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Continuing Education Programme
Program: M.S in Artificial Intelligence & Cyber Security
Curriculum and Syllabus-2025

Sl. No.	Subject Code	SEMESTER I	L	T	P	C
1	ECS 5101	Design and Analysis of Algorithms	3	0	2	4
2	ECS 5103	Advanced Cyber Security	3	0	2	4
3	EMC 5103	Probability and Statistics	3	0	2	4
4	EHS 5104	Technical Writing and Soft Skill	1	2	2	4
5		DE-1(Elective 1)	3	0	0	3
	TOTAL		**13**	**2**	**8**	**19**

Sl. No.	Subject Code	SEMESTER II	L	T	P	C
1	ECS 5201	Artificial Intelligence	3	0	2	4
2	EMC 5202	Numerical Linear Algebra and Optimization Techniques	3	0	2	4
3		DE-2(Elective 2)	3	0	0	3
4		DE-3(Elective 3)	3	0	0	3
5		IKS	2	0	0	2
	TOTAL		**14**	**0**	**4**	**16**

Sl. No.		SEMESTER III	L	T	P	C
1		DE-4(Elective 4)	3	0	0	3
2		DE-5(Elective 5)	3	0	0	3
3		Project I	0	0	34	17
	TOTAL		**6**	**0**	**34**	**23**

Sl. No.		SEMESTER IV	L	T	P	C
		DE-6(Elective 6)	3	0	0	3
1		DE-7(Elective 7)	3	0	0	3
2		Project II	0	0	40	20
	TOTAL		**6**	**0**	**40**	**26**

Total credits = 84

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Electives for M.S in Artificial Intelligence & Cyber Security:

Sl. No.	Subject Code	Elective-I	L	T	P	C
1	EIC 6101	Computer Forensics	3	0	0	3
2	EIC 6102	Pattern Recognition	3	0	0	3
3	EIC 6103	Advance Machine Learning	3	0	0	3

Sl. No.	Subject Code	Elective-II, III	L	T	P	C
1	EIC 6201	Deep Learning	3	0	0	3
2	EIC 6202	Physics of Neural Network	3	0	0	3
3	EIC 6203	Cryptography	3	0	0	3
4	EIC 6204	Federated Learning	3	0	0	3

Sl. No.	Subject Code	Elective-IV, V	L	T	P	C
1	EIC 6301	Artificial Internet of Things	3	0	0	3
2	EIC 6302	Natural Language Processing	3	0	0	3
3	EIC 6303	Generative Artificial Intelligence	3	0	0	3
4	EIC 6304	Advanced Cloud Computing	3	0	0	3

Sl. No.	Subject Code	Elective-VI, VII	L	T	P	C
1	EIC 6401	Reinforcement Learning	3	0	0	3
2	EIC 6402	Meta Learning	3	0	0	3
3	EIC 6403	Quantum Machine Learning	3	0	0	3
4	EIC 6404	Text Mining and Analytics	3	0	0	3

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Course number	**ECS 5101**
Course Credit	L-T-P-C: 3-0-2-4
Course Title	**Design and Analysis of Algorithms**
Learning Mode	Online
Learning Objectives	The objective of this course is to equip students with a solid understanding of data structures and algorithms, enabling them to design, analyze, and implement efficient algorithms to solve complex computational problems. The course covers fundamental topics such as data structures, complexity analysis, sorting and searching techniques, problem-solving strategies, graph algorithms, and advanced topics like string matching, FFT-DFT, and approximation algorithms. By the end of the course, students will have developed the skills to critically analyze algorithm efficiency and apply advanced algorithms in practical scenarios.
Course Description	This course will provide basic understanding of methods to solve problems on computers. It will also provide an overview to analyze those theoretically.
Course Outline	Data structures: linked list, stack, queue, tree, balanced tree, graph; Complexity analysis: Big O, omega, theta notation, solving recurrence relation, master theorem Sorting and searching: Quick sort, merge sort, heap sort; Sorting in linear time; Ordered statistics; Problem solving strategies: recursion, dynamic programming, branch and bound, backtracking, greedy, divide conquer, Graph algorithms: BFS, DFS, Shortest path, MST, Network flow; NP-completeness Advanced topics: string matching, FFT-DFT, basics of approximation and randomized algorithms. Lab Component: Implementation of above topics
Learning Outcome	By the end of this course, students will be able to: Use linked lists, stacks, queues, trees, balanced trees, and graphs. Analyze algorithm complexity and solve recurrence relations. Implement Quick sort, Merge sort, Heap sort, and linear time sorting methods. Apply recursion, dynamic programming, branch and bound, backtracking, greedy, and divide-and-conquer methods. Implement BFS, DFS, shortest path algorithms, MST, and network flow algorithms. Comprehend NP-completeness and its significance.
Assessment Method	Quiz / Assignment / ESE

Suggested Reading:

- Mark Allen Weiss, "Data Structures and Algorithms in C++", Addison Wesley, 2003.
- Adam Drozdek, "Data Structures and Algorithms in C++", Brooks and Cole, 2001.
- Aho, Hopcroft and Ullmann, "Data structures and Algorithm", Addison Welsey, 1984.
- Introduction to Algorithms Book by Charles E. Leiserson, Clifford Stein, Ronald Rivest, and Thomas H. Cormen

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Course Number	**ECS 5103**
Course Credit	L-T-P-C: 3-0-2-4
Course Title	**Advanced Cyber Security**
Learning Mode	Online
Learning Objective	To have a clear understanding of security and privacy issues in various aspects of computing, including Programs, Operating systems, Networks, Web Applications
Course Description	The course covers. security and privacy issues in various aspects of computing, including Programs, Operating systems, Networks, Web Applications
Course Outline	Introduction to Computer Security and Privacy: security and privacy; types of threats and attacks; methods of defense Basics of cryptography, Authentication & key agreement, Authorization and access control Program Security: nonmalicious program errors; vulnerabilities in code, Secure programs; malicious code; Malware detection Internet security: IPSEC, TLS, SSh, Email security Wireless security: WEP, WPA, Bluetooth security, Web Security: XSS attack, CSRF attack, SQL Injection, DoS attack & defense Lab Component: Implementation of above topics
Learning Outcome	After completion of this course a student will have • Understanding of security issues in computer and networks, • Understanding and analysis of internet security protocols • Understanding and analysis of web security protocols
Assessment Method	Quiz / Assignment / ESE

Textbooks:

- Computer Security: Principles and Practice: Dr. William Stallings and Lawrie Brown, Pearson
- O'Reilly Web Application Security by Andrew Hoffman

Course Number	**EMC 5103**

Course Credit (L-T-P-C)	L-T-P-C: 3-0-2-4
Course Title	**Probability and Statistics**
Learning Mode	Online
Learning Objective	To understand the basic concepts in Probability Theory and Statistics through practical examples.
Course Description	The course is divided into two parts: In first part, basic concepts of probability theory are introduced. In the second part, different problems in classical statistics are discussed.
Course Outline	Conditional probability, Bayes' rule, Total probability law, Independence of events. Random variables (discrete and continuous), probability mass functions, probability density functions, Expectation, variance, moments, cumulative distribution functions, Function of random variables, Multiple random variables, joint and marginal, conditioning and independence, Markov and Chebyshev inequalities, Different notions of convergence. Weak law of large number, Central limit theorem. Estimation: Properties, Unbiased Estimator, Minimum Variance Unbiased Estimator, Rao-Cramer Inequality and its attainment, Maximum Likelihood Estimator and its invariance property, Efficiency, Mean Square Error. Confidence Interval: Coverage Probability, Confidence level, Sample size determination. Testing of Hypotheses: Null and Alternative Hypotheses, Test Statistic, Error Probabilities, Power Function, Level of Significance, Neyman-Pearson Lemma.
Learning Outcome	Students will become familiar with principal concepts probability theory and statistics. This helps them to handle, mathematically, various practical problems arising in uncertain situations.
Assessment Method	Quiz / Assignment / ESE

Text Books:

1. Ross, S.M.(2008) Introduction to Probability Models, Ninth edition, Academic Press.
2. Statistical Inference (2007), G. Casella and R.L. Berger, Duxbury Advanced Series.

Reference Book:

1. An Introduction to Probability and Statistics, V.K. Rohatgi and A.K.Md. Ehsanes Saleh, John Wiley, 2nd Ed, 2009.

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Course Number	**ECS 5201**
Course Credit	L-T-P-C: 3-0-2-4
Course Title	**Artificial Intelligence**
Learning Mode	Online
Learning Objectives	● To understand the foundational concepts and motivations behinrtificial Intelligence and intelligent agents. ● To learn and apply uninformed and informed search strategies for problem-solving. ● To explore local search techniques and optimization methods beyond classical search. ● To implement adversarial search techniques and problem reduction strategies. ● To formulate and solve Constraint Satisfaction Problems (CSPs) using advanced techniques.
Course Description	This course aims to provide students with a comprehensive understanding of the fundamental principles and techniques of Artificial Intelligence (AI). It covers the basics of intelligent agents and their environments, various problem-solving methods through search strategies, and techniques beyond classical search. Students will learn about adversarial search, constraint satisfaction problems, knowledge representation, reasoning, planning, and various learning techniques. The course prepares students to design and implement AI solutions for complex real-world problems.
Course Outline	● Introduction and motivation Artificial Intelligence, intelligent agents, nature of environments ● Problem-solving by searching: Example problems, uninformed, informed search strategies ● Uninformed/ blind search techniques: Breadth-first search (BFS), Depth-first search (DFS), Uniform-cost search (UCS) ● Informed search: Heuristic function design and evaluation, A* search ● Beyond classical search: local search techniques and optimization, hill climbing, simulated annealing, beam search ● Adversarial search: Games, optimal decision in games, min-max, alpha-beta pruning, partially observable games ● Problem reduction techniques: And-OR (AO) and AO* ● Constraint Satisfaction Problem (CSP): definition and examples of CSPs, basic techniques: backtracking search, forward checking, arc consistency

	• Knowledge Representation, Reasoning, and Planning: Propositional logic, first-order logic, inference, planning • Learning Techniques: meta-heuristic (genetic algorithm), Bayesian, decision tree, etc. • Some advanced techniques of AI and its applications • Lab component: Implementation of above architectures.
Learning Outcome	By the end of this course, students will be able to: • Understand the foundational concepts and motivations behind Artificial Intelligence and intelligent agents. • Apply uninformed and informed search strategies to solve example problems. • Utilize local search techniques and optimization methods such as hill climbing, simulated annealing, and beam search. • Implement adversarial search techniques including min-max, alpha-beta pruning, and strategies for partially observable games. Apply problem reduction techniques. • Formulate and solve Constraint Satisfaction Problems (CSPs) using techniques like backtracking search, forward checking, and arc consistency. • Represent knowledge using propositional and first-order logic, and perform inference and planning. • Explore and apply various learning techniques such as genetic algorithms, Bayesian methods, and decision trees.
Assessment Method	Quiz / Assignment / ESE

<u>Suggested Reading</u>

1. Russell, S. J., & Norvig, P. (2016). Artificial intelligence: A modern approach. Pearson.
2. Poole, D. L., & Mackworth, A. K. (2010). Artificial Intelligence: foundations of computational agents. Cambridge University Press.
3. Hastie, T., Tibshirani, R., Friedman, J. H., & Friedman, J. H. (2009). The elements of statistical learning: data mining, inference, and prediction (Vol. 2, pp. 1-758). New York: Springer.

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Course Number	**EMC 5202**
Course Credit	L-T-P-C: 3-0-2-4
Course Title	**Numerical Linear Algebra and Optimization Techniques**
Learning Mode	Online
Learning Objectives	The objective of the course is to train students about the different numerical techniques to solve linear equations, linear least square problems and find eigen values of matrices as well as check the stability of numerical methods. Moreover, students would be able to perform modeling of convex programming problems and employ various classical and numerical optimization techniques and algorithms to solve these problems
Course Description	Numerical Linear Algebra and Optimization Techniques, as a basic subject for postgraduate students, provides the knowledge of various numerical techniques to solve linear equations as well as check the stability of numerical methods. Moreover, this course would help the students to models convex optimization problems and learn different algorithms to solve such problems with its applications in various problems arising in economics, science and engineering.
Course Content	Review of matrix Algebra, Norms and condition numbers of Matrix, Systems of Equations, Gaussian Elimination, LU, PLU and Cholesky Factorization, Iterative Solvers: Jacobi, Gauss Seidel, SOR and their convergence, Gram-Schmidt orthogonalization QR Factorization and Least Squares, Eigenvalues, Power method, Reduction to Hessenberg or Tridiagonal form, Rayleigh quotient, inverse iteration, QR Algorithm without and with shifts, Singular Value Decomposition and Its applications Introduction to nonlinear programming, Convex Sets, Convex Functions and their properties. Unconstrained optimization of functions of several variables: Classical techniques. Numerical methods for unconstrained optimization: One Dimensional Search Methods, Golden Section Search and Fibonacci search, Basic descent methods, Conjugate direction, Newton's and Quasi-Newton methods Constrained optimization of functions of several variables, Lagrange Multiplier method, Karush-Kuhn-Tucker theory, Constraint Qualifications, Convex optimization Merit functions for constrained minimization, logarithmic barrier function for inequality constraints, A basic barrier-function algorithm Practice of algorithms using Software.
Learning Outcome	On successful completion of the course, students should be able to: 1. Understand different Matrix factorization method and employ them to solve linear equations and linear least square problems 2. To comprehend the basic computer arithmetic and the concepts of conditioning and stability of a numerical method. 3. Understand the terminology and basic concepts of various kinds of convex optimization problems and solve different solution methods to solve convex Programing problem.
Assessment Method	Quiz / Assignment /ESE

Text Books:

1. Lloyd N. Trefethen, David Bau III: Numerical Linear Algebra, 1st Edition, SIAM, Philadelphia (1997)
2. Edwin K. P. Chong, Stanislaw H. Zak: An Introduction to Optimization, 4th Edition, Wiley India (2017)
3. Gilbert Strang: Lecture Notes for Linear Algebra, Wellesley Cambridge Press, SIAM (2021)

Reference Books:

1. Stephan Boyd and Lieven. Vandenberghe: Convex Optimization, Cambridge University Press (2004)

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Course Number	**EIC 6101**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Computer Forensics**
Learning Mode	Online
Learning Objectives	This course aims to: • impart principles and techniques for digital forensics investigation • make aware of various digital forensics tools • guide one how to perform forensics procedures to ensure court admissibility of evidence, as well as the legal and ethical implications
Course Description	Digital forensics involves the investigation of computer-related crimes with the goal of obtaining evidence to be presented in a court of law. In this course, students will learn the principles and techniques for digital forensics investigation and the spectrum of available computer forensics tools. One will learn about core forensics procedures to ensure court admissibility of evidence, as well as the legal and ethical implications. One will learn how to perform a forensic investigation on both Unix/Linux and Windows systems with different file systems. One will also be guided through forensic procedures and review and analyze forensics reports. Although the course does not have any lab components but students may have to work out some assignments/case project works related to data analysis and data recovery, data acquisition, recovering graphics file, validation of a forensic image file, etc.
Course Outline	Digital Forensics Fundamentals: Overview, Preparation for Digital Forensics, Conducting Investigation, Understanding Forensics Lab requirements, Cyber Laws Data Acquisition: Understanding the storage formats, determining acquisition method, Use of acquisition tools, Validating data acquisition Processing crime and incident scenes: Identifying digital evidence, preparing for a search, Seizing and storing Digital Evidence Working with Windows and Linux File Systems: Understanding File Systems, Exploring Microsoft File Structure, Examining NTFS Disks, Windows Registry, Virtual Machine, File structure in Ext4, Some Forensics Tools: Software Tools, Hardware Tool, Validating and Testing Forensics Software, Password protection, Password Recovery Tools Recovering Graphics Files: Recognizing Graphics File, Understanding Data Compression, Identifying Unknown File Formats, Understanding Copyright Issues with Graphics Digital Forensics Analysis and Validation: Determining what data to collect and analyze, Validating Forensics Data, Addressing Data Hiding Techniques, Forensics handwriting and signature

	analysis Overview Email and Social Media Investigations, Mobile Device Forensics, Cloud Forensics, Memory Forensics
Learning Outcome	Upon successful completion of this course, the students will: • be able to perform forensics analysis using digital evidence • gain exposure on analyzing the performance of various forensics tools • obtain more in depth knowledge on various file system related artifacts
Assessment Method	Quiz / Assignment / ESE

Suggested Readings:

• Amelia Phillips, Bill Nelson, Christopher Steuart - “Guide to Computer Forensics and Investigations”, 6th Editon, Cengage
• Darren Hayes: Practical Guide to Digital Forensics Investigations, Pearson
• Michael K. Robinson: Digital Forensics: Hands-on Activities in Digital Forensics, Createspace Independent Pub; Workbook edition
• Gerard Johnsen, Digital Forensics and Incident Response: Incident response tools and techniques for effective cyber threat response, 3rd Edition, 2022
• William Oettinger, Learn Computer Forensics: Your one-stop guide to searching, analyzing, acquiring, and securing digital evidence, 2nd Edition, 2022
• Thomas J. Holt, Adam M. Bossler, Kathryn C. Seigfried-Spellar, Cybercrime and Digital Forensics: An Introduction, 3rd Edition, 2022

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Course Number	**EIC 6102**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Pattern Recognition**
Learning Mode	Online
Learning Objectives	This course aims to help the students: (a) Understand the advanced topics of pattern recognition, including classification and clustering methods. (b) To understand the advanced topics of feature selection, multi-label classification. (c) Apply advanced pattern recognition algorithms to practical applications in image processing, speech recognition, and data mining.
Course Description	This course on pattern recognition aims to equip students with the advanced topics of classification, clustering, and feature selection. By focusing on advanced topics, students will develop the ability to implement and evaluate various pattern recognition algorithms. Students will enhance their understanding of advanced topics of classification, clustering, statistical methods, and data preprocessing techniques through interactive lectures, exercises, and projects. Upon completion, students will be proficient in designing and applying advanced pattern recognition systems for applications such as image processing, text mining, speech recognition, and data mining, thereby enhancing their analytical and problem-solving capabilities in diverse domains.
Course Outline	• Introduction and motivation of advanced pattern recognition • Modern Classification Methods, Random fields, Pattern recognition based on multidimensional models • Contextual classification, Hidden Markov models, Multi-classifier systems • Advanced parameter estimation methods, Advanced Unsupervised classification, Modern methods of feature selection. • Data normalization and invariants, Benchmarking. • Analysis and synthesis of image information. • Applications od pattern recognition in Text Processing and Healthcare.
Learning Outcome	• Mastery of advanced concepts in pattern recognition. • In-depth understanding of various advanced algorithms across different pattern recognition paradigms. • Comprehensive knowledge of advanced aspects of classification, clustering, feature selection, feature extraction, and projection techniques. • Ability to apply advanced pattern recognition algorithms to real-world projects

Assessment Method	Quiz / Assignment / ESE

TEXTBOOKS:

1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop, Springer, 2006.
2. "Pattern Classification" by Richard O. Duda, Peter E. Hart, and David G. Stork, Wiley, 2001.
3. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy, MIT Press, 2012.
4. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, MIT Press, 2016.

"Introduction to Statistical Pattern Recognition" by Keinosuke Fukunaga, Academic Press, 1990.

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Course Number	**EIC 6103**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Advance Machine Learning**
Learning Mode	Online
Learning Objectives	This course aims to help the students to understand the advanced machine learning techniques and its application in various dimensions.
Course Description	This course will concentrate on some advanced topics of machine learning like graphical models, auto-encoders, GANs, time series forecasting, advanced unsupervised classification algorithms, neural architectures for sequence and graph-structured predictions. When appropriate, the techniques will be linked to applications in translation, conversation modeling, and information retrieval.
Course Outline	Mathematics of machine learning, Overview of supervised, unsupervised learning and Multi-task learning. Undirected graphical models: Overview, representation of probability distribution and conditional independence statement, Factorization, CRFs, Applications to NLP. Deep Networks for Sequence Prediction: Encoder-decoder models (case study translation), Attention models, LSTM, Memory Networks. Deep Network for Generation: Sequence to Sequence Models, Variational Auto-encoders, Generative Adversarial Networks (GANs), Pointer Generator Networks, Transformer Networks, Learning Representations, Learning representations for text Models for continuous variables: Time series forecasting, Modern clustering techniques, Recent topics for solving various problems of natural language processing, bioinformatics information retrieval.
Learning Outcome	● Students can design and implement advanced machine learning models, such as deep learning, and transfer learning. ● Students can apply advanced techniques, such as attention mechanisms, generative adversarial networks (GANs), and transformers. ● Students can analyze and solve challenging machine learning problems, including those involving large datasets, high-dimensional spaces, and complex relationships.
Assessment Method	Quiz / Assignment / ESE

Textbook:

- Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012.
- Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016.

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Course Number	**EIC 6201**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Deep Learning**
Learning Mode	Online
Learning Objectives	This course aims to provide an introductory overview of deep learning and its application varied domains. The course will provide basic understanding of neural networks, mathematical description of it and finally applications of it in multiple domains. A few open source tools will be demonstrated during the course to provide hands-on experience.
Course Description	This course provides an introduction to big data problems and linear algebra, covering essential machine learning techniques like linear regression and classification. It delves into neural networks, gradient-based learning, regularization methods, optimization strategies, and advanced topics such as CNNs, RNNs, and deep reinforcement learning.
Course Outline	● Introduction: Introduction to bigdata problem, overview of linear algebra ● Feature engineering: Basics of machine learning (linear regression, classification) ● Neural network: Deep feed forward network, cost function, activation functions, overfitting, underfitting, Universal approximation theorem ● Gradient based learning: DG, SGD, Backpropagation ● Regularization: L2, L1, L\infinity, drop-out, early stopping, data augmentation, etc. ● Optimization: Multivariable taylor series, momentum, adaptive learning rate, ADAM, Nesternov, AdaGrad, etc. ● CNN: CNN and its application in computer vision ● RNN: RNN, LSTM, GRU and their applications in NLP ● Advanced topics: Autoencoder, Transformer, Deep reinforcement learning
Learning Outcome	● Basic understanding of deep learning and neural networks. ● Problem modeling skill ● Usage of different open source tools / libraries. ● Analysis of large volume of data
Assessment Method	Quiz / Assignment / ESE

Textbooks:

- Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, Book in preparation for MIT Press, 2016.

Reference books:

- Jerome H. Friedman, Robert Tibshirani, and Trevor Hastie, “The elements of statistical learning”, Springer Series in Statistics, 2009.

- Charu C Aggarwal, “Neural Networks and Deep Learning”, Springer.
- Aston Zhang, Zachary C. Lipton, Mu Li, Alexander J. Smola, "Dive into Deep Learning"
- Iddo Drori, "The Science of Deep Learning", Cambridge University Press
- Simon O. Haykin, "Neural Networks and Learning Machines", Pearson Education India
- Richard S. Sutton, Andrew G. Barto, "Reinforcement Learning: An Introduction", MIT Press
- Christopher M. Bishop, Hugh Bishop, "Deep Learning: Foundations and Concepts", Springer, 2022.
- Simon J. D. Prince, "Understanding Deep Learning", MIT Press 2023.

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Course Number	**EIC 6202**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Physics of Neural Network**
Learning Mode	Online
Learning Objectives	This course aims to help the students (a) Comprehend the basic models and structures of neural networks, including the structure and function of the central nervous system, associative memory, and information storage and recall principles. (b) Gain detailed knowledge of various neuron types, such as stochastic and cybernetic neurons, and different network architectures, including layered and perceptron networks.(c) Learn to apply neural network models to practical applications such as time series prediction, game playing (e.g., Backgammon), and protein structure prediction, as well as exploring their use in biomedicine and economics.(d) Delve into advanced topics like pattern recognition, unsupervised learning, evolutionary algorithms, combinatorial optimization, VLSI, specialized networks (e.g., Hopfield networks, Kohonen maps), and advanced learning techniques like back-propagation and solving optimization problems.
Course Description	This course offers a comprehensive exploration of neural networks, encompassing their fundamental models, the structure of the central nervous system, and a brief historical overview. Students will delve into the core principles of associative memory, information storage and recall, and learning mechanisms such as Hebb's rule. The curriculum covers a variety of neuron types, including stochastic and cybernetic neurons, and introduces layered and perceptron network architectures. Throughout the course, students will investigate practical applications of neural networks, ranging from time series prediction to strategic game playing (e.g., Backgammon) and protein structure prediction. The course also highlights the role of neural networks in biomedicine and economics, showcasing their versatility and impact. Advanced topics are thoroughly explored, including pattern recognition, unsupervised learning, and evolutionary algorithms. Students will engage with combinatorial optimization, VLSI design, and specialized network models such as Hopfield networks and Kohonen maps. The course emphasizes the significance of back-propagation, learning functions, and optimization problem-solving techniques. By the end of the course, students will have a deep understanding of neural networks' theoretical foundations and practical applications, equipping them with the skills to leverage these powerful tools in various scientific and industrial domains.
Course Outline	Models of Neural Networks, A Brief History of Neural Network Models, Prediction of the Secondary Structure of Proteins, Associative Memory for Time Sequences.

Learning Outcome	1. Understand the basic concept of PINN 2. Apply the concept of Partial Differential in PINN 3. Analysis of Optimization techniques for PINNs. 4. Demonstrate the practical utility of PINNs in handling complex, real-time applications that require efficient and accurate simulations.
Assessment Method	Quiz / Assignment / ESE

TEXTBOOKS:

1. Müller, B., Reinhardt, J. and Strickland, M.T., 2012. *Neural networks: an introduction*.
2. Peretto, P., 1992. An introduction to the modeling of neural networks (Vol. 2).
3. Relevant research articles.

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Course Number	**EIC 6203**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Cryptography**
Learning Mode	Online
Learning Objectives	To have a clear understanding of design and analysis of different cryptographic primitives
Course Description	The course covers design and analysis of different cryptographic primitives including Symmetric and asymmetric key cryptography
Course Outline	Mathematical Background: Modular Arithmetic, Finite Fields, The Group Law, Elliptic Curves over Finite Fields , Projective Coordinates. Symmetric Encryption: Shift Cipher, Substitution Cipher, Permutation Cipher, Stream Cipher Basics, Linear Feedback Shift Registers, RC4; Block Ciphers: DES, AES, and Different modes of Block ciphers. Key Management, Secret Key Distribution. Hash Functions and Message Authentication Codes: SHA, MD5, HMAC. Public Key Encryption: RSA, ElGamal Encryption, Rabin Encryption, Elliptic curve based encryption. Digital Signatures: RSA based, DSA, ECDSA. Public key based infra structure. Key Exchange: Diffie–Hellman Key Exchange, Authenticated Key Agreement
Learning Outcome	After completion of this course a student will have • Understanding of modular arithmetic and Finite fields, • Understanding and analysis of symmetric key cryptography DES, AES • Understanding and analysis of Hash function, MAC function, • Understanding and analysis of asymmetric key cryptography • Understanding and analysis of key agreement protocols
Assessment Method	Quiz / Assignment / End Semester Exam (ESE)

Suggested Readings:

1. W. Mao, Modern Cryptography: Theory and Practice. Pearson Education
2. Hand book of applied cryptography by A. Menezes, CRC press
3. Doug Stinson, Cryptography: Theory and Practice, Chapman and Hall/CRC,

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Course Number	**EIC 6204**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Federated Learning**
Learning Mode	Online
Learning Objectives	This course aims to help the students (a) Grasp Foundational Concepts and Developments of Federated Learning (FL), and stay informed about current developments and emerging trends in the field. (b) Implement Privacy and Security Techniques including privacy-preserving machine learning (PPML), privacy-preserving gradient descent, and threat and security models to ensure data confidentiality and integrity in FL systems. (c) Mastering horizontal and vertical FL architectures (HFL, VFL) and algorithms, such as the federated averaging algorithm and its enhancements. (d) FL techniques to practical applications in computer vision, natural language processing (NLP), and reinforcement learning, demonstrating the practical benefits and addressing limitations in these domains.
Course Description	This course offers a comprehensive exploration of Federated Learning (FL), a cutting-edge approach to collaborative machine learning where models are trained across decentralized devices or servers holding local data samples. The course begins with an introduction to FL, defining its principles, categories, and current developments in the field. Students will delve into essential topics such as privacy-preserving techniques, including privacy-preserving machine learning (PPML) and secure machine learning methods, to ensure data security and confidentiality in distributed learning environments. The curriculum covers scalable distributed machine learning (DML) techniques tailored for FL, addressing challenges in model aggregation and performance across heterogeneous data sources. Key architectural paradigms like horizontal and vertical FL (HFL, VFL) will be explored, alongside algorithms such as federated averaging and advancements in optimization for FL scenarios. The course emphasizes practical applications of FL in domains like computer vision, natural language processing (NLP), and reinforcement learning, showcasing its utility and addressing real-world challenges.By the end of the course, students will have a deep understanding of FL principles, techniques, and applications. They will be equipped to design and implement secure, scalable, and privacy-aware machine learning solutions suitable for collaborative environments with distributed data sources.
Course Outline	Introduction to Federated Learning, Current Development in Federated Learning, Privacy-Preserving Machine Learning, Horizontal Federated Learning, Vertical Federated Learning.
earning Outcome	● Understand the principles, definitions, and categories of federated learning ● Apply various privacy-preserving machine learning ● Design and improve federated learning algorithms, such as the federated averaging algorithm.

	• Utilize federated learning frameworks for practical applications in computer vision, natural language processing, reinforcement learning, and other areas.
Assessment Method	Quiz / Assignment / ESE

Suggested Reading

1. Deppeler, A., 2020. Automated Machine Learning and Federated Learning. *The AI Book: The Artificial Intelligence Handbook for Investors, Entrepreneurs and FinTech Visionaries*, pp.248-250.
2. Relevant research articles.

INDIAN INSTITUTE OF TECHNOLOGY PATNA

Continuing Education Programme
Program: M.S in Artificial Intelligence & Cyber Security
Curriculum and Syllabus-2025

Course Number	**EIC 6301**
Course Credit	3-0-0-3
Course Title	**Artificial Internet of Things**
Learning Mode	Online
Learning Objectives	• Gain a comprehensive understanding of the convergence of Artificial Intelligence (AI) and Internet of Things (IoT), including basic concepts, architectures, and applications. • Learn various AI techniques and their applications in IoT, including machine learning, deep learning, and data analytics. • Develop skills in designing and implementing IoT systems, integrating sensors, and managing data flow. • Understand the processes for collecting, storing, processing, and analyzing IoT data using AI techniques. • Identify and mitigate security risks and privacy concerns in AIoT systems. • Analyze various real-world applications of AIoT in industries such as healthcare, smart cities, agriculture, and manufacturing. • Understand the regulatory and ethical considerations related to AIoT technologies and their deployment.
Course Description	This course provides an in-depth exploration of the convergence of Artificial Intelligence (AI) and the Internet of Things (IoT), known as AIoT. It covers the fundamental principles and technologies of both AI and IoT, demonstrating how they can be integrated to create intelligent, autonomous systems. Students will learn about IoT architecture, AI algorithms, machine learning, data analytics, and the implementation of AI-driven IoT solutions. Through hands-on projects and real-world case studies, students will gain practical experience in developing smart applications for various domains such as smart cities, healthcare, industrial automation, and smart homes.
Course Outline	• Introduction to AIoT, Intersection of AI and IoT, Benefits and challenges of AIoT • Fundamentals of IoT, IoT Architecture and Protocols, Layers of IoT architecture, Communication protocols and standards, IoT Devices and Sensors • Fundamentals of Artificial Intelligence, Machine Learning and Deep Learning, Overview of AI tools and frameworks • AIoT System Architecture, Components and Designing AIoT, Edge Computing in AIoT, Edge vs. cloud computing, AI Models for IoT • Data Management in AIoT, Data Processing and Analysis, Handling large-scale IoT data, Big data technologies and platforms • AIoT Applications and Use Cases: Smart Homes and Buildings, Healthcare and Wearables, Industrial IoT (IIoT), Smart Cities and Transportation • AIoT Platforms and Tools: AI Development Tools, Case Studies of AIoT Solutions, AIoT Project Development, Future Trends and Innovations in AIoT
Learning Outcome	At the end of course, students will have achieved the following learning objectives.

	• Students should grasp the foundational concepts of AI and IoT, including machine learning algorithms, data analytics, sensor technologies, and network protocols. • Ability to integrate AI algorithms with IoT devices and platforms to create intelligent systems capable of data collection, analysis, and decision-making in real-time. • Proficiency in developing AI-driven IoT applications, including sensor data processing, predictive analytics, anomaly detection, and automation. • Awareness of security challenges and solutions in AIoT systems, including data privacy, authentication, encryption, and intrusion detection. • Knowledge of optimization techniques for AIoT systems to enhance performance, scalability, and energy efficiency.
Assessment Method	Quiz / Assignment / ESE

Suggested Reading

- Olivier Hersent, David Boswarthick, and Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley
- Maciej Kranz, Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry, Wiley
- John Paul Mueller and Luca Massaron, Machine Learning for the Internet of Things: Practical Guide, Packt.

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Continuing Education Programme
Program: M.S in Artificial Intelligence & Cyber Security
Curriculum and Syllabus-2025

Course Number	**EIC 6302**
Course Credit	3-0-0-3
Course Title	**Natural Language Processing**
Learning Mode	Online
Learning Objectives	● Define and describe fundamental concepts in NLP, including syntax, semantics, and pragmatics, and their relevance to text analysis and language modelling. ● Apply pre-processing techniques to clean and prepare text data for analysis, such as tokenization, lemmatization, stemming, and stop-word removal. ● Utilize methods for feature extraction and representation from text data, including bag-of-words, TF-IDF, and various types of word embeddings (e.g., Word2Vec, GloVe). ● Construct and evaluate machine learning and deep learning models for various NLP tasks, such as classification, regression, and sequence labelling, using techniques like Naïve Bayes, SVM, RNNs, and Transformers. ● Design and implement solutions for practical NLP problems, including sentiment analysis, named entity recognition, text summarization, and machine translation.
Course Description	● Understand foundational concepts and challenges in NLP, including language modelling, parsing, and semantic analysis. ● Apply text pre-processing techniques to prepare data for analysis, including tokenization, stemming, and lemmatization. ● Utilize various feature extraction and representation methods such as bag-of-words, TF-IDF, and word embeddings. ● Develop and evaluate both traditional machine learning models and advanced deep learning models for a range of NLP tasks. ● Implement practical solutions for applications such as sentiment analysis, named entity recognition, and text summarization.
Course Outline	Introduction to NLP, Simple Word Vector representations: word2vec, GloVe: Distributed Representations of Words and Phrases and their Compositionality, Efficient Estimation of Word Representations in Vector Space, Advanced word vector representations: language models, GloVe: Global Vectors for Word Representation, PoS tagging and named entity recognition, Language modelling and other tasks, Opinion Mining Parsing, Sentence classification, Machine Translation, Dynamic Memory Networks, Question Answering, Natural Language Generation and Summarization, Contextual Word Representations: BERT
Learning Outcome	At the end of course, students will have achieved the following learning objectives. ● Demonstrate a solid understanding of key concepts in NLP, including tokenization, stemming, lemmatization, and part-of-speech tagging. ● Apply techniques for text pre-processing and cleaning, including removing stop words, normalizing text, and handling noisy data.

	• Implement and evaluate methods for feature extraction and representation, such as bag-of-words, TF-IDF, and word embeddings (e.g., Word2Vec, GloVe). • Develop and train various NLP models, including traditional machine learning models (e.g., Naive Bayes, SVM) and deep learning models (e.g., RNNs, LSTMs, Transformers). • Apply techniques for natural language understanding (e.g., named entity recognition, sentiment analysis) and natural language generation (e.g., text summarization, machine translation).
Assessment Method	Quiz / Assignment / ESE

Tectbook:

- Dan Jurafsky and James H. Martin.Speech and Language Processing (3rd ed. draft)
- Jacob Eisenstein.Natural Language Processing
- Yoav Goldberg.A Primer on Neural Network Models for Natural Language Processing
- Ian Goodfellow, YoshuaBengio, and Aaron Courville.Deep Learning
- Delip Rao and Brian McMahan.Natural Language Processing with PyTorch (requires Stanford login).
- Michael A. Nielsen.Neural Networks and Deep Learning
- Eugene Charniak. Introduction to Deep Learning

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Course Number	**EIC 6303**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Generative AI**
Learning Mode	Online
Learning Objectives	• To provide a comprehensive understanding of advanced AI concepts with a focus on generative AI • To design and implement various generative models such as GANs, VAEs, and Diffusion Models. • To explore the architecture and applications of Generative Pre-trained Transformers (GPT). • To design application-specific architectures for prompt engineering and multimodal generative AI. • To analyze and address ethical considerations in the development and deployment of generative AI models. • · To conduct independent research and projects involving advanced generative AI techniques.
Course Description	This course provides an in-depth exploration of advanced artificial intelligence (AI) concepts, with a specific focus on generative AI (GenAI). Students will delve into advanced generative models, including Generative Adversarial Networks (GANs), Variational AutoEncoders (VAEs), Diffusion Models, and Generative Pre-trained Transformers (GPT). The course also covers the application of these models across various domains, the design of application-specific architectures for prompt engineering, and multimodal generative AI. Additionally, ethical considerations surrounding the use of generative AI will be discussed. By the end of the course, students will have the knowledge and skills to design, implement, and evaluate advanced generative AI models and understand their ethical implications
Course Outline	Introduction to Generative AI (GenAI): Overview of GenAI, historical context and scope. Generative Adversarial Networks (GAN) and Deep Convolutional GAN (DCGAN): Understanding the architecture of GANs, Training dynamics and loss functions in GANs, Implementation and applications of DCGANs, Challenges and solutions in training GANs. Advanced Variational AutoEncoders (VAE): Fundamentals of VAEs and their architectures, Latent space representation and sampling techniques, Advanced VAE variants and their improvements, Applications of VAEs in image and data generation. Basics of Diffusion Models and Attention Mechanisms in Generative Models: Introduction to diffusion models and their principles, Understanding the role of attention mechanisms in generative models, Implementation of attention-based generative models, Case studies and applications of diffusion models. Generative Pre-trained Transformers (GPT) Basics: Overview of transformer architecture, Understanding the training and functioning of GPT models, Applications of GPT models in text generation and NLP, Finetuning and optimizing GPT for specific tasks. Application-Specific Architecture for Prompt Engineering and Multimodality: Designing and optimizing prompt engineering techniques, exploring multimodal generative models, Integrating text, image, and audio in generative models, Case studies of application-specific generative architectures. Ethical Considerations in Generative AI: Understanding the ethical implications of Generative AI, Addressing bias, fairness, and accountability in generative models, Privacy concerns and data security in Generative AI.

Learning Outcome	By the end of this course, students will be able to: • Understand the foundational concepts and the latest advancements in artificial intelligence and generative AI. • Design and implement Generative Adversarial Networks (GANs) and their advanced variants, such as DCGAN. • Develop and apply advanced Variational AutoEncoders (VAEs) for generative tasks. • Grasp the basics of Diffusion Models and the role of attention mechanisms in enhancing generative models. • Understand the architecture and functioning of Generative Pre-trained Transformers (GPT) and their applications. • Create application-specific architectures for prompt engineering and explore the integration of multimodal generative AI techniques. • Analyze and address ethical considerations and challenges in the development and deployment of generative AI models. • Conduct independent research and projects involving advanced generative AI techniques, demonstrating a comprehensive understanding of both theoretical and practical aspects.
Assessment Method	Quiz / Assignment / End Semester Exam (ESE)

TEXTBOOKS:

• Foster, D. (2022). Generative deep learning: Teaching Machines to Paint, Write, Compose, and Play. O'Reilly Media, Inc.
• Valle, R. (2019). Hands-On Generative Adversarial Networks with Keras: Your guide to implementing next-generation generative adversarial networks. Packt Publishing Ltd.
• Research Papers and Articles from Journals such as JMLR, IEEE Transactions on Neural Networks and Learning Systems, etc., and Conference Proceedings from NeurIPS, ICML, and CVPR,etc.

Course Number	**EIC 6304**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Advanced Cloud Computing**

Learning Mode	Online
Learning Objectives	This course aims to help the students understand: a) How and why cloud systems work and the cloud technologies that manifest these concepts, such as those from Amazon AWS and Microsoft Azure; b) Distributed systems concepts like virtualization, data parallelism, CAP theorem, and performance analysis at scale; c) Big Data programming patterns such as Map-Reduce (Hadoop), Vertex-centric graphs (Graph), Continuous Dataflows (Storm), and NoSQL storage systems to build Cloud applications; d) Cloud native computing and micro-services.
Course Description	This course provides an in-depth understanding of cloud computing, virtualization, and distributed systems. It covers foundational concepts, advanced techniques, and real-world applications. Students will explore various aspects of cloud infrastructure, virtualization technologies, distributed algorithms, and cloud-native computing. By the end of the course, students will be equipped with the knowledge and skills to design, implement, and manage cloud-based solutions and distributed systems effectively.
Course Outline	• Introduction to Clouds, Virtualization, and Virtual Machines. • Network Virtualization and Geo-distributed Clouds. • Leader Election in Cloud, Distributed Systems, and Industry Systems. • Classical Distributed Algorithms and Industry Systems. • Consensus, Paxos, and Recovery in Clouds. • Cloud Storage: Key-value Stores/NoSQL Systems and their Use in Industry Systems. • Cloud Applications: MapReduce, Spark, and Apache Kafka. • Cloud Native Computing and Micro-services.
Learning Outcome	• Cloud Computing as a Distributed Systems: Explain and contrast the role of Cloud computing within this space. • Cloud Virtualization, Abstractions and Enabling Technologies: Explain virtualisation and their role in elastic computing. Characterise the distinctions between Infrastructure, Platform and Software as a Service (IaaS, PaaS, SaaS) abstractions, and Public and Private Clouds, and analyse their advantages and disadvantages. • Programming Patterns for "Big Data" Applications on Cloud: Demonstrate using Map-Reduce, Vertex-Centric and Continuous Dataflow programming models. • Application Execution Models on Clouds: Compare synchronous and asynchronous execution patterns. Design and implement Cloud applications that can scale up on a VM and out across multiple VMs. Illustrate the use of NoSQL Cloud storage for information storage. • Performance, scalability and consistency on Clouds: Explain the distinctions between Consistency, Availability and Partitioning (CAP

	theorem), and discuss the types of Cloud applications that exhibit these features.
Assessment Method	Quiz / Assignment / ESE

Suggested Reading

- Distributed and Cloud Computing From Parallel Processing to the Internet of Things; Kai Hwang, Jack Dongarra, Geoffrey Fox Publisher: Morgan Kaufmann, Elsevier, 2013.
- Cloud Computing: Principles and Paradigms; Rajkumar Buyya, James Broberg, and Andrzej M. Goscinski Publisher: Wiley, 2011.
- Distributed Algorithms Nancy Lynch Publisher: Morgan Kaufmann, Elsevier, 1996.
- Cloud Computing Bible Barrie Sosinsky Publisher: Wiley, 2011.
- Cloud Computing: Principles, Systems and Applications, Nikos Antonopoulos, Lee Gillam Publisher: Springer, 2012.

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Course Number	**EIC 6401**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Reinforcement Learning**
Learning Mode	Online
Learning Objectives	This course aims to help the students: **(a)** Understand the foundational concepts and mathematical frameworks of reinforcement learning. **(b)** Gain proficiency in key reinforcement learning algorithms, including dynamic programming, Monte Carlo methods, and temporal-difference learning. **(c)** Apply deep reinforcement learning techniques to solve complex problems using methods such as deep Q-networks and policy gradient algorithms. **(d)** Explore recent advancements and applications of reinforcement learning, including multi-agent systems and ethical considerations.
Course Description	This specialized course on reinforcement learning aims to give students a deep understanding of the algorithms and methodologies used to train agents to make decisions through trial and error. Students will learn to develop and implement reinforcement learning models by focusing on foundational theories and practical applications. Students will explore key concepts such as Markov decision processes, policy gradients, Q-learning, and deep reinforcement learning through a mix of theoretical lectures, coding exercises, and project-based learning. Upon completion, students will be equipped to design and apply reinforcement learning solutions to complex problems in fields such as robotics, game development, and autonomous systems, enhancing their expertise in this dynamic area of artificial intelligence.
Course Outline	• **Foundations**: Basics of machine learning and reinforcement learning (RL) terminology. • **Probability Concepts**: Axioms of probability, random variables, distributions, and correlation. • **Markov Decision Process**: Introduction to MDPs, Markov property, and Bellman equations. • **State and Action Value Functions**: Concepts of MDP, state, and action value functions. • **Tabular Methods and Q-networks**: Dynamic programming, Monte Carlo, TD learning, and deep Q-networks. • **Policy Optimization**: Policy-based methods, REINFORCE algorithm, and actor-critic methods. • **Recent Advances and Applications**: Meta-learning, multi-agent RL, ethics in RL, and real-world applications.
Learning Outcome	1. Mastery of fundamental principles and mathematical frameworks of reinforcement learning.

	2. Proficiency in implementing key reinforcement learning algorithms and techniques. 3. Ability to apply deep reinforcement learning methods to complex, real-world problems. 4. Understanding of recent advancements in reinforcement learning and their ethical implications.
Assessment Method	Quiz / Assignment / ESE

Suggested Reading

- Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto, The MIT Press (1 January 1998).
- Deep Reinforcement Learning Hands-On by Maxim Lapan, Packt Publishing Limited (21 June 2018).
- Algorithms for Reinforcement Learning by Csaba Szepesvari, Morgan and Claypool Publishers (2010)
- Deep Reinforcement Learning: Fundamentals, Research and Applications by Hao Dong, Springer Verlag (2020)

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Continuing Education Programme
Program: M.S in Artificial Intelligence & Cyber Security
Curriculum and Syllabus-2025

Course Number	**EIC 6402**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Meta Learning**
Learning Mode	Online
Learning Objectives	This course aims to help the students (a) Gain a solid understanding of the foundational principles of meta-learning, including model evaluation, basic machine learning concepts, and their limitations. (b) Delve into advanced techniques such as deep learning, transfer learning, and multitask learning, and understand how these methodologies enhance meta-learning capabilities. (c) Develop proficiency in key meta-learning strategies, including model-based, metric-based, and optimization-based approaches, and familiarize yourself with advanced architectures like memory-augmented networks and conditional sequential neural networks (CSNNs). (d) Apply meta-learning techniques to practical applications in various domains, such as computer vision, natural language processing (NLP), reinforcement learning, healthcare, recommendation systems, and climate science, demonstrating the ability to solve complex real-world problems.
Course Description	This comprehensive course provides an in-depth overview of meta-learning, guiding students from foundational principles to advanced techniques. The curriculum begins with the basics of model evaluation, machine learning concepts, and their inherent limitations. Students will then explore advanced topics such as deep learning, transfer learning, and multitask learning, gaining a robust understanding of how these methodologies enhance the capabilities of meta-learning systems.Key meta-learning strategies are thoroughly examined, including model-based, metric-based, and optimization-based approaches. The course features advanced architectures like memory-augmented networks and conditional sequential neural networks (CSNNs), showcasing their roles in improving learning efficiency and effectiveness.Practical applications of meta-learning are highlighted across various fields, including computer vision, natural language processing (NLP), reinforcement learning, healthcare, recommendation systems, and climate science. These examples demonstrate the versatility and power of meta-learning in addressing complex, real-world problems.By the end of the course, students will be equipped with a robust understanding of meta-learning principles and techniques, enabling them to leverage these advanced methodologies to solve intricate problems across diverse domains.
Course Outline	Meta-Learning Basics and Background, Evaluation of Meta learning, Model-Based Meta-Learning Approaches, Metric-Based Meta-Learning Approaches, Optimization-Based Meta-Learning Approaches

Learning Outcome	1. Understand and articulate the foundational principles of meta-learning 2. Apply probabilistic modeling and Bayesian inference to quantify uncertainty and improve model robustness in decision-making processes. 3. Analysis of Optimization-Based Meta-Learning Approaches. 4. Explore and address new challenges in emerging applications
Assessment Method	Quiz / Assignment / ESE

TEXTBOOKS:

1. Zou, L., 2022. *Meta-learning: Theory, algorithms and applications*.
2. Brazdil, P., Van Rijn, J.N., Soares, C. and Vanschoren, J., 2022. *Metalearning: applications to automated machine learning and data mining* (p. 346).

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Continuing Education Programme
Program: M.S in Artificial Intelligence & Cyber Security
Curriculum and Syllabus-2025

Course Number	**EIC 6403**
Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Quantum Machine Learning**
Learning Mode	Online
Learning Objectives	This course aims to help the students (a) proficiency in implementing and applying classical machine learning algorithms, including classification, regression, gradient descent, and neural networks. (b) grasp the foundational principles of quantum computing, quantum states, qubits, and basic quantum operations.(c) advanced quantum algorithms and their applications in machine learning and computational tasks. (d) gain practical experience in implementing quantum algorithms and simulating quantum processes.
Course Description	This course offers a comprehensive exploration of machine learning (ML) and quantum computing (QC) principles, preparing students to navigate the intersection of classical and quantum computational paradigms. Students will master classical ML techniques including classification, regression, neural networks, and optimization methods like gradient descent. In the quantum computing segment, foundational concepts such as quantum states, qubits, and basic quantum operations (e.g., Hadamard gates) will be covered, alongside encoding classical data on quantum systems and implementing basic quantum algorithms. Advanced topics include variational quantum algorithms, quantum support vector machines, the HHL algorithm for linear systems, and quantum neural networks. Through lectures, practical exercises using quantum programming frameworks, and real-world applications, students will develop a dual proficiency in classical ML and quantum computing, equipping them for roles in research, development, or applications across industries leveraging emerging quantum technologies.
Course Outline	Overview of Machine Learning, Quantum Circuit, Variational quantum algorithm, Quantum Neural Network
Learning Outcome	By the end of the course, students will be able to: • Understanding of Machine Learning and Quantum Computing Fundamentals. • Apply the concept of feature vectors, encode data in Quantum computing. • Analysis of Variational quantum algorithms to solve complex problems. • Implementation and analysis of advanced quantum machine learning algorithms. Explore advanced topics in Generative AI and apply acquired knowledge through hands-on projects, fostering innovation and practical problem-solving skills.
Assessment Method	Quiz / Assignment / ESE

Suggested Reading:

- Nielsen, M.A. and Chuang, I.L., 2010. Quantum computation and quantum information.
- Schuld, M. and Petruccione, F., 2021. Machine learning with quantum computers (Vol. 676). Berlin.
- Relevant research articles.

Course Number	**EIC 6404**

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Continuing Education Programme
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Course Credit	L-T-P-C: 3-0-0-3
Course Title	**Text Mining and Analytics**
Learning Mode	Online
Learning Objectives	• To understand the fundamental principles and scope of text mining and analytics. • To acquire skills in data collection, cleaning, and integration for text data. • To learn text preprocessing techniques including tokenization, stemming, stopword removal, and normalization. • To construct knowledge graphs by linking entities and extracting relationships. • To identify and mine frequent patterns and apply advanced pattern mining techniques. • To extract features from text data and apply clustering and classification methods. • To implement practical applications such as sentiment analysis and text summarization. • To utilize advanced techniques for enhanced text data analysis and mining.
Course Description	This course provides a comprehensive understanding of the principles and techniques of text mining and analytics. Students will learn about data collection, cleaning, integration, and preprocessing methods essential for handling text data. The course covers knowledge graph construction, pattern mining, feature extraction, and advanced text clustering and classification techniques. Practical applications such as sentiment analysis and text summarization are also explored. By the end of the course, students will be prepared to tackle real-world challenges in data mining and text analytics.
Course Outline	Text mining and analytics introduction: Overview, motivation, scope. Data Collection and Pre-processing: Techniques for collecting data from various sources. Text data cleaning and integration, descriptive analytics. Text preprocessing: tokenization, stemming, stopword removal, and normalization. Knowledge graph construction: Basics of graphs, entity linking, relationship extraction. Concepts of frequent patterns, closed patterns, max-patterns, and association rules, mining frequent patterns: apriori algorithm, pattern-growth approach. Advanced: mining sequential patterns. Feature extraction, Bag-of-Words, TF-IDF, word embeddings Clustering and classifying text data, Expectation-maximization (EM) algorithm for text data, Latent Dirichlet Allocation (LDA) for topic modeling, and some advanced techniques.

	Some applications: sentiment analysis, text summarization, etc. Some advanced topics and project.
Learning Outcome	• By the end of this course, students will be able to: • Understand the core principles and scope of text mining and analytics. • Collect, clean, and integrate text data from various sources. • Apply text preprocessing techniques such as tokenization, stemming, and normalization. • Construct and utilize knowledge graphs for entity linking and relationship extraction. • Identify and mine various patterns in text data, including frequent, closed, and sequential patterns. • Extract features from text data using methods like Bag-of-Words, TF-IDF, and word embeddings. • Perform text clustering and classification using algorithms such as EM and LDA. • Implement practical text analytics applications such as sentiment analysis and text summarization. • Utilize advanced techniques for enhanced text data analysis and mining.
Assessment Method	• Quiz / Assignment / ESE

Suggested Reading

- Srivastava, A. N., & Sahami, M. (Eds.). (2009). Text mining: Classification, clustering, and applications. CRC press.
- Chakraborty, G., Pagolu, M., & Garla, S. (2014). Text mining and analysis: practical methods, examples, and case studies using SAS. SAS Institute.
- Sarkar, D. (2016). Text analytics with python (Vol. 2). New York, NY, USA:: Apress.
- Witten, I. H., Frank, E., Hall, M. A., Pal, C. J., & Data, M. (2005, June). Practical machine learning tools and techniques. In Data mining (Vol. 2, No. 4, pp. 403-413). Amsterdam, The Netherlands: Elsevier