5	**Hours Allotted :**	60 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):**	

	CO1. To introduce students to the fundamental concepts of cyber forensics and the role of digital evidence in cybercrime investigation. **CO2.** To familiarize students with various digital forensic tools and techniques used for collecting, preserving, and analyzing digital evidence. **CO3.** To develop practical skills for investigating digital devices such as computers, storage media, and networks. **CO4.** To enable students to analyze different types of digital evidence including files, emails, logs, and browser data. **CO5.** To provide basic understanding of modern cyber forensic practices such as password recovery and mobile device forensics.
8	**Course Outcomes (CO):** OC1. Understand the fundamentals of cyber forensics and identify various digital forensic tools used in investigations. OC2. Apply forensic techniques to create and verify disk images and maintain the integrity of digital evidence using hashing methods. OC3. Analyze digital evidence by recovering deleted files, examining metadata, and investigating browser and system activities. OC4. Perform basic cybercrime investigation techniques including email analysis, network traffic analysis, and log file examination. OC5. Demonstrate awareness of modern forensic practices including password recovery techniques and basic mobile device forensics.
9	**Modules:-**
	Module 1:
	1. **Study of Cyber Forensics Tools** Study and installation of popular digital forensic tools such as **Autopsy, FTK Imager, EnCase, and Wireshark**. 2. **Creating and Verifying Disk Images** Create a forensic image of a storage device using **FTK Imager** and verify its integrity using **hash values (MD5/SHA1)**. 3. **Recovering Deleted Files** Perform recovery of deleted files from a storage device using tools like **Recuva or Autopsy**. 4. **Analysis of File Metadata** Extract and analyze metadata of files (documents, images) using tools like **ExifTool**. 5. **Password Cracking Techniques** Demonstrate password recovery using tools like **John the Ripper or Hashcat** on encrypted files.
	Module 2:

	6 **Email Forensics** Analyze email headers to trace sender information and detect phishing attempts. 7 **Network Traffic Analysis** Capture and analyze network packets using **Wireshark** to identify suspicious activities. 8 **Log File Analysis** Examine system and application log files to detect unauthorized access or security incidents. 9 **Browser Forensics** Investigate browsing history, cookies, and cached data from web browsers to identify user activity. 10 **Mobile Device Forensics (Basic Study)** Study techniques and tools used for extracting and analyzing data from mobile devices.
10	**Text Books** **1.Bill Nelson, Amelia Phillips, Christopher Steuart** Guide to Computer Forensics and Investigations, Cengage Learning. 2. **Eoghan Casey** Digital Evidence and Computer Crime: Forensic Science, Computers and the Internet, Academic Press.
11	**Reference Books** **1. Nelson, Bill., Phillips, Amelia., & Steuart, Christopher.** Guide to Computer Forensics and Investigations, Cengage Learning. 2. **Marcella, Albert J., & Menendez, Doug.** Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes, CRC Press. 3. **Sammons, John.** Digital Forensics: Threatscape and Best Practices, Syngress / Elsevier. 4. **Casey, Eoghan.** Digital Evidence and Computer Crime: Forensic Science, Computers and the Internet, Academic Press.
12	**Internal Continuous Assessment: 40%**
	Continuous Evaluation through: Students are expected to attend each practical and submit the written practical of the previous session. Performing Practical and writeup submission will be continuous internal evaluation. 2.5 marks can be awarded for each practical performance and writeup submission totalling to 50 marks and can be converted to 20 marks.
13	**Semester End Examination: 60%**

	30 marks Semester End Examination
14	**Format of Question Paper: (Semester End Examination : 30 Marks. Duration: 2Hr)** **Certified copy of Journal is compulsory to appear for the practical examination** **Practical Slip:** Q1. From Module 1 13 marks Q2. From Module 2 12marks Q3. Journal and Viva 05 marks

Syllabus
B.Sc. (Information Technology)
(Sem.- VI)

Name of the Course: AI Ethics

Sr.No.	Heading	Particulars
1	**Description the course : Including but Not limited to:**	AI Ethics is an interdisciplinary course that examines the moral, social, and legal implications of Artificial Intelligence. It explores issues such as bias, privacy, accountability, governance, and responsible AI development to ensure ethical and human-centered use of intelligent systems in society.
2	**Vertical :**	Minor
3	**Type :**	Theory
4	**Credits :**	2 credits (1 credit = 15 Hours for Theory in a semester)
5	**Hours Allotted :**	30 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** **CO1:** To understand the evolution of Artificial Intelligence and analyze its ethical implications in contemporary society. **CO2:** To examine philosophical perspectives on intelligence, human identity, and moral agency in relation to AI systems. **CO3:** To analyze issues of bias, fairness, privacy, transparency, and accountability in AI-driven decision-making systems. **CO4:** To evaluate the ethical use of AI in research, academia, and professional practice, including concerns of authorship and intellectual property. **CO5:** To understand AI governance frameworks, regulatory policies, and compliance mechanisms at national and global levels. **CO6:** To critically assess future challenges of AI, including societal impact, sustainability, environmental concerns, and responsible innovation.	

8	**Course Outcomes (OC):** **OC1:** Explain the foundational concepts, evolution, and ethical dimensions of Artificial Intelligence. **OC2:** Evaluate philosophical and societal debates related to AI, including issues of superintelligence, human agency, and technological impact. **OC3:** Identify and analyze ethical risks such as bias, privacy violations, and lack of transparency in AI systems. **OC4:** Apply ethical principles and regulatory guidelines to assess real-world AI applications in academic and professional contexts. **OC5:** Propose responsible and sustainable AI practices aligned with governance frameworks and societal values.
9	**Modules**
	Module I: Foundations of AI Ethics and Philosophical Perspectives
	Chapter 1: Introduction to AI and the Ethical Landscape • Evolution of Artificial Intelligence: From Symbolic AI to Generative AI • AI in Society: Real-world Applications and Impacts • Foundational Concepts in AI Ethics • AI Hype vs. Reality • Human-AI Interaction and Technological Transformation **Chapter 2: Philosophical Foundations and Human Identity** • What is Intelligence? Human vs. Artificial Intelligence • Superintelligence, Singularity, and Transhumanism • AI and the Concept of Humanity • Moral Agency and Machine Responsibility • The "Frankenstein Complex" and Ethical Narratives **Chapter 3: Bias, Fairness, and Ethical Risks** • Algorithmic Bias and Discrimination • Data Ethics and Fairness • Privacy and Surveillance • Explainability and Transparency • Responsibility and Accountability in AI Systems
	Module II: Governance, Regulation and Responsible AI Implementation
	Chapter 4: AI in Research, Academia, and Professional Practice • Ethical Use of Generative AI in Research • AI in Writing, Publishing, and Academic Integrity • Intellectual Property and Authorship Issues • Data Management and Ethical Data Handling • Responsible AI Adoption in Institutions **Chapter 5: AI Governance, Policy, and Regulation** • Global AI Regulatory Frameworks • Data Protection and Privacy Laws • Ethical Guidelines and Compliance • AI Risk Assessment and Audit Mechanisms • Institutional Governance and Policy Proposals **Chapter 6: Future Challenges and Sustainable AI**

	• AI and the Future of Work • Societal and Economic Transformations • Environmental Impact of AI (AI and Climate) • Open Science and AI • Responsible Innovation and Human-Centered AI
10	**Text Books** 1. **Haber, Eldar; Jemielniak, Dariusz; Kurasiński, Artur; and Przegalińska, Aleksandra**, Using AI in Academic Writing and Research: A Complete Guide to Effective and Ethical Academic AI, Springer Nature Switzerland AG, 1st Edition, 2025. 2. **Coeckelbergh, Mark**, AI Ethics, The MIT Press, 1st Edition, 2020. 3. Floridi, Luciano; and Cowls, Josh, The Ethics of Artificial Intelligence: Principles, Challenges, and Opportunities, Oxford University Press, 1st Edition, 2021. 4. Boddington, Paula, Towards a Code of Ethics for Artificial Intelligence, Springer International Publishing, 1st Edition, 2017. 5. Russell, Stuart, Human Compatible: Artificial Intelligence and the Problem of Control, Viking (Penguin), 1st Edition, 2019.
11	**Reference Books** 1. O'Neil, Cathy, Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy, Crown Publishing, 1st Edition, 2016. 2. Eubanks, Virginia, Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor, St. Martin's Press, 1st Edition, 2018. 3. Mittelstadt, Brent Daniel; Allo, Patrick; Taddeo, Mariarosaria; Wachter, Sandra; and Floridi, Luciano, The Ethics of Algorithms: Mapping the Debate, Big Data & Society Journal, 2016. 4. Burgess, Mary; and Galliot, Marion; (editors), Ethics and Governance of Artificial Intelligence: Global Perspectives, Routledge, 1st Edition, 2020. 5. Zuboff, Shoshana, The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power, PublicAffairs, 1st Edition, 2019.
12	**Internal Continuous Assessment: 40%**
	Continuous Evaluation through: 1. Class test of 1 of 15 marks 2. Class test of 2 of 15 marks Average of the two: 15 marks 3. Quizzes/ Presentations/ Assignments: 5 marks **4.** Total: 20 marks
13	**Semester End Examination: 60%**
	30 marks Semester End Examination

14	**Format of Question Paper:** (**Semester End Examination : 30 Marks. Duration: 1Hr)** Q1: Attempt any three (out of five) from Module 1 (15 marks) Q2: Attempt any three (out of five) from Module 2 (15 marks)

Syllabus
B.Sc. (Information Technology)
(Sem.- VI)

Name of the Course: **Green IT Practices and Sustainability**

Sr.No.	Heading	Particulars
1	**Description the course :** **Including but Not limited to:**	This course provides a comprehensive understanding of Green ICT and its challenges. It covers various environmental impacts, ICT Metrics, sustainable cloud computing parameters and effects on software design perspectives on sustainability
2	**Vertical :**	Minor
3	**Type :**	Theory
4	**Credits :**	2 credits (1 credit = 15 Hours for Theory in a semester)
5	**Hours Allotted :**	30 Hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives(CO):** CO 1. Understand challenges for Green ICT CO 2: Discuss various environmental impacts CO 2: Learn different aspects of ICT metrics CO 3: Identify Sustainable Cloud Computing Parameters CO 4: Explore effects of software design on sustainability.	
8	**Course Outcomes (OC):** CO1: Classify the challenges for Green ICT CO2: Relate the environmental impact due to emerging technologies CO3: Demonstrate different aspects of ICT metrics.	

	CO4: Compare the various parameters related to Sustainable Cloud Computing. CO5: Interpret the effects of software design on the sustainability.
9	**Modules:-**
	Module 1: **Green ICT -History, Agenda, and Challenges Ahead:** Introduction, Industrial Revolution, The Emergence of Information and Communication Technologies, The Agenda and Challenges Ahead **Emerging Technologies and Their Environmental Impact:** Introduction, Number of Connected Devices, Increased, Functionality, Increased Number of Separate Functions, Increased Demand for Speed and Reliability, Obsolescence—The Problem of Backward Compatibility, The Other Side of the Balance Sheet, Video conference as an Alternative to Business Travel, Dematerialization of Product Chain, Travel Advice/Road Traffic Control, Intelligent Energy Metering, Building Management Systems, Saving IT. **Measurements and Sustainability:** Introduction, ICT Technical Measures, Ecological Measures and Ethical Consideration, Systems Engineering for Designing Sustainable ICT-Based Architectures.
	Module 2: **Sustainable Cloud Computing:** Introduction, Challenges in the Use of Cloud Computing As Green Technology, Cloud Computing and Sustainability, Sustainable Applications of Cloud Computing, Technologies Associated With Sustainable Cloud Computing, Future Prospects of Sustainable Cloud Computing, Reflections on Sustainable Cloud Computing Applications**.** **Sustainable Software Design:** Overview and Scope, Evaluating Sustainability Effects, Sustainability and the Product Life Cycle , Direct Effects: Sustainability During Use, Runtime Energy Consumption Basics , Analysing the Energy Consumption of an Application , Energy Consumption Reduction Using Physical Properties of Semiconductors, Optimizing the Energy Consumption of an Application: Compiler Techniques, Optimizing the Energy Consumption of an Application: Runtime Approaches**.**
10	**Text Books:** 1. Green Computing and Green IT Best Practice by Jason Harris, Emereo 2. Green Computing Tools and Techniques for Saving Energy, Money and Resources by Bud E. Smith, CRC Press 3. 3. Green Data Center: Steps for the Journey by Alvin Galea, Michael Schaefer, Mike Ebbers, Shroff Publishers and Distributors
11	**Reference Books** 1. 1.Green Information Technology – A Sustainable Approch, Mohammad Dastbaz Colin Pattinson, Babak Akhgar, Elsevier, 2015 Inc. 2. San Murugesan; G. R. Gangadharan, Harnessing Green IT: Principles and

	Practices, Wiley-IEEE Press.
12	**Internal Continuous Assessment: 40%**
	Continuous Evaluation through: 1. Class test of 1 of 15 marks 2. Class test of 2 of 15 marks Average of the two: 15 marks 3. Quizzes/ Presentations/ Assignments: 5 marks **4.** Total: 20 marks
13	**Semester End Examination: 60%**
	30 marks Semester End Examination
14	**Format of Question Paper: (Semester End Examination : 30 Marks. Duration:1Hr)** Q1: Attempt any three (out of five) from Module 1 (15 marks) Q2: Attempt any three (out of five) from Module 2 (15 marks

Sd/-	**Sd/-**	**Sd/-**
Sign of the BOS	**Sign of the**	**Sign of the Offg. Dean**
Dr. R. Srivaramangai	**Offg. Associate Dean**	**Prof. Shivram S. Garje**
Chairman/Co-ordinator	**Dr. Madhav R. Rajwade**	**Faculty of Science &**
BOS/Ad-hoc BOS in	**Faculty of Science &**	**Technology**
Information Technology	**Technology**	