AC – 25/03/2026
Item No. – 6.18 (N) (8)

As Per NEP 2020

University of Mumbai

Syllabus for Minor Vertical II	
Faculty of Science & Technology	
Board of Studies in Computer Science	
UG Third Year Programme in Minor B.Sc. (Computer Science)	
Semester V	
Title of Paper	**Total Credits 4**
I) Cyber Security	**2**
II) Cyber Security Practical	**2**
Semester VI	
Title of Paper	**Total Credits 4**
I) AI & Data Science	**2**
II) AI & Data Science Practical	**2**
From the Academic Year	**2026 – 2027**

Sem. – V

Name of the Course: Cyber Security

Sr. No.	Heading	Particulars
1	**Description the course:**	**Introduction:** Cyber Security focuses on protecting computer systems, networks, and digital information from unauthorized access, attacks, and misuse. With increasing reliance on digital technologies, understanding basic cybersecurity principles has become essential for ensuring safe and responsible use of information systems. **Relevance:** The growing use of online platforms, digital transactions, and networked systems has increased exposure to cyber threats. Knowledge of cybersecurity helps individuals and organizations protect sensitive data and maintain secure digital environments. **Usefulness:** This course helps students develop awareness about cyber threats, security practices, and safe digital behaviour. It introduces fundamental concepts such as cryptography, authentication, and basic network security mechanisms. **Application:** The concepts learned can be applied in protecting personal data, understanding secure communication methods, and adopting safe practices while using digital platforms and information systems. **Interest:** Cybersecurity is a dynamic and evolving field that involves understanding real-world cyber threats and the techniques used to prevent them, making it both practical and engaging for students. **Connection with Other Courses:** This course supports learning in related areas such as Computer Networks, Operating Systems, Web Technologies, Data Privacy, and Cloud Computing by introducing the security aspects of digital systems. **Demand in the Industry:** With increasing cyber attacks and digital transformation across sectors, organizations require professionals with

		cybersecurity awareness and basic security knowledge to safeguard information systems. **Job Prospects:** Students may explore roles such as Security Analyst, Network Security Associate, SOC Analyst, Ethical Hacker, or pursue advanced studies and certifications in cybersecurity.
2	**Vertical:**	Minor
3	**Type:**	Theory
4	**Credits:**	2 credits
5	**Hours Allotted:**	30 hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives (CO):** **CO 1.** To introduce the basic concepts and principles of cybersecurity. **CO 2.** To familiarize students with common cyber threats and vulnerabilities. **CO 3.** To understand fundamental cryptographic techniques used for secure communication. **CO 4.** To provide an overview of network and web security practices. **CO 5.** To create awareness about cyber laws, digital ethics, and safe use of technology.	
8	**Course Outcomes (OC):** After successful completion of this course, students would be able to - **OC 1.** Explain the fundamental concepts and importance of cybersecurity. **OC 2.** Identify common cyber threats, attacks, and vulnerabilities. **OC 3.** Understand the role of cryptography in securing digital communication. **OC 4.** Describe basic mechanisms used for network and web security. **OC 5.** Demonstrate awareness of cyber laws, digital ethics, and responsible digital behaviour.	
9	**Modules:** **Module 1:**	
	Introduction to Cyber Security: Definition and Need of Cyber Security, CIA Triad, Types of Security Attacks, Malware Types: Virus, Worm, Trojan, Ransomware, Spyware, Cyber Threat Landscape (APT, Hacktivism, Insider Threats), Ethical Hacking vs Malicious Hacking **Security Architecture and Mechanisms:** OSI Security Architecture, Security Services and Mechanisms, Authentication, Authorization, Accounting (AAA Model), Multi-Factor Authentication (MFA) **Cryptography Fundamentals:** Symmetric Key Cryptography, Substitution &	

	Transposition Techniques, Block vs Stream Ciphers, DES, AES **Public Key Cryptography:** Principles, RSA, Diffie-Hellman Key Exchange, Hash Functions, MD5, SHA Family, Message Authentication Codes (MAC), Digital Signatures **Key Management & PKI:** Public Key Infrastructure (PKI), Digital Certificates, X.509 Overview, Role of Certificate Authorities	
	Module 2:	
	Network Security: Firewalls Introduction, Types of Firewalls, Intrusion Detection & Prevention Systems, Virtual Private Network (VPN), Secure Socket Layer (SSL) / Transport Layer Security (TLS), IP Security **Web and Application Security**: Web Security Threats, SQL Injection, Cross-Site Scripting (XSS), Phishing, Secure Coding Principles, Email Security (PGP & S/MIME) **Cyber Laws and Ethics:** Cyber Crimes and Types, IT Act 2000 and Amendments, Digital Evidence and Introduction to Cyber Forensics (Introduction), Privacy and Data Protection, Responsible Disclosure **Emerging Trends in Cyber Security:** Cloud Security, IoT Security, AI in Cyber Security, Zero Trust Architecture	
10	**Text Books** 1. Cryptography and Network Security: Principles and Practice 7th edition, William Stallings, Pearson 2. Certified Ethical Hacker: Matt Walker, TMH.	
11	**Reference Books** 1. Cryptography and Network Security, 2nd edition, Behrouz A Fourouzan, Debdeep Mukhopadhyay, TMH. 2. Atul Kahate, “Cryptography and Network Security”, Tata McGraw-Hill.	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60%**

Name of the Course: Cyber Security Practical

Sr. No.	Heading	Particulars
1	**Description the course:**	**Introduction:** Cyber Security has emerged as a critical domain in the digital era where organizations, governments, and individuals rely heavily on information systems and networked technologies. The Cyber Security Practical course provides hands-on exposure to essential security concepts such as network monitoring, vulnerability assessment, cryptography, web security, and intrusion detection. Through laboratory-based exercises, students learn to identify security threats, analyze vulnerabilities, and implement basic defensive mechanisms in controlled environments. **Relevance:** With increasing cyber threats, data breaches, and digital transformation across industries, knowledge of cyber security practices has become indispensable. This course introduces students to practical security tools and techniques that are widely used in modern cyber defense and ethical security testing. **Usefulness:** The course equips students with fundamental practical skills in network analysis, system security, cryptographic techniques, and web application security. It develops analytical thinking and awareness of secure computing practices required for protecting digital assets. **Application:** The concepts and tools learned in this course can be applied in areas such as vulnerability assessment, security auditing, network monitoring, secure software development, and digital forensics. The practical knowledge gained also supports implementation of security best practices in real-world computing environments. **Interest:** Cyber Security is a highly engaging field that combines problem-solving, investigative thinking, and technology. Practical experiments involving security testing tools, encryption techniques, and network monitoring stimulate curiosity and motivate students to

		explore advanced areas of cyber defense. **Connection with Other Courses:** This course complements subjects such as Computer Networks, Operating Systems, Data Communication, Database Systems, and Cloud Computing by introducing the security aspects associated with these technologies. It also supports advanced studies in Ethical Hacking, Digital Forensics, and Information Security. **Demand in the Industry:** Cyber security professionals are in high demand globally due to the increasing number of cyber attacks and the growing dependence on digital systems. Organizations across sectors such as finance, healthcare, government, e-commerce, and IT require skilled professionals capable of protecting information infrastructure. **Job Prospects:** Students gaining foundational knowledge in cyber security can pursue careers as Cyber Security Analyst, Information Security Specialist, Security Operations Center (SOC) Analyst, Penetration Tester, Network Security Engineer, or Security Auditor. The course also serves as a foundation for advanced certifications such as CEH, Security+, CISSP, and OSCP.
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):** **CO 1.** To introduce students to the fundamental concepts of cyber security and ethical security practices. **CO 2.** To provide hands-on experience with tools used for network monitoring, vulnerability scanning, and system security. **CO 3.** To develop practical understanding of cryptographic techniques and secure communication methods. **CO 4.** To enable students to identify and analyze common security vulnerabilities in networks and web applications. **CO 5.** To promote awareness of defensive security mechanisms and responsible cyber practices.	

8	**Course Outcomes (OC):** After successful completion of this course, students would be able to - **OC 1.** Understand the basic principles and practices of cyber security in computing environments. **OC 2.** Perform basic network reconnaissance, packet analysis, and vulnerability scanning using standard security tools. **OC 3.** Demonstrate implementation of basic cryptographic techniques for secure communication. **OC 4.** Identify common security vulnerabilities in systems and web applications. **OC 5.** Apply appropriate security measures and analyze security incidents in controlled laboratory environments.
9	**Modules:** **Module 1:**
	Installation and Configuration of Kali Linux Set up a controlled penetration testing environment for performing ethical security experiments. **Network Reconnaissance using Nmap** Identify open ports, running services, and OS fingerprinting of target machine in a lab network. Tool: Nmap **Packet Analysis using Wireshark** Inspect TCP handshake, HTTP requests, DNS queries and detect suspicious patterns. Tool: Wireshark **DNS Enumeration and WHOIS Lookup** Extract domain information, subdomains, mail servers, and name servers of a test domain. Tools: nslookup, dig, whois **Vulnerability Scanning using OpenVAS / Nessus (Community Edition)** Scan a vulnerable VM (e.g., Metasploitable) and generate vulnerability report. **Password Cracking using John the Ripper / Hydra** Crack weak passwords from sample hash file and analyze time complexity. **Firewall Configuration in Linux (iptables / ufw)** Create rules to block specific ports and restrict SSH access. **Sniffing and ARP Spoofing Demonstration** Capture traffic between two machines using ARP poisoning. Tools: Ettercap, arpspoof **Intrusion Detection using Snort** Detect malicious traffic using custom Snort rules. **Log Analysis and Incident Identification** Examine authentication logs and identify brute-force attempts.

	Module 2:	
	Web Application Vulnerability Testing using OWASP ZAP Scan a vulnerable web application and interpret vulnerability findings. **SQL Injection Attack Demonstration** Bypass login authentication in a vulnerable test application. Platform: DVWA (Damn Vulnerable Web App) **Cross-Site Scripting (XSS) Attack Demonstration** Inject malicious JavaScript in vulnerable form fields. **Hashing Algorithms Implementation** Compare hash outputs and demonstrate collision resistance concept. **Symmetric Encryption using AES** Implement secure file encryption tool in Python. **Public Key Cryptography using RSA** Securely exchange messages between two users. **Digital Signature Implementation** Demonstrate integrity and non-repudiation using digital signatures. **SSL/TLS Certificate Inspection** Analyze certificate validity, issuer, and encryption protocol used by a website. Tools: Browser Dev Tools / OpenSSL **Steganography Implementation** Implement simple LSB-based image steganography in Python. **Basic Malware Analysis (Static Analysis)** Extract strings and analyze executable behavior without execution.	
10	**Text Books** 1. Cryptography and Network Security: Principles and Practice 7th edition, William Stallings, Pearson	
11	**Reference Books** 3. Cryptography and Network Security, 2nd edition, Behrouz A Fourouzan, Debdeep Mukhopadhyay, TMH. 1. **Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill.**	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60%**

Sem. – VI

Name of the Course: AI & Data Science

Sr. No.	Heading	Particulars
1	**Description the course:**	**Introduction:** Artificial Intelligence (AI) and Data Science are transforming the way organizations analyze information, automate decision-making, and create intelligent systems. This course introduces students to the fundamental concepts of AI and data-driven technologies, including data analysis, machine learning basics, and intelligent applications. It provides an overview of how data is collected, processed, and used to build predictive and intelligent solutions in modern digital environments. **Relevance:** With the rapid digitalization of society, AI and Data Science have become essential across multiple disciplines such as business, healthcare, governance, education, and engineering. This course helps students understand how intelligent technologies operate and prepares them to engage with emerging digital ecosystems and data-driven decision-making processes. **Usefulness:** The course develops analytical thinking and introduces students to basic tools and techniques used in AI and Data Science. It helps learners understand data interpretation, algorithmic thinking, and the role of machine learning in solving real-world problems. **Application:** Concepts learned in this course can be applied in areas such as predictive analytics, recommendation systems, automation, fraud detection, healthcare analytics, and smart decision systems. Students gain awareness of how AI-driven applications operate in everyday technologies such as search engines, digital assistants, and data dashboards. **Interest:** Artificial Intelligence and Data Science represent some of the most exciting and rapidly evolving areas of modern technology. The interdisciplinary nature of these fields stimulates curiosity and encourages students to explore innovative solutions to complex problems using

		data and intelligent algorithms. **Connection with Other Courses:** This course complements subjects such as Programming, Statistics, Database Systems, Machine Learning, Data Analytics, and Cloud Computing. It provides a foundational understanding that supports advanced study in emerging areas such as AI, Big Data Analytics, and Intelligent Systems. **Demand in the Industry:** Industries across sectors are increasingly relying on AI and data analytics to improve efficiency, optimize decision-making, and develop intelligent services. Skills related to data analysis, machine learning, and AI technologies are among the most sought-after competencies in the global technology workforce. **Job Prospects:** Although this course serves as a foundational introduction, it prepares students for further specialization leading to roles such as Data Analyst, AI Engineer, Machine Learning Engineer, Data Scientist, Business Intelligence Analyst, and AI Product Specialist.
2	**Vertical:**	Minor
3	**Type:**	Theory
4	**Credits:**	2 credits
5	**Hours Allotted:**	30 hours
6	**Marks Allotted:**	50 Marks
7	**Course Objectives (CO):** **CO 1.** To introduce the fundamental concepts of Artificial Intelligence and Data Science. **CO 2.** To develop an understanding of data-driven problem solving and analytical thinking. **CO 3.** To familiarize students with basic machine learning techniques and intelligent systems. **CO 4.** To highlight real-world applications of AI and data analytics across various industries. **CO 5.** To create awareness about ethical considerations and responsible use of AI technologies.	
8	**Course Outcomes (OC):** After successful completion of this course, students would be able to - **OC 1.** Explain fundamental concepts of Artificial Intelligence and Data Science.	

	OC 2. Understand the process of data collection, analysis, and visualization. **OC 3.** Identify basic machine learning techniques and their applications. **OC 4.** Analyze real-world scenarios where AI and data analytics are applied. **OC 5.** Demonstrate awareness of ethical issues related to AI and data usage.	
9	**Modules:** **Module 1:**	
	Introduction to Artificial Intelligence: What is AI? History and Evolution, Applications of AI, Intelligent Agents: Concept and Types **Introduction to Data Science:** What is Data Science?, Data Types (Structured, Semi-structured, Unstructured), Data Lifecycle, Role of Statistics in Data Science **Data Preprocessing and Exploration:** Data Cleaning, Handling Missing Values, Basic Data Visualization (Bar charts, Pie charts, Line graphs), Introduction to Python Libraries (NumPy, Pandas, Matplotlib) **Basic Machine Learning Concepts:** Supervised vs Unsupervised Learning, Classification and Regression, Clustering Concept, Overfitting and Underfitting	
	Module 2:	
	Core Machine Learning Algorithms: Linear Regression, K-Nearest Neighbour, Decision Trees, Introduction to Neural Networks **Introduction to Deep Learning and Generative AI:** What is Deep Learning?, Basics of Artificial Neural Networks, Introduction to Generative AI, Use cases of tools like Chatbots and LLMs **Data Visualization and Basic Analytics:** Descriptive Analytics, Predictive Analytics, Simple Dashboard Concept, Introduction to Data Storytelling **Ethical AI and Responsible Data Usage:** Bias in AI, Data Privacy and Protection, AI and Society, Responsible AI Principles	
10	**Text Books** 1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2010. 2. Data Science from Scratch First Principles with Python- Joel Grus O'reilly, 2nd Edition	
11	**Reference Books** 1. Artificial Intelligence: Foundations of Computational Agents, David L Poole,Alan K. Mackworth, 2nd Edition, Cambridge University Press ,2017. 2. Introduction to Machine Learning with Python, Andreas C. Muller, Sarah Guido, Oreilly, First Edition	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60%**

Name of the Course: AI & Data Science Practical

Sr. No.	Heading	Particulars
1	**Description the course:**	**Introduction:** The AI & Data Science Practicals course provides hands-on exposure to fundamental concepts of Artificial Intelligence and Data Science through practical exercises using Python-based tools and libraries. Students learn to work with different types of data, perform preprocessing, apply basic machine learning algorithms, visualize insights, and explore emerging technologies such as neural networks and generative AI. The course emphasizes practical understanding and real-world data analysis skills suitable for beginners. **Relevance:** Artificial Intelligence and Data Science are among the most transformative technologies shaping modern industries. This course equips students with practical skills required to analyze data, build simple predictive models, and understand AI-driven applications, making the subject highly relevant to contemporary technological and societal developments. **Usefulness:** The practical exercises help students develop foundational skills in data handling, statistical analysis, machine learning, and visualization. These skills enable students to interpret data-driven insights, understand intelligent systems, and apply AI tools effectively in academic and professional contexts. **Application:** The knowledge and skills gained in this course can be applied in various domains including business analytics, healthcare analytics, recommendation systems, financial forecasting, social media analysis, and intelligent automation. **Interest:** The course introduces students to exciting and rapidly evolving areas such as machine learning, neural networks, chatbots, and generative AI. Through hands-on activities and real datasets, students gain exposure to modern AI technologies that stimulate curiosity and encourage further exploration in data-driven

		technologies. **Connection with Other Courses:** This course complements subjects such as Artificial Intelligence, Machine Learning, Statistics, Data Analytics, Python Programming, and Database Systems, and strengthens the practical understanding of concepts introduced in the AI & Data Science theory course. **Demand in the Industry:** AI and Data Science skills are increasingly demanded across industries including IT, finance, healthcare, e-commerce, manufacturing, and governance. Organizations rely on data-driven decision making and intelligent systems, creating strong demand for professionals with basic data analysis and AI skills. **Job Prospects:** Students with foundational knowledge of AI and Data Science can pursue roles such as Data Analyst, Junior Data Scientist, Business Analyst, Machine Learning Assistant, AI Support Engineer, and Data Visualization Specialist, or continue advanced studies in Artificial Intelligence, Data Science, and related fields.
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):** **CO 1.** To introduce students to practical aspects of Artificial Intelligence and Data Science. **CO 2.** To develop skills in data preprocessing, exploration, and visualization using Python tools. **CO 3.** To provide hands-on experience with basic machine learning algorithms and data analysis techniques. **CO 4.** To familiarize students with neural networks, generative AI tools, and simple intelligent systems. **CO 5.** To create awareness about ethical AI practices and responsible use of data.	
8	**Course Outcomes (OC):** After successful completion of this course, students would be able to -	

	OC 1. Work with different types of datasets and perform basic data preprocessing and cleaning. **OC 2.** Analyze and visualize data using Python libraries such as NumPy, Pandas, and Matplotlib. **OC 3.** Implement simple machine learning models for classification, regression, and clustering. **OC 4.** Demonstrate basic understanding of neural networks and generative AI tools. **OC 5.** Interpret analytical results and communicate insights through visualizations and dashboards. **OC 6.** Understand ethical considerations related to AI, data privacy, and responsible use of technology.
9	**Modules:** **Module 1:**
	Working with Different Types of Data Load and explore: CSV file (Structured data), JSON file (Semi-structured data), Text file (Unstructured data), Understand format differences. **Understanding Data Lifecycle** Choose a simple dataset and document steps: Collection → Cleaning → Analysis → Visualization → Conclusion. **Basic Statistical Analysis using Python** Calculate Mean, Median, Standard deviation, Correlation and Interpret results. **Handling Missing Data** Identify missing values and replace using mean or mode. **Simple Data Visualization** Create: Bar chart, Pie chart, Line graph, using Matplotlib. **Exploring Data using Pandas** Perform sorting, filtering, grouping, and summary statistics. **Introduction to Supervised Learning** Apply Linear Regression on a simple dataset **Introduction to Classification** Apply Logistic Regression for pass/fail prediction. **Introduction to Clustering** Apply K-Means clustering on a small dataset **Demonstrating Overfitting** Train a simple regression model with increasing polynomial degree and observe performance changes.
	Module 2:

	Linear Regression using Scikit-Learn Predict house prices or sales data. **K-Nearest Neighbour (KNN)** Classify Iris dataset using different K values. **Decision Tree Classification** Build a simple decision tree and visualize decision rules. **Model Evaluation Basics** Generate Confusion Matrix, Accuracy, Precision & Recall for a given model **Introduction to Neural Networks** Build a simple ANN model for binary classification using Keras. **Basic Deep Learning Demonstration** Train a small neural network on MNIST dataset (few epochs only). **Introduction to Generative AI Tools** Use a pre-trained LLM tool to Generate a summary, Generate short content, Discuss limitations. **Simple Chatbot Development** Develop a rule-based chatbot for FAQ using Python. **Creating a Simple Dashboard** Build a small dashboard using Streamlit showing charts and basic predictions. **Ethical AI Case Study** Identify bias in a small dataset and write a short report discussing Bias, Privacy concerns, Responsible AI practices	
10	**Text Books** 1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 3rd Edition, Pearson, 2010. 2. Data Science from Scratch First Principles with Python- Joel Grus O'reilly, 2nd Edition	
11	**Reference Books** 1. Artificial Intelligence: Foundations of Computational Agents, David L Poole,Alan K. Mackworth, 2nd Edition, Cambridge University Press ,2017. 2. Introduction to Machine Learning with Python, Andreas C. Muller, Sarah Guido, Oreilly, First Edition 3. Hands-On Programming with R, Garrett Grolemund,1st Edition, 2014	
12	**Internal Continuous Assessment: 40%**	**Semester End Examination: 60%**

EVALUATION SCHEME

A. Evaluation for Theory Courses (2 Credit Courses)

I. Internal Evaluation for Theory Courses – 20 Marks

Sr. No.	Component
1	**Class Tests** Class Test 1 on Module 1: 10 marks Class Test 2 on Module 2: 10 marks **Average of 2 Class Tests: 10 marks**
2	**Assignments** Assignment on Module 1: 5 marks Assignment on Module 2: 5 marks **Total of 2 Assignments: 10 marks**
	Total: 20 Marks

II. External Examination for Theory Courses – 30 Marks

A **Semester End Theory Examination** of **1 hour duration** for **30 marks** as per the paper pattern given below:

Total Marks: 30 **Duration: 1 Hour**

Question	Based On	Options	Marks
Q. 1	Module 1	*Any 2 out of 4*	10
Q. 2	Module 2	*Any 2 out of 4*	10
Q. 3	Module 1 & 2	*Any 2 out of 4*	10

B. Evaluation for Practical Courses (2 Credit Courses)

I. Internal Evaluation for Practical Courses – 20 Marks

Sr. No.	Component
1	**Mid – Term Practical Examination 15 marks**
2	**Final Journal: 5 marks**
	Total: 20 Marks

II. External Examination for Practical Courses – 30 Marks

A **Semester End Practical Examination** of **2 hours duration** for **30 marks** as per the paper pattern given below.

Total Marks: 30 **Duration: 2 Hours**

Question	Practical Question Based On	Marks
Q. 1	Module 1	15
Q. 2	Module 2	15

Certified Journal is **compulsory** for appearing at the time of Practical Exam

Sd/-	**Sd/-**	**Sd/-**
Sign of the BOS Chairman	**Sign of the Offg. Associate Dean**	**Sign of Offg. Dean**
Dr. Jyotshna Dongardive	**Dr. Madhav R. Rajwade**	**Prof. Shivram S. Garje**
Ad-hoc BOS (Computer Science)	Faculty of Science & Technology	Faculty of Science & Technology