



DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF LUCKNOW

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



YEAR 2--SEMESTER IV

CORE COURSE 16	
Course code: MSCTCC401	
Course Title: Parallel and Distributed Computing	
Credit: 4	
Course Objectives: <ul style="list-style-type: none"> ✓ To train students to enhance the processing speed of computing devices. ✓ To know the parallel and synchronized utility of processors. ✓ To train students to fill the gap between data transfer and processing. ✓ To train students to design distributed architecture of central controlling microprocessor. 	
UNIT	TOPICS
Unit I	Parallel Computing, Trends in microprocessor architectures, memory system performance, dichotomy of parallel computing platforms, physical organization of parallel platforms, communication costs in parallel machines, SIMD versus MIMD architectures, global versus distributed memory, the PRAM shared-memory model, distributed-memory or graph models, basic algorithms for some simple architectures: linear array, binary tree, 2D mesh with shared variables
Unit II	Distributed Computing Architectures, Characteristics and goals of distributed computing, architectural styles: centralized, decentralized, and hybrid architectures, layered, object-based and service oriented, resource-based, publish-subscribe architectures, middleware organization: wrappers, interceptors, and modifiable middleware, system architecture, example architectures: network file system and web.
Unit III	Distributed Processes and Communication in Distributed Systems, Threads in distributed systems, principle of virtualization, clients: network user interfaces and client-side software for distribution transparency; servers: design issues, object servers, server clusters; code migration; Layered protocols, remote procedure call: RPC operation, parameter passing; message oriented communication: transient messaging with sockets, message-oriented persistent communication; multicast communication: application-level tree-based multicasting, flooding-based multicasting, gossip-based data dissemination.
Unit IV	Naming and Coordination in Distributed Systems, identifiers, and addresses, flat naming, Structured naming, and attribute-based naming; coordination: clock synchronization, logical clocks, mutual exclusion: centralized, distributed, token-ring, and decentralized algorithms; election algorithms, location systems, distributed event matching, gossip-based coordination.

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	Consistency and replication, Fault Tolerance, and Security: Introduction to consistency models and protocols, fault tolerance, and security issues in distributed systems
REFERENCE BOOKS:	
1.	"Introduction to Parallel Computing", Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Addison-Wesley, 2003.
2.	"Introduction to Parallel Processing: Algorithms and Architectures", B. Parhami, Springer, 1999.
3.	"Distributed Systems", M. van Steen, A. S. Tanenbaum, Create Space Independent Publishing Platform, 2017.





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YEAR 2—SEMESTER IV

ELECTIVE COURSE 17a	
Course code: MSCTEC402A	
Course Title: Deep Learning	
Credit: 4	
Course Objectives: <ul style="list-style-type: none"> ✓ To understand the language formation. ✓ To understand and analysis the language patterns. ✓ To form language-based grammar for computational machines. ✓ To recognise pattern and utilise it for repetitive task. 	
UNIT	TOPICS
Unit I	Historical context and motivation for deep learning; basic supervised classification task, optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum, and adaptive sub-gradient method.
Unit II	Neural Networks, Feedforward neural networks, deep networks, regularizing a deep network, model exploration, and hyperparameter tuning. Convolution Neural Networks, Introduction to convolution neural networks: stacking, striding and pooling, applications like image, and text classification.
Unit III	Sequence Modelling, Recurrent Nets, Unfolding computational graphs, recurrent neural networks (RNNs), bidirectional RNNs, encoder-decoder sequence to sequence architectures, deep recurrent networks. Autoencoders, Undercomplete autoencoders, regularized autoencoders, sparse autoencoders, denoising autoencoders, representational power, layer, size, and depth of autoencoders, stochastic encoders and decoders.
Unit IV	Structuring Machine Learning Projects, Orthogonalization, evaluation metrics, train/dev/test distributions, size of the dev and test sets, cleaning up incorrectly labelled data, bias and variance with mismatched data distributions, transfer learning, multi-task learning.
REFERENCE BOOKS:	
1.	"Introduction to Parallel Computing", Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Addison-Wesley, 2003
2.	"Introduction to Parallel Processing: Algorithms and Architectures", B. Parhami, Plenum, 1999, Springer
3.	"Distributed Systems", M. van Steen, A. S. Tanenbaum, CreateSpace Independent Publishing Platform, 2017.

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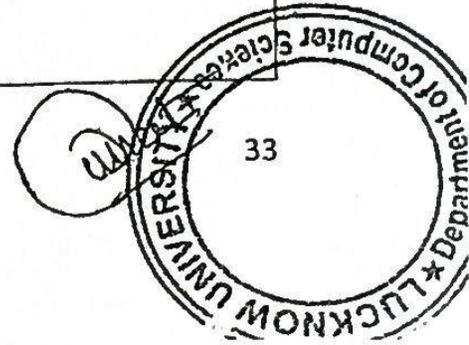
M.Sc. Computer Science (PG 2 Year) Programme



YEAR 2--SEMESTER IV

ELECTIVE COURSE 17b	
Course code: MSCTEC402B	
Course Title: Numerical Method and Computer Graphics	
Credit: 4	
Course Objectives: <ul style="list-style-type: none"> ✓ To develop proficiency in numerical methods. ✓ To implement numerical algorithms computationally. ✓ To understand the principles of computer graphics. 	
UNIT	TOPICS
Unit I	Understanding sources of errors, round-off errors, truncation errors, floating point arithmetic, Convergence Solution of linear systems, Gauss elimination, Gauss Jordan elimination, Gauss-Seidel method, Diagonal dominance, Banded matrices, storage schemes for banded matrices, skyline solver.
Unit II	Solution of non-linear systems, Newton Raphson method, Local and global minimum, rates of convergence, convergence criteria, conjugate gradient method. Ordinary Differential Equations solution, Taylor series, Euler method, Runge-Kutta method, Finite Difference Method Partial Differential Equations: Finite Difference Method, Laplace equation, Poisson equation, 1-D heat equation, 1-D wave equation.
Unit III	Computer Graphics, Application of Computer Graphics in Entertainment, Education and Training, Visualization, Image Processing, Graphical User Interface, Refresh Cathode-Ray Tubes, Raster-Scan Display, Random-Scan Displays, Colour CRT Monitors. Geometric Liquid Crystal Display (LCD), Three-Dimensional Viewing Devices, Stereoscopic and Virtual-Reality Systems, Raster-Scan Systems, Video Controller, Architecture of a raster-graphics system with a display processor, Raster-scan Display Processor
Unit IV	Random-scan systems, Graphic Monitors and workstations, Data Glove, Digitizers, Points and Lines, Line Drawing Algorithms, DDA Algorithms, Bresenham's Line Algorithm, Circle-Generating Algorithms, Properties of Circles, Midpoint Circle Algorithms. Filled-Area Primitives, Scan-Line Polygon Fill Algorithm, Inside-Outside Tests, Scan-Line fill of Curved Boundary Areas, Boundary-Fill Algorithms, Basic Transformation, Translation, Rotation, Scaling, Matrix Representation and Homogeneous Coordinates, Composite Transformations, Reflection, Shear, The Viewing Pipeline, Window to view port coordinate transformation.

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



<u>REFERENCE BOOKS:</u>	
1.	"Applied Numerical Analysis", C. F. Gerald and P. O. Wheatley, Addison Wesley, Massachusetts, 1994
2.	"Introduction to Numerical Analysis", K. E. Atkinson, John Wiley, New York, 1989
3.	"Procedural Elements for Computer Graphics", D. F. Rogers, McGraw-Hill Publication, 2008
4.	"Fundamentals of Digital Image processing", Anil K. Jain, Pearson Publication, 2015.





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UNIVERSITY OF LUCKNOW**



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

YEAR 2-SEMESTER IV

ELECTIVE COURSE 17c	
Course code: MSCTEC402C	
Course Title: Natural Language Processing & Text Analytics	
Credit: 4	
Course Objectives:	
<ul style="list-style-type: none"> ✓ To implant fundamental NLP concepts and techniques among the students. ✓ To utilise text analytics in information retrieval and text indexing methods. ✓ To utilise NLP concepts in text categorization and clustering datasets. ✓ To use text analytics concept in search algorithms. 	
UNIT	TOPICS
Unit I	Introduction to Natural Language Processing (NLP) and Text Analytics, Tokenization, Part-of-speech tagging, Stemming and lemmatization, NLP toolkits, Indexing text using inverted file index, Posting lists, Information retrieval, Authorship attribution, Sentiment analysis, Named-entity recognition, Document summarization.
Unit II	Document representation and Language models: Representation of the unstructured text documents, Heaps' and Zipf's Laws, Boolean vector representation, Bag-of-words model, tf-idf model, Term weighting, Scoring and ranking, Vector space model, Visualization techniques, Unigrams, bi-grams and n-grams, language models.
Unit III	Text categorization: Supervised text categorization algorithms, Naive Bayes, k Nearest Neighbour (KNN), Logistic Regression
Unit IV	Text clustering: Clustering structure of a corpus of text documents, Hierarchical clustering, Centroid-based clustering. Topic Modelling- Latent Semantic Indexing (LSI).
REFERENCE BOOKS:	
1.	"Modern Information Retrieval: The concepts and Technology behind Search", Ricardo Baeza Yates, Berthier Ribeiro Neto, (ACM Press Books), 2011.
2.	"Introduction to Information Retrieval", Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, Cambridge University Press, 2008.
3.	"Practical Text Analytics: Interpreting Text and Unstructured Data for Business Intelligence", Steven Struhl, Kogan Page, 2015
4.	"Mining the Social Web", Matthew A. Russell, O'Reilly Media, 2013





**DEPARTMENT OF COMPUTER SCIENCE
UNIVERSITY OF LUCKNOW**

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



YEAR 2--SEMESTER IV

ELECTIVE COURSE 18a	
Course code: MSCTEC403A	
Course Title: Neural Network	
Credit: 4	
Course Objectives: <ul style="list-style-type: none"> ✓ To understand the basic concept of neural network. ✓ To establish the relation among artificial electrical agents. ✓ To map the learning of human behaviour as machine. ✓ To make students able to automate human behaviour as a machine. 	
UNIT	TOPICS
Unit I	Neuron as basic unit of neurobiology, perceptron as a model of learning, perceptron convergence theorem, batch perceptron learning algorithm, relation between perceptron and Bayesian learner for a Gaussian environment; linear regression model, maximum a posteriori (MAP) estimation of the parameter vector, least mean squares algorithm.
Unit II	Perceptron, Multilayer Perceptron, Backpropagation algorithm, batch learning and online learning, adaptive control of learning rate; estimating regularization parameter: Tikhonov's regularization theory, complexity regularization, and network pruning
Unit III	Kernel Methods and Support Vector Machines: Separability of patterns, interpolation problem, radial basis function (RBF) networks, support vector machines.
Unit IV	Introduction to Hopfield networks, Boltzmann machines, restricted Boltzmann machines.
REFERENCE BOOKS:	
1.	"Neural Networks and Learning Machines", Simon O. Haykin, Pearson Education, 2016
2.	"Pattern Recognition and Machine Learning", C. M. Bishop, Springer, 2010.
3.	"Neural Networks and Machine Learning", C. Bishop, Springer, 1998

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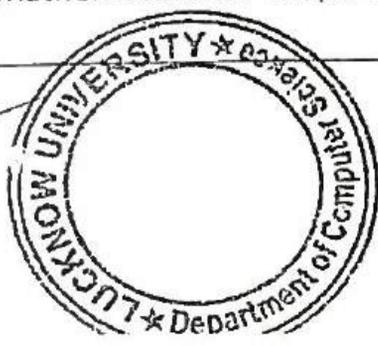
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M.Sc. Computer Science (PG 2 Year) Programme

YEAR 2--SEMESTER IV

ELECTIVE COURSE 18b	
Course code: MSCTEC403B	
Course Title: Discrete Mathematics	
Credit: 4	
Course Objectives:	
<ul style="list-style-type: none"> ✓ To understand and apply set theory, relations, and function. ✓ To grasp the fundamentals of algebraic structures. ✓ To analyze ordered sets, lattices, and Boolean algebra. ✓ To develop proficiency in propositional and predicate logic. 	
UNIT	TOPICS
Unit I	Set Theory: Introduction, Combination of sets, Multisets, ordered pairs, Set Identities. Relations: Definition, Operations on relations, Properties of relations, Composite Relations, Equality of relations, Order of relations. Functions: Definition, Classification of functions, Operations on functions, recursively defined functions. Natural Numbers: Introduction, Mathematical Induction, Variants of Induction, Induction with Nonzero Base cases
Unit II	Algebraic Structures: Definition, Groups, Subgroups and order, Cyclic Groups, Cosets, Lagrange's theorem, Normal Subgroups, Permutation and Symmetric groups, Group Homomorphisms, Definition and elementary properties of Rings and Fields, Integers Modulo n.
Unit III	Partial order sets: Definition, Partial order sets, Combination of partial order sets, Hasse diagram. Lattices: Definition, Properties of lattices – Bounded, Complemented, Modular and Complete Lattice, Morphisms of lattices. Boolean Algebra: Introduction, Axioms and Theorems of Boolean algebra, Algebraic manipulation of Boolean expressions. Simplification of Boolean Functions, Karnaugh maps, Logic gates, Digital circuits and Boolean algebra. Combinational and sequential Circuits
Unit IV	Propositional Logic: Proposition, well-formed formula, Truth tables, Tautology, Satisfiability, Contradiction, Algebra of proposition, Theory of Inference, Natural Deduction. Predicate Logic: First order predicate, well-formed formula of predicate, quantifiers, Inference theory of predicate logic.
REFERENCE BOOKS:	
1.	"Elements of Discrete Mathematics", Liu and Mohapatra, McGraw Hill, 2011
2.	"Discrete Mathematical Structures with Application to Computer Science", Jean Paul Trembley, R Manohar, McGraw-Hill, 1987
3.	"Discrete Mathematics and Graph Theory", Biswal, PHI Learning Private Limited, Delhi, 2014





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

YEAR 2--SEMESTER IV

ELECTIVE COURSE 18c	
Course code: MSCTEC403C	
Course Title: Computational Intelligence	
Credit: 4	
Course Objectives:	
<ul style="list-style-type: none"> ✓ To understand, analyse, and solving computational problems. ✓ To choose a suitable constructs and inbuilt data structure for real world problem. ✓ To debug computational based intelligence process. ✓ To optimise and establish relations among computational intelligence layers. 	
UNIT	TOPICS
Unit I	Computational intelligence as a computing paradigm. Rough Sets: Introduction, set approximation, decision tables
Unit II	Fuzzy Logic Systems, Notion of fuzziness, operations on fuzzy sets, T-norms and other aggregation operators, basics of approximate reasoning, compositional rule of inference, fuzzy rule-based systems, schemes of fuzzification, inferencing, defuzzification, fuzzy clustering, fuzzy rule based classifier. Type-2 Fuzzy Sets: Notion of uncertainty of membership in a fuzzy set, foot print of uncertainty, embedded fuzzy sets, operations on type-2 fuzzy sets, type-2 fuzzy relations, type reduction, type-2 fuzzy inference system.
Unit III	Neural Networks: Review of basic concepts of a neuron, perceptron, back propagation, feedforward neural networks. Multilayer perceptron – Batch learning and online learning, adaptive control of learning rate, estimating regularization parameter.
Unit IV	Evolutionary Computation: Genetic operators, building block hypothesis, evolution of structure, genetic algorithms based on tree and linear graphs, multi-objective optimization, applications in science and engineering
REFERENCE BOOKS:	
1.	"Computational Intelligence: Principles, Techniques and Applications", Russell Eberhart, Elsevier, 2012
2.	"Computational Intelligence: Methods and Techniques", Leszek Rutkowski, Springer 2008.
3.	"Neural Networks and Learning Machines", Simon O. Haykin, Pearson Education, 2016

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YEAR 2-SEMESTER IV

DISSERTATION

Course code: MSCTDI404

Course Title: Dissertation

Credit: 8

Course Objectives:

- ✓ Cultivate the ability to design and execute a structured research project.
- ✓ Enhance analytical and problem-solving skills by critically evaluating literature, methodologies, and data.
- ✓ Independent Learning: Encourage self-directed learning and the ability to work independently on a long-term project.
- ✓ Allow students to apply theoretical concepts and methodologies to practical or theoretical research questions.
- ✓ Provide an opportunity to explore a specific topic in-depth and potentially contribute new insights or findings to the academic or professional domain.
- ✓ Develop the ability to present research findings clearly, both in writing and verbally, adhering to academic or professional standards.

As per the Guidelines provided in the NEP Ordinances