DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF LUCKNOW

M.Sc. Computer Science (PG 2 Year) Programme

YEAR 1—SEMESTER II

CORE COURSE 6 Course code: MSCTCC201 Course Title: Artificial Intelligence & Machine Learning	
Credit: 4	
Course Objectives: ✓ To acquaint with fundamentals of artificial intelligence and machine learning. ✓ To learn feature extraction and selection techniques for processing data set. ✓ To understand basic algorithms used in classification and regression problems. ✓ To implement and analyse machine learning model in mechanical engineering problems.	
UNIT	TOPICS
Unit I	History of AI, Comparison of AI with Data Science, Need and applications of AI Introduction to Machine Learning. Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion, and manipulation. Approaches to AI- Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical. Approaches to ML- Supervised learning, Unsupervised learning, Reinforcement learning.
Unit II	Feature extraction- Statistical features, Principal Component Analysis. Feature selection Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms
Unit III	Classification, Decision tree, Random Forest, Naive Bayes, Support vector machine. Regression, Logistic Regression, Support Vector Regression, Regression trees, Decision tree, random forest, K-Nearest Neighbour (KNN). Applications of classification and regression algorithms
Unit IV	Development of ML Model, Problem identification, classification, clustering, regression, ranking. Steps in ML modelling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Predictions, Hyper parameter Tuning.
REFERENCE BOOKS:	
1.	"Mathematics for Machine Learning", Deisenroth, Faisal, Ong, Cambridge University Press, 2020.
2.	"Machine Learning and Artificial Intelligence", B Joshi, Springer, 2020
3.	"Artificial Intelligence – Building Intelligent Systems", Parag Kulkarni and Prachi Joshi, PHI learning Pvt. Ltd., 2015
4.	"Artificial Intelligence: A Modern Approach", Stuart Russell and Peter Norvig, Pearson, 2003.

DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF LUCKNOW

M.Sc. Computer Science (PG 2 Year) Programme

YEAR 1—SEMESTER II

CORE COURSE 7
Course code: MSCTCC202
Course Title: Data Communication and Computer Networks

Credit: 4

Course Objectives:

- ✓ To Focus on information sharing and networks.
- ✓ To Introduce flow of data, categories of network, different topologies.
- ✓ To Focus on different coding schemes.
- ✓ Brief the students regarding protocols and standards.
- ✓ To give clear idea of signals, transmission media, errors in data communications and their correction, networks classes and devices, etc.

UNIT	TOPICS
Unit I	Data Communications: Components – Direction of Data flow – Networks – Components and Categories – Types of Connections – Topologies –Protocols and Standards – ISO / OSI model, Example Networks such as ATM, Frame Relay, ISDN Physical layer: Transmission modes, Multiplexing, Transmission Media, Switching, Circuit Switched Networks, Datagram Networks, Virtual Circuit Networks.
Unit II	Data link layer: Introduction, Framing, and Error – Detection and Correction – Parity – LRC – CRC Hamming code, Flow and Error Control, Noiseless Channels, Noisy Channels, HDLC, Point to Point Protocols. 111 Medium Access sub layer: ALOHA, CSMA/CD, LAN – Ethernet IEEE 802.3, IEEE 802.5 – IEEE 802.11, Random access, Controlled access, Channelization.
Unit III	Network layer: Logical Addressing, Internetworking, Tunnelling, Address mapping, ICMP, IGMP, Forwarding, Uni-Cast Routing Protocols, Multicast Routing Protocols. Transport Layer: Process to Process Delivery, UDP and TCP protocols, Data Traffic, Congestion, Congestion Control, QoS, Integrated Services, Differentiated Services, QoS in Switched Networks. Application Layer: Domain name space, DNS in internet, electronic mail, SMTP, FTP, WWW, HTTP, SNMP.
Unit IV	Introduction to system and network security, security attacks, security services and mechanisms Cryptography: Traditional and Modern Symmetric-Key Ciphers, DES and AES. Asymmetric-Key Cryptography, RSA and ELGAMAL cryptosystems, Message Digest, Digital Signature, Key Management. Network Security: Security at Application Layer (E-MAIL (, PGP and S/MIME). Security at Transport Layer (SSL and TLS) Security at Network Layer (IPSec). Firewall and Intrusion Detection: Firewalls and their types. DMZ, Limitations of firewalls, Intruders, Intrusion detection (Host based, Networked, Distributed), IDS.

	Malicious software and Internet Security: Viruses and related threats, virus countermeasures, denial of service attacks, Hacking, Security policies and plan, Strategies for a secure network

REFERENCE BOOKS:

1.	"Data Communications and Networking", Behrouz A. Forouzan, Tata McGrawHill, 2017
2.	"Computer Networks", Andrew S Tanenbaum, Pearson Education, PHI, 2018
3.	"Data communications and Computer Networks", P.C. Gupta, PHI, 2013
4.	"Cryptography and Network Security", Atul Kahate, Tata McGrawHill, 2017

LUCKNOW UNIVERSITY ★ Department of Computer Science ★

DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF LUCKNOW

M.Sc. Computer Science (PG 2 Year) Programme

YEAR 1—SEMESTER II

CORE COURSE 8 Course code: MSCTCC203 Course Title: Advanced Operating System	
Credit: 4	
Course Objectives: ✓ To study the characteristics of OS for Multiprocessor and Multicomputer. ✓ To learn the issues related to designing OS. ✓ To learn the latest trends in building Mobile OS.	
UNIT	TOPICS
Unit I	Generations, Types, Structure, functions, Services, System Calls, System Boot, System Programs, Protection and Security, Multiprocessor Operating Systems: System Architectures, Structure of OS, Process Concepts, Process States, Process Control Block, Scheduling-Criteria, Scheduling Algorithms and their Evaluation, Threads, Threading Issues Process synchronization– Process Scheduling and Allocation- memory management.
Unit II	Process synchronization, Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classic Problems of Synchronization, Monitors. Memory management, Main Memory, Swapping, Contiguous Memory Allocation, Paging, Structure of Page Table, Segmentation, Virtual Memory, Demand Paging, Page Replacement Algorithms, Allocation of Frames, Thrashing. Deadlock, Deadlock Characterization, Deadlock Prevention, Detection and Avoidance, Recovery form Deadlock.
Unit III	Storage management, Mass-Storage Structure, Disk Structure, Disk Attachment, Disk Scheduling, RAID Structure File Management, File Concept, Access Methods, Directory Structure, File System Structure, Allocation Methods, and Free-Space Management
Unit IV	Distributed Operating Systems, System Architectures- Design issues, Communication models, clock synchronization, mutual exclusion, Distributed Deadlock detection Distributed scheduling- Distributed shared memory- Distributed File system – Multimedia file systems- File placement- Caching Database Operating Systems: Requirements of Database OS – Transaction process model – Synchronization primitives- Concurrency control algorithms
REFERENCE BOOKS:	
1.	"Advanced Concepts in Operating Systems", M Singhal and NG Shivaratri, Tata McGraw Hill, 2001
2.	"Distributed Operating Systems", A S Tanenbaum, Pearson Education, 2001
3.	"Modern Operating Systems", Andrew S. Tanenbaum, Pearson Education, 2006

DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF LUCKNOW

M.Sc. Computer Science (PG 2 Year) Programme

YEAR 1—SEMESTER II

CORE COURSE 9
Course code: MSCTCC204
Course Title: Information Security

Credit: 4

Course Objectives:

- ✓ To provide the student with an overview of the field of Information Security and Assurance. Students will be exposed to the spectrum of Security activities, methods, methodologies, and procedures.
- ✓ Coverage will include inspection and protection of information assets, detection of and reaction to threats to information assets, and examination of pre- and post-incident procedures, technical and managerial responses
- ✓ Overview of the Information Security Planning and Staffing functions

UNIT	TOPICS
Unit I	Definition of security, CIA triad, Assessing security, Security terminology, Historical developments, Structure of security, Introduction to Information Security, The Need for Security, Legal, Ethical, and Professional Issues in Information Security
Unit II	Risk Management and Special requirements such as Emanation Security/TEMPEST Standards, Planning for Security, Rainbow Series Reports for DOD; FIPS for all Federal Govt; DHS and CNSS guidance: Firewalls & VPNs
Unit III	Cryptography, Evolution of cryptography, Applications of cryptography, Terminology, Caesar ciphers, one-time pads, Operation of DES, AES ,Public-key cryptosystems, Topics in Information Systems Security, Minimum privilege ,Compartmentalization , Dual controls ,Security perimeters, Trustworthy software, proof of design correctness, Single-points-of-failure, Covert channels, Inference UNIT Technology: IDS and Access Control Cryptography, Physical Security including Emanations Security , (EMSEC)/TEMPEST/CFR 32 Marking, Handling, labelling and destruction of Sensitive information) Implementing Security, Security and Personnel, InfoSec Maintenance
Unit IV	Security models: Requirements; Types, State-machine models, Mandatory/Discretionary controls, Information-flow models, Informal models, Kerberos Authentication, Authentication in centralized systems, Distributed Authentication Denial of Service attacks, Security vs. ATM, IP, wireless mobile networks, QoS, Traffic modelling, Security Protocols, Zero-knowledge proofs, Subliminal channels, Oblivious transfer, Digital signature schemes, Bit commitment, Digital cash, Secure contract signing, Secure voting, Digital certified mail, Anonymous message broadcast

REFERENCE BOOKS:

LUCKNOW UNIVERSITY * Department of Computer Science *

1.	"Principles of Information Security", M. Whitman and H. Mattord, 2005.
2.	"Secrets and Lies: Digital Security in a Networked World," Bruce Schneier, Wiley, 2015
3.	"Applied Cryptography: Protocols, Algorithms, and Source Code in C", Bruce Schneier, Wiley, 1995

LUCKNOW UNIVERSITY ★ Department of Computer Science ★

DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF LUCKNOW
M.Sc. Computer Science (PG 2 Year) Programme

YEAR 1—SEMESTER II

CORE COURSE 10 Course code: MSCTCC205 Course Title: Theory of Computation	
Credit: 2	
Course Objectives: ✓ To give an overview of the theoretical foundations of computer science from the perspective of formal languages ✓ To illustrate finite state machines to solve problems in computing ✓ To explain the hierarchy of problems arising in the computer sciences. ✓ To familiarize Regular grammars, context frees grammar	
UNIT	TOPICS
Unit I	Introduction to theory of computation and basic Mathematical objects: Sets, Logic, Function, Relation, Languages Regular and Non regular Languages. A Criterion for Regularity, Minimal Finite Automata, The Pumping Lemma for Regular Languages, Decision Problems
Unit II	Regular Language and Finite automata. Regular Languages and Regular expressions, Finite automata and Memory required to recognize a Language, Distinguishing one string from another, Union, Intersections and Complements, Non deterministic Finite Automata, Kleen's theorems, various conversions like NFA to DFA etc.
Unit III	Context Free Grammars and Pushdown Automata. Introduction to grammars, Derivation trees and Ambiguity, An unambiguous CFG for Algebraic Expressions, Simplified Forms and normal Forms. Definitions, Deterministic Push down Automata, PDA corresponding to Given Grammar, CFG corresponding to given PDA, Parsing, Pruning lemma for Context free Languages
Unit IV	Turing Machines (TM), Formal definition and behaviour, Languages of a TM, TM as accepters Recursive and recursively enumerable languages (REL), Properties, Universal Turing machine, The Halting problem, Undecidable problems about TMs. Context sensitive language and linear bounded automata (LBA), Chomsky hierarchy, Decidability, Post's correspondence problem (PCP), undecidability of PCP.

REFERENCE BOOKS:

1.	"Introduction to Automata Theory Languages and Computation", John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Pearson Education, 2007
2.	"Theory of Computer Science-Automata Languages and Computation", K. L. P Mishra, N. Chandrashekaran, Prentice Hall of India, 2003

LUCKNOW UNIVERSITY ★ Department of C... Science ★

DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF LUCKNOW

M.Sc. Computer Science (PG 2 Year) Programme

YEAR 1—SEMESTER II

INTERDEPARTMENTAL COURSE Course code: MSCTID206 Course Title: Data Science
Credit: 2
Course Objectives: ✓ To train students for effective data storage and efficient data retrieval. ✓ To categorise and clustering voluminous data. ✓ To train students to select suitable data storage and acquisition algorithms. ✓ To group similar data and implement viewing technologies.

UNIT	TOPICS
Unit I	Introduction data acquisition, data preprocessing techniques including data cleaning, selection, integration, transformation and reduction, data mining, interpretation. Review of basic probability theory and distributions, correlation coefficient, linear regression, statistical inference, exploratory data analysis and visualization.
Unit II	Introduction to predictive modelling, decision tree, nearest neighbour classifier and naïve Baye's classifier, classification performance evaluation and model selection. Introduction to clustering, partitional, hierarchical, and density-based clustering (k-means, agglomerative, and DBSCAN), outlier detection, clustering performance evaluation.
Unit III	Introduction to frequent pattern mining and association rule mining, Apriori algorithm, measures for evaluating the association pattern.
Unit IV	Introduction of the vector space model for document representation, term frequency-inverse document frequency (tf-idf) approach for term weighting, proximity measures for document comparison, document clustering and text classification.

REFERENCE BOOKS:

1.	"Data Science from Scratch", Joel Group, O'Reilly, 2015
2.	"Smarter Data Science: Succeeding with Enterprise-Grade Data and AI Projects", Neal Fishman, Wiley 2020
3.	"Data Science for Beginners", Andrew Park, 2020
4.	"Essential Math for Data Science: Take Control of Your Data with Fundamental Calculus, Linear Algebra, Probability, and Statistics", Hadrien Jean, O'Reilly, 2021

Department of Computer Science ★ LUCKNOW UNIVERSITY ★