List of Additional Elective courses for M.TechProgramme

CSE654 Machine Learning

CSE655 System Design

CSE657 Computer Vision and Pattern Recognition

CSE659 Natural Language Processing

CSE660 Blockchain Technology

CSE661 Game Theory

CSE663 Deep Learning

CSE664 Cyber Security: Attacks and Defences

CSE661 GAME THEORY

Course Outline: This course provides an introduction to Game Theory. Game Theory is a mathematical framework that studies strategic interactions amongst self-interested decision makers. It has applications in a wide variety of areas, including statistical decision theory, artificial intelligence (online learning, multi-agent systems), economics and business (auctions, pricing, bargaining), political science (stability of government, military strategy), philosophy (ethics, morality and social norms) and biology (evolution, signalingbehavior, fighting behavior).

Course Overview: The novel concepts of game theory and how to find different equilibrium solutions to different types of games will be extensively covered in this course. These will be explained and elucidated with relevant examples. This course provides a rigorous treatment of solution concepts for games with perfect and imperfect information including rationalxizability, Nash and subgame perfect Nash equilibria.

UNIT 1- Games with Perfect Information-Strategic Games; Nash Equilibrium and Existence Properties; Some Games in Normal Form, Nash Equilibria in Zero-Sum Games, Bräss' Paradox, and more on Mixed Strategies, Games in Extensive Form, Market Equilibrium and Pricing.

UNIT 2- Electoral Competition: Median Voter Theorem; Auctions: Definitions and The role of Knowledge; Decision Making and Utility Theory; Mixed Strategy Equilibrium.

UNIT 3-The Paretian System Equilibrium, and Walrasian General Equilibrium Theory, Von Neumann and Morgenstern Utility Function, Theory of Risk Aversion, Equilibrium Theory.

UNIT 4- Sealed Bid Auctions, VCG Procedures, Generalized Vickrey Auctions, VCG Procedures, Cournot Competition and Stackelberg Equilibrium; Arrow's Impossibility Theorem, Gibbard-Satterthwaite Theorem, Bargaining Game with Alternating Offers; Bargaining Game with Alternating Offers (General Utilities); Nash Bargaining Solution.

TEXT/REFERENCE BOOKS:

1) "Fun and Games: A Text on Game Theory", KenBinmore, A.I.T.B.S Publishers.

2) "A Course in Game Theory", Martin J. Osborne and Ariel Rubinstein, MIT Press.

3) PrajitDutta, Strategies and Games, MIT Press

Learning Outcomes: On successful completion of this course, students will be able to model competitive real world phenomena using concepts from game theory and identify optimal strategy and equilibrium solution for such models. They will be ready to explain the potential or proven relevance of game theory and its impact in various fields of human interaction which involve conflict of interest between two or more participants.

CSE654Machine Learning		
Teaching Scheme	Examination Scheme	Credits allocated
Theory 3 h/week+ Practical 2h/week	End of semester Examination-60 marks	Theory-3, Practical-1

Course Objective:

1. To understand concepts of Machine learning.
2. To learnand develop models for real world applications.

Course Outcomes: On completion this course, students will be able to

1. Student will be able to Understand ML Fundamentals
2. Learn to apply Data Preprocessing Techniques
3. Develop ML Applications for real world problems.

Level	Masters	
Course Content:		
Unit –I	Introduction to Machine Learning; Learning Problems, Types of Machine Learning, Linear algebra. Linear Models for Regression & Classification, Linear regression, Logistic Regression. Bias-Variance; Training/Testing, Evaluation: Cross-Validation.	11 hrs
Unit-II	K-nearest neighbour algorithm, Introduction to Decision Trees – Basic concepts, advantages, and real-world applications.Tree Splitting Criteria - (ID3, C4.5, CART).Ensemble Methods: Bagging & Boosting, Random Forest, Gradient Boosting Machines and XGBoost.	11 Hrs
Unit-III	Introduction to Probability, Naïve Bayes,Maximum Likelihood Estimation (MLE) , Maximum APosteriori (MAP) Neural Networks,Multilayer Perceptron, Backpropagation.Activation Functions (ReLU, Sigmoid, Tanh, Softmax). Stochastic Gradient Descent, Introduction to SVM. Evaluation Metrics like - accuracy, TPR, FPR, FRR, FPR, Sensitivity, Specificity, ROC / DET curve, Precision-Recall, F1-Score	16 hrs
Unit-IV	Unsupervised Learning: Clustering, k-means Clustering. Density-Based Clustering, DB-Scan.	8 hrs
Internal assessment		
Part A	CIA-I: Unit I, and II	20 Marks
	CIA-II: Unit III, and IV	20 Marks
Part B	ESE: Term Exam	60 Marks

Text/Reference Books:

1. Machine Learning, Tom M. Mitchell, McGraw Hill, 1997.
2. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, 2006

Reference Books.

1. Pattern Classification. Duda, Hart and Stork. 2nd ed., Wiley, 2006
2. Understanding Machine Learning: From Theory to Algorithms, Shai Shalev-Shwartz and Shai Ben-David,Cambridge University Press, 2014.
3. A First Course in Machine Learning, Simon Rodgers and Mark Girolami, Second Edition CRC Press
4. Learning From Data, Yaser Abu-Mostafa, AML BooksML, PR, Data Mining
5. Machine Learning An algorithmic Perspective, Second Edition, Stephen Marsland, CRC Press
6. Fundamentals of Machine Learning, John D. Kelleher, The MIT Press

7. An Introduction to Machine Learning, Second ed, Miroslav Kubat, Springer
8. An Introduction to Statistical Learning, Gareth James, Robert Tribshirani, Springer

CSE659 Natural Language Processing		
Teaching Scheme	Examination Scheme	Credits allocated
Theory 3 h/week+ Practical 2h/week	End of semester Examination-60 marks	Theory-3, Practical-1
Level	Masters	
Course Content:		
Unit –I	Introduction to NLP: Introduction natural language processing, stop word removal,stemming, lemmatization. Language Modeling: N-grams, chain rule, Markovassumption, Evaluating Language Models, Smoothing: Laplace Smoothing, Add-ksmoothing, interpolation, backoff methods.	10 hrs
Unit-II	Classification, Learning representation: Text classification, Naïve bayes, EvaluationPrecision, Recall, F-measure. Vector space model, Term weighting schemes, TermFrequency, Term Frequency-Inverse Document Frequency, Binary.Vector Semantics: Embeddings, Cosine for measuring similarity, Point wise MutualInformation (PMI).	10 Hrs
Unit-III	Dimensionality reduction for NLP: Latent semantics, Singular value decomposition,Principal Component Analysis. Distributional semantics, Word Embeddings,Word2Vec, skipgram, continuous bag of words (CBOW), Embeddings using SVD.	10 hrs
Unit-IV	Neural Networks and Neural Language Models: Gradient descent, convolution, Convolutional neural network for NLP applications. Recurrent neural network, Long short term memory, GRU.Unsupervised Approaches, Latent semantic analysis. NLP Applications – Sentiment Analysis, Spam Detection, Abusivelanguage detection, Fake news detection etc.	10 hrs
Internal assessment		
Part A	CIA-I: Unit I, and II	20 Marks
	CIA-II: Unit III, and IV	20 Marks
Part B	ESE: Term Exam	60 Marks

Text/Reference Books:

1. Dan Jurafsky and James Martin. Speech and Language Processing: An Introduction to Natural LanguageProcessing, Computational Linguistics and Speech Recognition. Prentice Hall, Second Edition, 2009.
2. Chris Manning and HinrichSchütze. Foundations of Statistical Natural Language Processing. MIT Press,Cambridge, MA: May 1999.

Reference Books:

1. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
2. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.

CSE663 Deep Learning		
Teaching Scheme	Examination Scheme	Credits allocated
Theory 3 h/week+ Practical 2h/week	End of semester Examination-60 marks	Theory-3, Practical-1
Level	Masters	
Course Content:		
Unit –I	Introduction to Machine Learning, Neural Networks Overview and its Representation,Neuron Model and Network Architecture, Transfer Function, Single layer and Multiple layers of Neurons. Role of Hidden layers, Computing a Neural Network's Output,Activation Functions, Derivative of Activation Function, Need of Non-linearActivation.Deep Neural Networks, Challenges and issues with deep networks. Perceptron, Gradient Descent and its role in Neural Networks, Stochastic gradientdescent and contemporary variants, Feedforward and Backpropagation, PerceptronLearning Rules.	11 hrs
Unit-II	Autoencoders, Variational Autoencoders, Deep Boltzmann Machines. Introduction to deep learning models. Convolutional Neural Network, Differentarchitectures, convolution / pooling layers. Standard CNN architectures, TransferLearning	11 Hrs
Unit-III	Sequential learning, Recurrent Neural Network and Long term short memory (LSTM),GRU, Encoder Decoder Architectures	11 hrs
Unit-IV	Evaluation metrics.Deep learning application in Computer Vision and NLP: Image segmentation,object detection, Introduction to NLP and Vector Space Model, Word Vector representations: Continuous Skip-Gram Model, Continuous Bag-ofWords model (CBOW), Text classification, Object detection.	11 hrs
Internal assessment		
Part A	CIA-I: Unit I, and II	20 Marks
	CIA-II: Unit III, and IV	20 Marks
Part B	ESE: Term Exam	60 Marks

Text/Reference Books:

1. Martin T. Hagan, et al. “Neural Network Design”, Latest Edition
2. Charu C. Aggarwal, “Neural Networks and Deep Learning: A Textbook”, Springer
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, MIT Press book

Reference Books.

I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2016.
2. K. P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

CSE670 Blockchain Technology		
Teaching Scheme	Examination Scheme	Credits allocated
Theory 3 h/week+ Practical 2h/week	End of semester Examination-60 marks	Theory-3, Practical-1

Course Prerequisite: Students should have knowledge of Computer Networks and Network Programming

Course Objective:

1. To understand concepts of Blockchain and applications
2. To understand the implementations of Peer-peer networking applications

Course Outcomes: On completion this course, students will be able to

1. Differentiate the different types of blockchain application based on underlying P2P systems
2. Design a P2P system for a given application.
3. Design a Publish-subscribe system
4. Analyze the issues in any blockchain application

Level	Masters	
Course Content:		
Unit –I	Introduction to blockchain technology, Characteristics of blockchain, Basics of Networking, TCP/IP model, IPv4 Address scheme, Socket Programming, TCP client and Server, UDP client and Server. Client/Server Networking architecture, P2P networking architecture.	10 hrs
Unit-II	Interplanetary File System, P2P Swarm, publish-subscribe system, SHA256, RSA public and private key cryptography, digital signature.	10 hrs
Unit-III	Blocks, blockchain architecture, byzantine fault tolerance, consensus mechanism, Contest driven decentralisation, types of blockchain networks, CAP theorem, and smart contracts.	10 hrs
Unit-IV	Case studies on blockchain application such as Bitcoin, filecoin etc.	10 hrs

Internal assessment		
Part A	CIA-I: Unit I, and II	20 Marks
	CIA-II: Unit III, and IV	20 Marks
Part B	ESE: Term Exam	60 Marks

Text/Reference Books:

1. Computer Networking by J. Kurose and k. Ross, Pearson Education
2. P2P Networking and Applications by John Buford, Heather Yu, Eng Keong Lua, Morgan Kaufmann
3. IPFS, https://docs.ipfs.tech/
4. Bitcoin: A peer-peer Electronic cash system by Satoshi Nakamoto.

CO/PO mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	2	3				2	2
CO2	2	3	3	2	3				2	2
CO3	2	3	3	2	3				2	2
CO4	2	3	3	2	3				2	2

CSEXXX- Cyber Security: Attacks and Defences		
Teaching Scheme	**Examination Scheme**	**Credits**
Theory 3 hrs/week **Practical 2 hrs/week**	**End of semester** **Examination: 60 marks**	4 (Theory-3 and Lab-1)
Internal assessment: 40 marks		
Total-3		
Course Prerequisite: course on programming and information security.		
Course Objective: This course has a focus on enabling the students to understand various attacks, attack models, launching methods, defence mechanisms, evaluation metrics and attack case studies.		
Course Outcomes: On completion this course, students will be able to		
CO1:	Understand cyber security principles and understand the cyber-attack space.	
CO2:	Students should be able to understand the attack terminology, attack taxonomies, attack models and related risks.	
CO3:	Students should be able to understand various defense mechanisms of different attacks, their implementations, overheads and related circumvention issues.	
CO4:	Student should also be able to learn methods to evaluate different defence mechanisms.	

Course Content:		Total Hrs
Unit -I	Introduction to security principles, Digital threat landscape, incident statistics, economics of security threats, threat actors, target areas.	10 hrs
Unit-II	Attack taxonomies, attack scale, attack methods, attack and threat models, Discussion of attacks such as MITM, Side-Channel, DDoS, injection, software-vulnerability-driven, phishing, malware-driven, and password attacks etc.	10hrs
Unit-III	Defense mechanisms of various attacks, evaluation methods, sophistication attacks, Evaluation of defense methods.	10hrs
Unit-IV	Case studies of well-known attack and defense mechanisms.	10hrs

Internal assessment		
Part A	CIA-I: Unit I, and II	20 Marks
	CIA-II: Unit III, and IV	20 Marks
Part B	ESE: Term Exam	60 Marks

Text Books:

1. Versatile cybersecurity , Conti, Mauro, Gaurav Somani, and RadhaPoovendran, eds.. Vol. 72. Springer, 2018.
2. Pfleeger, C.P., 2009. Security in computing. Pearson Education India.

Reference Books:

1. Various Research Papers and White papers including standards and web resources

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	2	3		2		2	2
CO2	2	3	3	2	3		2		2	2
CO3	2	3	3	2	3		2		2	2
CO4	2	3	3	2	3		2		2	2