

Punyashlok Ahilyadevi Holkar Solapur University, Solapur



Name of the Faculty: Science & Technology

(As per New Education Policy 2020)

Subject:-Computer Science and Engineering

Name of the Course: B. Tech. (Sem.–VII & VIII)

(Syllabus to be implemented from-2026-27)



Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science and Technology

Final Year B.Tech. (Computer Science and Engineering)

NEP 2020 Compliant Curriculum

With effect from 2026-2027

SEMESTER - VII

Course Code	Name of the Course	Engagement Hours			Credits	FA	SA			Total
		L	T	P			ESE	ISE	ICA	
						POE				
CSEPCC-13	Artificial Intelligence and Machine Learning	3			3	70	30			100
CSEPCC-14	Information And Cyber Security	2		2	3	70	30	25		125
CSEPEC-04	Project Elective Course-IV or MOOCS##	4			4	100				100
CSEProject	Capstone Project			8*	4			100	100	200
RM	Research Methodology and IPR	3		2	4	70	30	25		125
MDM-05	MD Minor-V	2			2	70	30			100
	Total	14		12	20	380	120	150	100	750

PCC-Programme Core Course

PEC-Programme Elective Course

AEC- Ability Enhancement Course

MDM-Multidisciplinary Minor: It should be selected from other UG Engineering Minor Programme.

Semester - VIII

Course Code	Name of the Course	Engagement Hours			Credits	FA	SA			Total
		L	T	P			ESE	ISE	ICA	
						POE				
CSEPCC-10	Data Science	4#			4	100				100
CSEPEC-05	Self learning offered by Institute / MOOC Courses	4#			4	100				100
CSEOJT	On-Job Training			24	12			200	100	300
	Total	8		24	20	200		200	100	500

Programme Elective Course-IV

PEC/Sem	Course code and name
CSEPEC - 04/ VII	CSEPEC - 04A: DevOps
	CSEPEC - 04B: Business Intelligence
	CSEPEC - 04C: Distributed Systems
OR	
CSEPEC - 04/ VII	MOOC Courses offered by NPTEL/SWAYAM
	CSEPEC – 04D : <As per the list provided by BoS>
	CSEPEC – 04E : <As per the list provided by BoS>

PEC/Sem	Course code and name
CSEPEC - 05/VIII	MOOC Courses offered by NPTEL/SWAYAM
	CSEPEC – 05E: <As per the list provided by BoS>
	CSEPEC – 05F: <As per the list provided by BoS>

CSEHON: CSE Honors

Honors in Artificial Intelligence and Machine Learning

Semester	Course Code	Name of the Course	Engagement Hours			Credits	FA	SA		Total
			L	T	P		ESE	ISE	ICA	
VII	CSEHON-05A	Mini Project	--	--	4*	2	--	--	50	50

Honors in Cyber Security

Semester	Course Code	Name of the Course	Engagement Hours			Credits	FA	SA		Total
			L	T	P		ESE	ISE	ICA	
VII	CSEHON-05B	Mini Project	--	--	4*	2	--	--	50	50

Honors in Data Science

Semester	Course Code	Name of the Course	Engagement Hours			Credits	FA	SA		Total
			L	T	P		ESE	ISE	ICA	
VII	CSEHON-05C	Mini Project	--	--	4*	2	--	--	50	50

Multidisciplinary Minor in “Data Science”

Semester	Course Code	Course Title
VII	CSEMMDM-05A	Artificial Intelligence

Multidisciplinary Minor in “Software Engineering”

Semester	Course Code	Course Title
VII	CSEMMDM-05B	Information Retrieval



Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science and Technology

Final Year B.Tech (Computer Science and Engineering)

SEMESTER - VII

CSEPCC-13 : Artificial Intelligence and Machine Learning

Teaching Scheme

Lectures - 3 Hrs./week, 3 Credits

Examination Scheme

ESE - 70 Marks

ISE – 30 Marks

Course Objectives:

1. Introduce fundamental concepts of Artificial Intelligence, Machine Learning, and Deep Learning.
2. Provide knowledge of data preprocessing and exploratory data analysis techniques.
3. Develop understanding of core machine learning algorithms and their applications.
4. Explain the basics of neural networks, deep learning, and model evaluation.
5. Understand deep learning concepts and CNNs.
6. To analyze applications and impact of deep learning architectures such as U-Net, ResNet, and GoogLeNet.

Course Outcomes:

At the end of the course, students will be able to

1. Explain basic concepts of AI, ML, DL, and learning paradigms.
2. Apply data preprocessing and EDA techniques on real datasets.
3. Implement fundamental machine learning algorithms for regression and classification.
4. Build and evaluate basic neural networks and deep learning models.
5. Explain deep learning fundamentals and CNN architecture.
6. Analyze applications and impact of U-Net, ResNet, and GoogLeNet in real-world problems.

SECTION-I

Unit 1: Introduction to AI and ML

(07)

Artificial Intelligence: Definitions, History, and Evolution of AI; Understanding the relationship and differences between Artificial Intelligence, Machine Learning, and Deep Learning; Types of Learning: Supervised Learning, Unsupervised Learning, Reinforcement Learning; Applications: Real-world use cases (Healthcare, Finance, Robotics, NLP); Ethics in AI: Bias, Fairness, and Explainability.

Unit 2: Data Pre-processing and Processing

(06)

Data Basics: Types of Data (Structured vs. Unstructured, Categorical vs. Numerical); Data Cleaning: Handling missing values (Imputation), Removing duplicates, Handling outliers; Feature Engineering: Scaling: Normalization (Min-Max) and Standardization (Z-score); Encoding: One-Hot Encoding, Label Encoding; Data Splitting: Training, Validation, and Test sets; Exploratory Data Analysis: Visualization techniques and correlation analysis.

Unit 3: Machine Learning Algorithms

(07)

Linear Regression: Simple and Multiple Linear Regression, Cost Function, Gradient Descent; Decision Trees: Entropy, Information Gain, Gini Impurity, Pruning; Random Forest: Ensemble methods, Bagging, Bootstrapping; Support Vector Machines: Hyperplanes, Margins, Kernel Trick (Linear, RBF); K-Nearest Neighbors (KNN): Distance metrics (Euclidean, Manhattan), choosing 'K'.

SECTION-II

Unit 4: Introduction to Neural Networks & Model Evaluation

(08)

Foundations of NNs: Biological inspiration, The Perceptron Unit; Network Architecture: Single Layer vs. Multi-Layer Perceptron, Input/Hidden/Output layers; Training Networks: Activation Functions (Sigmoid, ReLU), Forward Propagation, Basics of Backpropagation; Problem Identification: Distinguishing between Classification, Regression, and Prediction problems; Model Evaluation & Metrics: Confusion Matrix: True Positives, False Positives, True Negatives, False Negatives; Performance Metrics: Accuracy, Precision, Recall (Sensitivity), F1-Score.

Unit 5: Introduction to Deep Learning

(07)

Need for Deep Learning for high-dimensional data (Images, Text). Deep Learning Concepts: Vanishing Gradient Problem, Overfitting in Deep Networks; Optimization in DL: Stochastic Gradient Descent, Adam Optimizer; Regularization: Dropout, L1/L2 Regularization; Introduction to CNN.

Unit 6: Application of Deep Learning

(07)

Impact of Deep Learning Algorithms: Study of application-oriented deep learning architectures such as U-Net (medical image segmentation), ResNet (deep image classification and recognition), and GoogLeNet (efficient vision models). Segmentation, Clusters, Regression Prediction etc. Testing and validation approaches.

Textbooks :

1. Machine Learning by Tom Mitchell.
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron.
3. Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.

Reference Books :

1. Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig (Pearson) – The standard comprehensive textbook for AI.
2. Pattern Recognition and Machine Learning by Christopher M. Bishop (Springer)- Great for deep mathematical understanding.
3. Deep Learning with Python by François Chollet (Manning) – Written by the creator of Keras,
4. Deep Learning; by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (MIT Press) –The definitive academic text on Deep Learning.



Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science and Technology

Final Year B.Tech (Computer Science and Engineering)

SEMESTER-VII

CSEPCC-14 : Information And Cyber Security

Teaching Scheme

Lectures - 2 Hrs./week, 2 Credits

Practical -2 Hrs/week, 1 credit

Examination Scheme

ESE - 70 Marks

ISE – 30 Marks

ICA – 25 Marks

Introduction:

Information and Cyber Security focuses on protecting information systems, digital data, and cyber infrastructure from security threats and cyber attacks. It integrates cryptographic techniques, cyber security tools, cyber laws, and digital forensics to ensure confidentiality, integrity, authentication, and availability of information in modern computing environments.

Course Prerequisite:

Students should have prior knowledge of Computer Networks, Discrete Mathematics, Basic Programming Concepts, and Operating Systems, including an understanding of data communication, number systems, modular arithmetic, and process execution.

Course Objectives:

1. To learn symmetric cipher models, classical substitution/transposition techniques, and block ciphers including DES and AES.
2. To study principles of public-key cryptography and implement secure communication using RSA, Diffie–Hellman, ElGamal, and ECC.
3. To explore cryptographic hash functions, MAC, and digital signature mechanisms for integrity and authentication.
4. To Introduce cyber security concepts, cybercrimes, and cyber laws, with specific emphasis on the Indian Information Technology Act.
5. To Identify and evaluate tools and techniques used in cybercrimes
6. To understand computer forensics principles and processes for handling digital evidence in cybercrime investigations.

Course Outcomes:

At the end of the course, students will be able to

1. Implement symmetric encryption techniques to secure digital data
 2. Apply public-key cryptography algorithms for secure key exchange and communication
 3. Evaluate cryptographic hash functions to ensure data integrity, authentication, and non-repudiation in secure systems
 4. Interpret cyber security concepts, cybercrime classifications, and Indian cyber laws to assess legal and ethical implications of cyber incidents.
 5. Analyze cyber attack tools to identify vulnerabilities
 6. Apply computer forensics principles to investigate cyber incidents.
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SECTION-I

Unit-1: Symmetric Ciphers (06)

Introduction: OSI Security Architecture, Classical Encryption techniques: Symmetric Cipher Model, Substitution Techniques, Transposition Techniques. Block Ciphers and Data Encryption Standards: Traditional Block Cipher Structure, The Data Encryption Standard, Advanced Encryption Standard: AES Transformation Functions, AES Key Expansion

Unit-2: Public key Cryptography and RSA (06)

Principles of Public-Key Cryptosystems, The RSA Algorithm. Other Public-Key Cryptosystems: Diffie-Hellman Key Exchange, Elgamal Cryptographic System, Elliptic Curve Arithmetic, Elliptic Curve Cryptography

Unit-3: Cryptographic Hash Functions and MAC (06)

Applications of Cryptographic Hash Functions, Two Simple Hash Functions, Hash Functions Based on Cipher Block Chaining, Secure Hash Algorithm (SHA). **Message Authentication Code:** Message Authentication Requirements, Message Authentication Functions, Requirements for Message Authentication Codes, Security of MAC, **Digital Signature:** Digital Signature Standard, x.509 Certificate.

SECTION-II

Unit-4 Introduction to Cyber Security (05)

Introduction, Definition and Origins of the Word, Cybercrime and Information Security, Who are Cyber Criminals, Classification of Cybercrimes, How Criminal plan the Attack, Cyberstalking. Why do we need cyber law: the Indian Context, The Indian IT Act, Digital Signature and Indian IT Act, Amendment to the Indian IT Act.

Unit-5 Tools and Method used in cybercrime (05)

Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and spywares, Virus and worms, Trojan Horses and Backdoors, DoS and DDoS Attacks, SQL Injection, Buffer Overflow.

Unit - 6 Understanding Computer Forensics (05)

Introduction, Background of Cyber Forensics , Digital Forensics Science, Need for Computer Forensics , Cyber forensics and Digital Evidence, Digital Forensics Life Cycle, Chain of Custody Concept, Challenges in Computer Forensics,

Internal Continuous Assessment (ICA) :

ICA shall consist of minimum ten practical assignment problems.

Suggested Experiment List is as follows:

1. Implementation of Substitution Cipher
2. Implementation of Transposition Cipher
3. Implementation of Block Cipher DES/AES
4. Write a program to simulate RSA algorithm
5. Implement key exchange using the Diffie-Hellman method.Algorithm
6. Implement cryptographic hash function – (SHA-1, SHA-256, and SHA-3 algorithms.)
7. Case Study on Cyber Crimes under the Indian IT Act, 2000
8. Write a program to simulate KeyLogger
9. Write a program to demonstrate working of SQL Injection attack
10. Study of different open source forensics platform such as FTK Imager, USB Write blocker, Autopsy etc.

11. Study of following tools/e-resources: Wireshark, COFEE Tool, RAM Capture, NFI Defrager, Toolsley, Volatility.
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Text Books:

1. Cryptography And Network Security - Principles and Practices, William Stallings Pearson Education Limited, 7th Edition, 2017. ISBN-13: 978-0134444284 ISBN-10: 0134444280.
 2. Cryptography and Network Security, Behrouz A. Forouzan, Tata McGraw-Hill, 2008, ISBN-13:978-0-13-187319-3. RV College of Engineering® Digital Communication Engineering 10
 3. Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Nina Godbole, Sunita Belapure
 4. Cyber Security Essentials by James Graham, Richard Howard, Ryan Olson
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Reference Books :

1. Michael Whitman and Herbert Matford, "Principles of Information Security", Course Technology Ink, 7th edition
2. Cryptography and Network Security, Atul Kahate, Tata McGraw-Hill, 2003,ISBN-81:203-2186-
3. Network Security Essentials: Applications and Standards" – William Stallings
4. Cory Altheide, Harlan Carvey, Digital Forensics with Open Source Tools, Syngress imprint of Elsevier.
5. Vacca, J, Computer Forensics, Computer Crime Scene Investigation, 2nd Ed, Charles River Media, 2005, ISBN: 1-58450-389.



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Faculty of Science and Technology

Final Year B.Tech (Computer Science and Engineering)

SEMESTER - V

CSEPEC-04A : Project Elective Course-IV : DevOps

Teaching Scheme

Lectures– 4 Hours/week, 4 Credit

Examination Scheme

ESE – 100 Marks

Introduction:

This course introduces DevOps concepts and workflows for continuous and reliable software delivery. It covers version control, CI/CD, containerization, orchestration, and cloud-based DevOps pipelines aligned with industry practices.

Course Prerequisite:

Students should have basic knowledge of programming, software development lifecycle, operating systems, and networking concepts.

Course Objectives:

1. To introduce DevOps terminology, principles, and lifecycle
2. To understand the role of version control systems in collaborative development
3. To understand Continuous Integration and Continuous Deployment concepts
4. To introduce containerization and orchestration technologies
5. To understand cloud-based DevOps workflows and their benefits

Course Outcomes:

At the end of the course, students will be able to

1. Understand the fundamental concepts of DevOps and Git
2. Apply build automation techniques using Maven
3. Comprehend the concept of continuous integration using Jenkins.
4. Explain containerization concepts and Docker architecture.
5. Describe Kubernetes architecture, components, and container orchestration concepts.
6. Use cloud services to build modern DevOps pipelines.

SECTION-I

UNIT-1 Introduction to DevOps

(08)

Evolution of software development, DevOps Definition, Goals, and Benefits, Tools we use in DevOps, Need of DevOps on Cloud, Introduction To AWS, Version control systems, Git fundamentals, Git fundamentals: repository, commit, branch (conceptual), GitHub: repositories and collaboration concepts

UNIT 2 -Compile and Build Using Maven

(07)

Introduction to Build Automation Tools, Introduction to Apache Maven, Maven architecture, Project Object Model, Maven Build lifecycle, Build Phases (compile build, test, package), Maven Repositories (local, central, global), Dependency Management Concepts

UNIT 3 - Continuous Integration Using Jenkins

(08)

CI/CD Concepts and its Importance, CI/CD workflow, Introduction to Jenkins, Jenkins Architecture Overview, Build Jobs and Configurations, Jenkins Plugins overview.

SECTION-II

UNIT 4 - Containerization with Docker

(08)

Introduction to Containerization, Introduction to Docker, Docker architecture, Basic Docker Commands, Understanding Images and Containers, Working with Containers.

UNIT 5 - Kubernetes

(07)

Need for Container Orchestration Introduction to Kubernetes, Kubernetes Architecture, Kubernetes components (cluster, node, pod), Scaling and self-healing concepts, Benefits and limitations of Kubernetes

UNIT 6 - Building DevOps Pipelines Using Cloud

(08)

Overview of Cloud-Based DevOps Services, Role of cloud platforms in DevOps pipelines, CI/CD pipeline architecture on cloud, DevOps workflow using cloud services, Build and deployment concepts, Introduction to Monitoring and logging, Benefits of cloud-based DevOps pipelines.

Text Book:

1. DevOps Tools from Practitioner's Viewpoint. Deepak Gaikwad, Viral Thakkar,. Wiley publications.
2. Jenkins, The Definitive Guide, John Ferguson Smart, O'Reilly Publication.

Reference Books :

1. The DevOps2.1 ToolKit : Docker Swarm, Building, Testing, Deploying, and Monitoring services inside Docker Swarm clusters by Viktor Farcic Packt Birmingham, Mumbai.
2. Mariot Tsitoara, "Ansible 6. Beginning Git and GitHub: A Comprehensive Guide to Version Control, Project Management, and Teamwork for the New Developer", Second Edition, 2019.



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SEMESTER - VII

CSEPEC-04B : Project Elective Course-IV : Business Intelligence

Teaching Scheme

Lectures– 4 Hours/week, 4 Credit

Examination Scheme

ESE – 100 Marks

Introduction:

This course introduces concepts, tools, and techniques of Business Intelligence for effective decision-making using data analytics, data warehousing, and mining.

Course Prerequisite:

Basic knowledge of databases, SQL, and programming concepts

Course Objectives:

1. To understand Business Intelligence concepts and architecture.
2. To study data warehousing and OLAP techniques.
3. To apply data mining and analytics for business decision making.

Course Outcomes:

At the end of the course, students will be able to

1. Understand BI frameworks and architectures.
2. Design data warehouses and OLAP systems.
3. Apply data mining techniques for business problems.
4. Use BI tools for reporting and visualization.

SECTION-I

UNIT 1 – Introduction to Business Intelligence

(08)

Business Intelligence concepts, evolution, BI architecture, components, BI applications, BI vs Business Analytics.

UNIT 2 – Data Warehousing

(07)

Data warehouse concepts, architecture, ETL process, dimensional modeling, star and snowflake schema.

UNIT 3 – OLAP

(08)

OLAP concepts, operations, MOLAP, ROLAP, HOLAP, OLAP vs OLTP, OLAP tools.

SECTION-II

UNIT 4 – Data Mining

(08)

Data mining concepts, preprocessing, classification, clustering, association rule mining.

UNIT 5 – Business Analytics and BI Tools

(07)

Business analytics types, dashboards, KPIs, BI tools like Power BI, Tableau, future trends.

Text Book:

1. Business Intelligence: A Managerial Perspective – Sharda, Delen, Turban
2. Data Mining Concepts and Techniques – Han & Kamber.



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SEMESTER - VII

CSEPEC-04C : Project Elective Course-IV : Distributed Systems

Teaching Scheme

Lectures– 4 Hours/week, 4 Credit

Examination Scheme

ESE – 100 Marks

Course Objectives:

1. To provide an Introduction to distributed Computing Systems, Distributed Operating systems and its design issues.
2. To describe various Communication techniques, message passing and Remote Procedure call mechanisms used for Inter process communication.
3. To discuss the synchronization issues such as Clock synchronization and mutual exclusion in distributed systems.
4. To study the issues and approaches for designing distributed file system.

Course Outcomes:

At the end of the course, student will be able to

1. Describe the basics of distributed systems and middleware.
2. Design and simulate distributed system software modules using various methods, strategies, and techniques presented in the course that fulfils requirements for desired properties.
3. Apply principles of distributed systems in a real world setting across multidisciplinary areas.
4. Apply knowledge of Hadoop Distributed File system, its architecture and working for active research at the forefront of these areas.

Unit – 1 Fundamentals

(05)

Fundamentals of OS, What is Distributed System? Evolution of Distributed Computing System, Distributed Computing System Models, Distributed Computing Gaining Popularity, Issues in Designing Distributed System, Introduction to Distributed Computing Environment, Protocols for Distributed Systems – FLIP and VMTP

Unit – 2 Message Passing

(06)

Introduction, Desirable features of Good Message-Passing System, Issues in IPC by Message Passing, Synchronization, Buffering, Message Passing Interface, Multi-datagram Messages, Process Addressing, Failure Handling, Group communication, Case Study: RMI, CORBA

Unit – 3 Remote Procedure Calls

(07)

Introduction, The RPC Model, Transparency of RPC, Implementing RPC mechanism, Stub Generation, RPC Messages, Marshalling Arguments and Results, Server Management, Parameter-Passing Semantics, Call Semantics, Communication Protocols for RPCs, Client-Server Binding, Exception Handling, Security

Unit – 4 Synchronization in Distributed Systems

(06)

Introduction, Process Migration, Threads, Clock Synchronization, Event Ordering, Election algorithms, Distributed Consensus algorithms

Unit – 5 Distributed Mutual Exclusion

(05)

Introduction, Classification of Mutual Exclusion Algorithms, Preliminaries, A simple solution to Distributed Mutual Exclusion, Non-Token-Based Algorithms, Lamport's Algorithm, The Ricart-Agrawala Algorithm, Token-Based Algorithms, Suzuki-Kasami's Broadcast Algorithms

Unit – 6 Distributed Deadlock Detection

(06)

Introduction, Preliminaries, Deadlock handling strategies in Distributed Systems, Issues in Deadlock Detection and Resolution, Control organizations for distributed deadlock detection, Centralized

deadlock detection algorithms, Distributed deadlock detection algorithms, Avoidance and Prevention algorithms, Hierarchical deadlock detection algorithms

Unit – 7 Distributed File Systems

(06)

Introduction, Architecture, Mechanisms for building Distributed File System, Design issues, Log-Structured file systems, Case studies- Google FS

Unit – 8 Distributed Shared Memory

(06)

Introduction, Architecture and Motivation, Algorithms for implementing DSM, Memory Coherence, Coherence Protocols, Design issues, Case studies-Linda

Text Books

1. Distributed O.S. Concepts and Design, P.K. Sinha, PHI (Unit 1, 2, 3, 4)
 2. Advanced Concepts in Operating Systems, Mukesh Singhal & N.G. Shivaratri, TMH (Unit 5, 6, 7, 8)
 3. Distributed Computing, Sunita Mahajan, Seema Shah, OXFORD University Press (Unit 1, Case studies 7, 8)
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Reference Books

1. Distributed System Principles and Paradigms, Andrew S. Tanenbaum, 2nd edition, PHI
Distributed Systems, Colouris, 3rd Edition



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SEMESTER-VII

CSEProject : Capstone Project

Teaching Scheme

Practical- 8 Hours/week, 4 Credit

Examination Scheme

ICA - 100 Marks

POE -100 Marks



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SEMESTER-VII

RM : Research Methodology and IPR

Teaching Scheme

Lectures - 3 Hours/week, 3 Credit

Practical – 2 Hours/week, 1 Credit

Examination Scheme

ESE - 70 Marks

ISE - 30 Marks

ICA – 25 Marks



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SEMESTER - VIII
CSEPCC-10: Data Science

Teaching Scheme

Lectures - # 4 Hrs./week, 4 Credits

: students will practice or attend in self-learning mode

Examination Scheme

ESE - 100 Marks

Introduction:

This course introduces the basic of data science, representation of Data and applications of data science

Course Prerequisite:

Students should have knowledge of Data Preprocessing.

Course Objectives:

1. To understand core data science concepts
2. To provide mathematical approaches for analysis of data science.
3. To Explain Data manipulation, representation and visualization techniques
4. To learn Incubation of data science in multidisciplinary domains.

Course Outcomes:

At the end of the course, students will be able to

- 1. Understand core of Data Science concepts**
- 2. Apply mathematics for data science concepts**
- 3. Analyze data, data patterns and hidden inferences**
- 4. Evaluate Data and its relationship through visualization**

SECTION-I

UNIT – 1: Introduction to Data Science

(05)

What is Data Science, importance and scope of Data Science, Big Data and Data Science, current industry scenario and career roles, types of data including structured and unstructured data and quantitative and categorical data, Big Data versus Little Data, data science lifecycle or process, role of a Data Scientist, overview of commonly used tools including Python, SQL and Power BI.

UNIT – 2: Mathematics for Data Science

(07)

Probability and Statistics: Random variables, probability mass function, joint and conditional probability, Bayes' Theorem, mean, variance and standard deviation, correlation and covariance, normal distribution.

Linear Algebra: Vectors and matrices, matrix operations, eigenvalues and eigenvectors, singular value decomposition.

UNIT – 3: Data Manipulation and Exploratory Data Analysis (08 Hours)

Data acquisition through files and APIs, basic web crawling concepts, data cleaning including handling missing values and duplicates, basic outlier handling, data transformation including normalization and encoding of categorical data, exploratory data analysis using summary statistics and pattern detection, hands-on implementation using Python with Pandas and NumPy.

SECTION – II

UNIT – 4: Data Visualization

(07)

Introduction to data visualization, importance of visualization in decision making, types of data visualization, data types for visualization, visual encodings and retinal variables, mapping variables to visual encodings, common charts including bar, line, scatter and histogram, visualization using Matplotlib and Seaborn, case study on a real-world dataset.

UNIT – 5: Model Usage and Agentic Data Science

(08)

Use of machine learning models in the data science workflow, model selection based on data and problem type, feature importance interpretation, training and validation overview, evaluation and comparison of models for decision making, integration of models into data science pipelines, introduction to agentic paradigm, automated analytics pipelines, conceptual overview of deployment and monitoring.

UNIT – 6: Applications of Data Science

(05)

Customer behavior analysis in e-commerce, demand forecasting in retail and supply chain systems, fraud detection in financial services, patient data analysis in healthcare, brief case studies emphasizing problem definition, data usage and business impact.

Text Book:

1. Introduction to Data Science: Practical Approach with R and Python B. Uma Maheswari, R.Sujatha
2. Data Science from Scratch, 2nd Edition, O’Reilly Publication
3. Data-Driven Agentic AI: Integrating Data Science and Machine Learning Kindle Edition by Anand Vemula

Reference Books :

1. Data Science by John D. Kelleher and Brendan Tierney



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Final Year B.Tech (Computer Science and Engineering)

SEMESTER-VII

Honors in Artificial Intelligence and Machine Learning

CSEHON-05A: Mini Project

Teaching Scheme

Practical – 4 Hours/week, 2 Credits

Examination Scheme

ICA– 50 Marks



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SEMESTER-VII

Honors in Cyber Security

CSEHON-05B: Mini Project

Teaching Scheme

Practical – 4 Hours/week, 2 Credits

Examination Scheme

ICA– 50 Marks



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SEMESTER-VII

Honors in Data Science

CSEHON-05C: Mini Project

Teaching Scheme

Practical – 4 Hours/week, 2 Credits

Examination Scheme

ICA– 50 Marks



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SEMESTER-VII

Multidisciplinary Minor in Data Science

CSEMDM-05A: Artificial Intelligence

Teaching Scheme

Lectures–2 Hours/week, 2 Credits

Practical – 2 Hours/week, 1 Credit

Examination Scheme

ESE –70 Marks

ISE – 30 Marks

ICA– 25 Marks

Introduction:

This course presents a basic introduction to the techniques used in developing Artificial Intelligent systems. It is a walkthrough to problem spaces and search algorithms, Knowledge representation, reasoning, logic programming and applications of Artificial Intelligence.

Course Prerequisite:

Student shall have some exposure to algorithms and programming.

Course Objectives :

1. Understand the fundamental concepts, scope, and challenges of Artificial Intelligence.
2. Analyze and design intelligent agents for problem-solving and decision-making.
3. Apply search techniques and knowledge representation methods to solve AI problems.
4. Reason under uncertainty using probabilistic and decision-theoretic models.
5. Understand learning mechanisms and knowledge acquisition techniques in AI systems.

Course Outcomes:

At the end of the course students will be able to

1. Formulate and solve sequence of actions for an agent as a search problem.
2. Infer from represented knowledge using logical and probabilistic reasoning methods.
3. Solve agent decision problems using probability theory.
4. Comprehend forms of learning and demonstrate their working.
5. Apply AI techniques to real-world problems to develop intelligent systems.
6. Examine the issues involved in knowledge bases, reasoning systems and planning

SECTION - I

Unit 1 – Overview

(04)

Foundations, scope, problems and approaches of AI, Intelligent agents: reactive, deliberative, goal driven, utility-driven, and learning agents, Forms of Learning: Supervised, Unsupervised, Semi-supervised, Statistical learning.

Unit 2 - Problem-solving through Search

(06)

Forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications.

Unit 3 - Knowledge Representation and Reasoning

(08)

Ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; first order logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications.

Probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference and sample applications

SECTION – II

Unit 4 -Representing and Reasoning with Uncertain Knowledge (08)

Probability, connection to logic, independence, Baye's rule, Bayesian networks, probabilistic inference and sample applications.

Unit 5 – Decision-Making (06)

Basics of utility theory, decision theory, sequential theory, decision problems, elementary game, sample applications.

Unit 6 –AI Applications, Ethics and Future Direction (04)

AI application in Robotics, Embedded System, IOT, Healthcare, AI –assisted programming and code generation, Ethical issues in AI: Bias, fairness, transparency Responsible AI Deployment guidelines, Future trends in Artificial intelligence

Text Books:

1. A First Course in Artificial Intelligence, Deepak Khemani, McGraw Hill Education (India)
 2. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.
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Reference Book:

1. Artificial Intelligence, Elaine Rich and Kevin Knight, Tata McGraw Hill
 2. Artificial Intelligence: A Modern Approach — Stuart J. Russell & Peter Norvig.
 3. Artificial Intelligence: A New Synthesis — Nils J. Nilsson
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Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Faculty of Science and Technology

Final Year B.Tech (Computer Science and Engineering)

SEMESTER-VII

Multidisciplinary Minor in Software Engineering

CSEMDM-05B - Information Retrieval

Teaching Scheme

Lectures–2 Hours/week, 2 Credits

Practical- 2 Hours/week, 1 Credit

Examination Scheme

ESE –70 Marks

ISE – 30 Marks

ICA – 25 Marks

Introduction:

Information Retrieval (IR) deals with the representation, storage, organization, and access of large collections of unstructured and semi-structured information. Modern engineering practice across disciplines such as mechanical, civil, electronics, and computer science relies heavily on efficient retrieval of technical documents, standards, research literature, and web content.

This course introduces the fundamental models, algorithms, and evaluation techniques of Information Retrieval, along with practical exposure to building simple retrieval systems. The course also presents an overview of recent advancements where Generative AI enhances traditional IR systems.

Course Prerequisite:

Basic understanding of:

- Data structures and algorithms
- Programming fundamentals (any one language)
- Probability and basic statistics

Course Objectives:

1. Introduce the fundamental concepts, architecture, and models of information retrieval systems.
2. Enable students to design and implement core components of IR systems such as indexing, query processing, and ranking.
3. Provide practical exposure to real-world IR applications including web search and digital libraries.
4. Teach standard evaluation metrics to assess the effectiveness of retrieval systems.
5. Familiarise students with advanced IR challenges and the role of Generative AI in modern information access systems.

Course Outcomes:

At the end of the course, students will be able to

1. Explain the architecture and working principles of information retrieval systems.
2. Apply text processing and indexing techniques for document collections.
3. Compare Boolean, Vector Space, and Probabilistic retrieval models.
4. Evaluate IR systems using standard performance metrics such as precision and recall.
5. Design a basic IR application by integrating Generative AI for enhanced retrieval.

SECTION-I

Unit 1: Introduction to Information Retrieval

(06)

- Information Retrieval: definition and scope
- Information Retrieval vs Database Systems
- IR system architecture and components

- Information needs, relevance, and user interaction
- Applications of IR in engineering and scientific domains

Unit 2: Text Processing and Index Construction (08)

- Document representation and bag-of-words model
- Tokenization, normalization, stop-word removal
- Stemming and term normalization
- Term Frequency (TF) and Inverse Document Frequency (IDF)
- Inverted index structure and construction

Unit 3: Retrieval Models (08)

- Boolean retrieval model and query processing
- Limitations of Boolean retrieval
- Ranked retrieval
- Vector Space Model
- Similarity measures and term weighting
- Overview of Probabilistic Retrieval Model

Unit 4: Evaluation of Information Retrieval Systems (06)

- Relevance assessment
- Precision, Recall, and F-measure
- Mean Average Precision (MAP)
- Introduction to relevance feedback
- Efficiency considerations in IR systems

Unit 5: Web Search, Advanced IR Challenges, and Generative AI (06)

- Web search engines: crawling, indexing, and ranking (overview)
- Domain-specific IR: digital libraries and technical document retrieval
- IR challenges: information overload, semantic ambiguity, and user intent
- Introduction to text classification and clustering for IR (conceptual)
- Generative AI in Information Retrieval:
 - Query expansion and reformulation
 - Retrieval-Augmented Generation (RAG) architecture
 - Use of GenAI tools for search, summarization, and document exploration

Internal Continuous Assessment (ICA) :

ICA–1: Conceptual Assessment (10 Marks) (Weeks 4–5)

Mode (any one):

- Written test / Quiz
- MCQs + short descriptive answers

Coverage:

- Unit 1: Introduction to IR
- Unit 2: Text processing and indexing

Sample Areas:

- IR vs DBMS
- Components of an IR system
- Tokenization, stemming, stop-word removal
- Inverted index structure
- TF–IDF concepts

CO Mapping: CO1, CO2

ICA–2: Practical / Mini-Project (10 Marks) (Weeks 7–10)

Objective:

To design and implement a **basic information retrieval system** or **IR-based application**.

Suggested Mini-Project Options (choose any one):

1. Document search system for:
 - o Engineering standards / manuals
 - o Research papers / technical reports
2. Keyword-based search engine using inverted index
3. Comparison of Boolean vs Ranked retrieval
4. IR system enhanced using GenAI tools:
 - o Query expansion using LLM
 - o AI-based document summarization over retrieved results

Expected Deliverables:

- Problem definition
- Dataset description
- IR model used
- Output demonstration
- Short report (5–7 pages)

Evaluation Rubric:

- Problem formulation – 2 marks
- Design & implementation – 4 marks
- Results & analysis – 2 marks
- Report & presentation – 2 marks

CO Mapping: CO2, CO3, CO5

ICA–3: Case Study / Presentation (10 Marks) (Weeks 11–13)

Mode:

- Group presentation (2–3 students)
- Individual submission (optional)

Suggested Topics:

- Architecture of a web search engine
- Evaluation of an IR system using precision & recall
- IR challenges in domain-specific applications
- Role of Generative AI in modern search engines
- Ethical issues and limitations of GenAI in IR

Assessment Criteria:

- Understanding of topic – 4 marks
- Clarity of explanation – 2 marks
- Technical depth – 2 marks
- Presentation & communication – 2 marks

CO Mapping: CO1, CO4, CO5

ICA Component	CO1	CO2	CO3	CO4	CO5
ICA–1	✓	✓	–	–	–
ICA–2	–	✓	✓	–	✓
ICA–3	✓	–	–	✓	✓

Textbook:

1. Introduction to Information Retrieval, Manning, C. D., Raghavan, P., & Schütze, H., Cambridge University Press.
2. Modern Information Retrieval, Baeza-Yates, R., & Ribeiro-Neto, B., Pearson.

Unit	Primary Book (Manning)	Secondary Book (Baeza-Yates)
Unit 1	Ch. 1	Ch. 1
Unit 2	Ch. 2, 3	Ch. 3
Unit 3	Ch. 1, 6, 11	Ch. 2
Unit 4	Ch. 9, 11	Ch. 4
Unit 5	Ch. 13–16, 19, 20	Ch. 7

Reference Books :

1. Croft, W. B., Metzler, D., & Strohman, T., Search Engines: Information Retrieval in Practice, Pearson.
2. Grossman, D. A., & Frieder, O., Information Retrieval: Algorithms and Heuristics, Springer.