TULSIRAMJI GAIKWAD-PATIL
College of Engineering & Technology

Mohgaon, Wardha Road, Nagpur - 441 108

(An Autonomous Institute Affiliated to RTM Nagpur University)

DEPARTMENT OF INFORMATION TECHNOLOGY

M.Tech Artificial Intelligence & Machine Learning

Structure & Curriculum

From

Academic Year 2021-22

Vision of Institute

To emerge as a learning Center of Excellence in the National Ethos in domains of Science, Technology and Management

Mission of Institute

[M1] To strive for rearing standard and stature of the students by practicing high standards of Professional ethics, transparency and accountability

[M2] To provide facilities and services to meet the challenges of Industry and Society

[M3] To facilitate socially responsive research, innovation and entrepreneurship

[M4] To ascertain holistic development of student and staff members by inculcating knowledge and profession as work practices

Vision of the Department

To contribute in the enhancement of capabilities of youth to face Information Technology challenges, by empowering them with innovative ideas.

Mission of the Department

- To stimulate students to learn effectively and apply the knowledge in the field of Engineering and Technology.
- To undertake industry academic collaboration to enhance competency in graduates.
- To foster innovative ideas amongst students for becoming leaders.
- To create an environment of research culture.
- To impart social and ethical values for inculcating the culture of lifelong learning.

Program Education Objectives (PEO)

- Acquire fundamental knowledge of mathematics, science and engineering to analyze, design and implement solutions to the Information Technology problems
- Understand emerging concepts and trends in Information Technology.
- Apply IT tools to develop innovative computational systems.
- The students are encouraged to develop the habit of lifelong learning to face the challenges.
- The students will be embedded as a responsible individual having ethical and social values to lead the society and to nurture team spirit.

Program Outcomes (PO)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

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Scheme of Instructions

Scheme of Instructions for First Year M. Tech. Program in Artificial Intelligence & Machine Learning

Semester – I (w.e.f.: AY 2021-22)

Sr.	Course Category	CourseCode	Course Title	L	T	P	Contact Hrs / week	Credits	Exam Scheme				
									CT – 1	CT – 2	TA / CA	ESE	TOTAL
1.	PCC	MAI1101	Artificial Intelligence	3	-.	-	3	3	15	15	10	60	100
2.	PCC	MAI1102	Natural Language Processing	3	-	-	3	3	15	15	10	60	100
3.	PCC	MAI1103	Probability & Statistics	3	-	-	3	3	15	15	10	60	100
4.	PCC	MAI1104	Laboratory –I (AI)	-	-	2	2	1	-	-	25	25	50
5.	PCC	MAI1105	Laboratory –II (NLP)	-	-	2	2	1	-	-	25	25	50
6.	PEC	MAI1106-09*	Professional Elective – I	3	-	-	3	3	15	15	10	60	100
7.	PEC	MAI1110-13*	Professional Elective - II	3	-	-	3	3	15	15	10	60	100
8.	MCC	MAU1101	Pedagogy Studies	2	-	-	2	Audit	-	-	-	-	-
			Total	**17**	-	**4**	**21**	**17**	**75**	**75**	**100**	**350**	**600**

L- Lecture T-Tutorial P-Practical CT1- Class Test 1 CT2- Class Test 2 TA/CA- Teacher Assessment / Continuous AssessmentESE- End Semester Examination (For Laboratory: End Semester Performance)

*** Indicates out of the four course codes each student has to select any one PEC from the list provided at the end of structure.**

PROGRESSIVE TOTAL CREDITS= 17

BoS Chairman
Head of Dept. (Information Technology)
Tulsiramji Gaikwad-Patil College of
Engineering & Technology, Nagpur.

Dean Academics
Dean Academics
Tulsiramji Gaikwad-Patil
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Principal
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Engineering & Technology
Nagpur

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Scheme of Instructions

Scheme of Instructions for First Year M. Tech. Program in Artificial Intelligence & Machine Learning

Semester – II (w.e.f.: AY 2021-22)

Sr.	Course Category	CourseCode	Course Title	L	T	P	Contact Hrs / week	Credits	Exam Scheme				
									CT – 1	CT- 2	TA / CA	ESE	TOTAL
1.	PCC	MAI1201	Machine Learning for Data Analysis	3	-	-	3	3	15	15	10	60	100
2.	PCC	MAI1202	Big Data Mining And Analytics	3	-	-	3	3	15	15	10	60	100
3.	PCC	MAI1203	Information & Cyber Security	3	-	-	3	3	15	15	10	60	100
4.	PCC	MAI1204	Laboratory –III (ML using Python)	-	-	2	2	1	-	-	25	25	50
5.	PCC	MAI1205	Laboratory –IV (BDMA)	-	-	2	2	1	-	-	25	25	50
6.	FC	MAI1206	Research Methodology#	2	-		2	2	-	-	25	25	50
7.	PEC	MAI1207-10*	Professional Elective – III	3	-	-	3	3	15	15	10	60	100
8.	PEC	MAI1211-14*	Professional Elective – IV	3	-	-	3	3	15	15	10	60	100
9.	MCC	MAU1202	Research Paper Writing	2	-	-	2	Audit	-	-	-	-	-
			Total	**19**	**-**	**4**	**23**	**19**	**75**	**75**	**125**	**375**	**650**

L- Lecture T-Tutorial P-Practical CT1- Class Test 1 CT2- Class Test 2 TA/CA- Teacher Assessment / Continuous AssessmentESE- End Semester Examination (For Laboratory: End Semester Performance)

Students is expected to complete it online by appearing NPTEL/Swayam Certification for 03 credits. Weekly 02 Hrs practical in which students are expected to work on mathematical modeling, Seminar on IPR, Patent filing, Removing Plagiarisms, etc. will be done.

* Indicates out of the four course codes each student has to select any one PEC from the list provided at the end of structure.

PROGRESSIVE TOTAL CREDITS= 17+19 = 36

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Scheme of Instructions

Scheme of Instructions for Second Year M. Tech. Program in Artificial Intelligence & Machine Learning

Semester – III (w.e.f.: AY 2021-22)

Sr.	Course Category	CourseCode	Course Title	L	T	P	Contact Hrs / week	Credits	Exam Scheme				
									CT - 1	CT - 2	TA / CA	ESE	TOTAL
1	PROJ	MAI2301	Dissertation Phase-I	-	-	20	20	10	-	-	100	100	200
2	PEC	MAI2302	MOOC course (8-12)$	-	-	-	-	3	-	-	-	-	-
3	OEC	M$$XX01-06#	Open Elective –I	3	-	-	3	3	15	15	10	60	100
			Total	**3**	-	**20**	**23**	**16**	-	-	**110**	**160**	**300**

ote:

1. MAI2301 will be decided by respective Guide in Consultation with Program Coordinator. Course is mandatory is for student and hisdissertation phase I will be considered incomplete without this Mandatory MOOC Course.

2. In Case, the course offered online are not completely relevant with the topic of dissertation then any course suggested by NASSCOM on recent technologies can be opted by candidate.

3. $ Programme coordinator will provide list of 03 MOOC courses of minimum 08 weeks duration (as per availability). Students are expected to complete any one out of three courses in order to get the required credits.

 # Indicates out of the 06 course codes each student has to select any one OEC except MCSXX01

L- Lecture T-Tutorial P-Practical
CT1- Class Test 1 TA/CA- Teacher Assessment/Continuous Assessment
CT2- Class Test 2 ESE- End Semester Examination (For Laboratory End Semester performance)**PROGRESSIVE**

TOTAL CREDITS= 36+16 = 52

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Scheme of Instructions

Scheme of Instructions for Second Year M. Tech. Program in Artificial Intelligence & Machine Learning

Semester – IV (w.e.f.: AY 2021-22)

Sr.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs / week	Credits	Exam Scheme				
									CT - 1	CT - 2	TA / CA	ESE	TOTAL
1.	PROJ	MAI2401	Dissertation Phase- II	-	-	32	32	16	-	-	100	200	300
			Total	-	-	**32**	**32**	**16**	-	-	**100**	**200**	**300**

TA/CA- Teacher Assessment / Continuous Assessment

ESE- End Semester Examination (For Laboratory: End Semester Performance)

PROGRESSIVE TOTAL CREDITS= 52+16 = 68

BoS Chairman
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NAAC A+

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Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II | **MAI1201**: Machine Learning for Data Analysis

Teaching Scheme			Examination Scheme	
Theory	**3 Hrs/week**		CT-I	15 Marks
Tutorial	**-**		CT-II	15 Marks
Total Credits	**3**		CA	10 Marks
Duration of ESE: 3Hrs			ESE	60 Marks
			Total Marks	100 Marks

Pre-Requisites: Statistics, Linear Algebra, Calculus, Probability, Programming Languages, Artificial Intelligence

Course Objectives:

1.	Student shall be able to understand the importance of Machine Learning.
2.	Student shall be able to understand Supervised Learning-1 and Supervised Learning-2.
3.	Student shall be able to understand about the Unsupervised Learning
4.	Student shall be able to understand the Design and Analysis of Machine Learning Experiments
5.	Student shall be able to understand about the Advances in Machine Learning .

Course Contents

Unit I	**Introduction to machine learning.** What Is Machine Learning, Examples of Machine Learning Applications, Learning Associations, Classification, Regression, Supervised and Unsupervised Learning, Reinforcement Learning, Generalization, Over-fitting, and Under-fitting
Unit II	**Supervised Learning-1:** k-Nearest Neighbors, linear Models, Naive Bayes Classifiers, Decision Trees, And Supervised Learning-2: Kernelized Support Vector Machines, Uncertainty Estimates from Classifiers, The Decision Function, predicting Probabilities, Uncertainty in Multiclass Classification, multivariate classification and regression.
Unit III	**Unsupervised Learning:** k-Means Clustering , Expectation-Maximization Algorithm, Supervised Learning after Clustering , Hierarchical Clustering, Choosing the Number of Clusters
Unit IV	**Design and Analysis of Machine Learning Experiments:** Factors, Response, and Strategy of Experimentation, Randomization, Replication, and Blocking, Guidelines for Machine Learning Experiments , Cross-Validation and Resampling Methods, K-Fold Cross-Validation, Bootstrapping, Measuring Classifier Performance, Hypothesis Testing, Assessing a Classification Algorithm’s Performance, Comparing Two Classification Algorithms.
Unit V	**Advances in Machine Learning:** Combining multiple learners, bagging and boosting, introduction to learning using Neural networks, shallow and deep networks.

Text Books

T.1	Introduction to Machine Learning, Second Edition by Ethem Alpaydın, The MIT Press
T.2	Introduction to Machine Learning with Python, A Guide for Data Scientists by Andreas C. Müller and Sarah Guido, ORIELLY

Reference Books

R.1	Machine Learning, Tom M. Mitchel by McGraw Hill
Useful Links	
1	https://nptel.ac.in/courses/106/106/106106139/
2	https://onlinecourses.nptel.ac.in/noc21_cs24/preview
3	https://nptel.ac.in/courses/106/105/106105152/

	Course Outcomes	**PO/PSO**	**CL**	**Class Sessions**
MAI1201.1	**Reviewing** the various models of supervised and unsupervised learning.	PO1,PO2,PO3	5	9
MAI1201.2	**Identify** appropriate learning paradigm to solve it.	PO1,PO2,PO3	4	9
MAI 1201.3	**Criticizing** the supervised learning for the given set of labeled samples and design the model to meet the desired output.	PO1,PO2,PO3	5	9
MAI 1201.4	**Validating** the unsupervised learning for the given set of samples, and design the model to meet the desired Output.	PO1,PO2,PO3	5	9
MAI 1201.5	**Analyzing** the advances in Machine Learning.	PO1,PO2,PO3	4	9

Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II | **MAI1202**: Big Data Mining & Analytics

Teaching Scheme		Examination Scheme	
Theory	**3 Hrs/week**	CT-I	15 Marks
Tutorial	**-**	CT-II	15 Marks
Total Credits	**3**	CA	10 Marks
Duration of ESE: 3Hrs		ESE	60 Marks
		Total Marks	100 Marks

Pre-Requisites: Data Visualizations, Big data, SQL, Data Mining, Public Clouds & hybrid Clouds, Hadoop , Database Management Systems

Course Objectives:

1.	Student shall be able to understand the Analytics Methods.
2.	Student shall be able to understand Relational Database.
3.	Student shall be able to understand about the Clustering
4.	Student shall be able to understand the ARIMA Model
5.	Student shall be able to understand about the Analytics for Unstructured data.

Course Contents

Unit I	**Big data overview:** State of the practice in Analytics-Key roles for new big data ecosystem Data Analytics Lifecycle-Data analytics lifecycle overview- Discovery- Data Preparation-Model Planning-Model Building-Communicate Results-operationalize
Unit II	**Introduction to R: Exploratory Data Analytics-**Statistical methods for evaluation Hadoop & Map Reduce framework for R, R with Relational Database Management Systems, R with Non-Relational (NoSQL) DBs
Unit III	**Clustering:** Overview of Clustering-K-means, Association Rules-Overview-Apriori Algorithm-Evaluation of candidate rules-An Example: Transactions in grocery Store-Validation and Testing-Diagnostics, Regression-Linear Regression-Logistic Regression-Reason to choose and Cautions-Additional Regression Models
Unit IV	**Classification:** Decision Trees-Naïve Bayes-Diagnostics of Classifiers-Additional classification methods, Time series Analysis Overview of Time series analysis-ARIMA Model-Additional methods, Text Analysis-Text analysis steps-A text analysis Example-Collecting raw Text-Representing Text-Term Frequency—Inverse document frequency(TFIDF)-Categorizing documents by Topics-Determining Sentiments-Gaining insights
Unit V	**Analytics for Unstructured data:** The Hadoop Ecosystem-NoSQL, In-Database Analytics-SQL Essentials-In-Database Text Analysis-Advanced SQL

Text Books

T.1	EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015
T.2	Simon Walkowiak, "Big Data Analytics with R" PackT Publishers, 2016

Reference Books

R.1	Kim H. Pries and Robert Dunnigan, “Big Data Analytics: A Practical Guide for Managers” CRC Press, 2015.
R2	Bart Baesens, “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications”, Wiley Publishers, 2015.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc20_cs92/preview
2	https://nptel.ac.in/courses/106/104/106104189/
3	https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-cs33/

Bart
Appl

	Course Outcomes	PO/PSO	CL	Class Sessions
MAI1202.1	**Validating** big data and data analytics lifecycle	PO1,PO2,PO3	5	9
MAI1202.2	**Measuring** Basic Data analytic methods using R	PO2,PO3	5	9
MAI1202.3	**Reviewing** a knowledge on advanced analytical methods, technology and tools	PO1,PO2,PO3	5	9
MAI1202.4	**Apply** the Analytical methods, Technology and tools in the industry.	PO2,PO3	3	9
MAI1202.5	**Simulating** hadoop ecosystem and apply to solve real-life problems	PO2,PO3	6	9

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Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II	**MAI1203**: Information and Cyber Security

Teaching Scheme			**Examination Scheme**	
Theory	**3 Hrs/week**		CT-I	15 Marks
Tutorial	**-**		CT-II	15 Marks
Total Credits	**3**		CA	10 Marks
Duration of ESE: 3Hrs			ESE	60 Marks
Pre-Requisites:			Total Marks	100 Marks

Course Objectives:

1.	To understand the basics of computer, network and information security.
2.	To study operating system security and malwares
3.	To acquaint with security issues in internet protocols
4.	To analyze the system for vulnerabilities.
5.	To apply the scientific method for security assessment

Course Contents

Unit I	**Security Fundamentals:** An Overview of Information Security: The Basic Components, Threats, Policy and Mechanism, Assumptions and Trust, Assurance, Operational Issues, Human Issues, Security nomenclature. Access Control Matrix, Security Policies: Confidentiality, Integrity, Availability Policies and Hybrid Policies, OS Security
Unit II	**Modular Arithmetic and Cryptography Basics:** Modular Arithmetic Notations, Modular Arithmetic Operations, Euclid's method of finding GCD, The extended Euclid's algorithm. Cryptography : Classical encryption techniques, Block and Chain ciphers, Data Encryption Standard, Advanced Encryption Standard, RC5
Unit III	**Advanced Cryptography:** Chinese Remainder Theorem and its implication in Cryptography, Diffie-Hellman key exchange algorithm, RSA algorithm, Elgamal Arithmetic, Elliptic Curve Cryptography, Message Digest and Cryptographic Hash Functions, MD5 and SHA-1, Digital Signatures and Authentication.
Unit IV	**Issues in Security Management and Key Management:** Overview, Risk identification, Risk Assessment, Risk Control Strategies, Quantitative vs. Qualitative Risk Control Practices. Risk Management. Public Key Infrastructure(PKI), X.509 Certificate, Needham Schroeder algorithm and Kerberos. IP Security: IPv6 and IPSec, Web Security: SSL, HTTPS, Mail Security: PGP, S/MIME
Unit V	**Attacks, Malicious Logic and Countermeasures:** Phishing, Password Cracking, Key-loggers and Spywares, Types of Virus, Worms, DoS and DDoS, SQL injection, Buffer Overflow, Spyware, Adware and Ransomware. Antivirus and other security measures Intrusion Detection System : IDS fundamentals, Different types of IDS. Intrusion Prevention

Text Books

T.1	Ms. Monali R. Borade , Sachin P. Godse, "Information & Cyber Security "

T.2	Identity management for Internet of things by ParikshitMahalle, River Publishers
Reference Books	
R.1	Cyber Criminology: Exploring Internet Crimes and Criminal Behavior, Edited by K. Jaishankar, CRC Press, ISBN 978-1-4398-2949-3 2. Mark Merkow, “Information Security-Principles and Practices”, Pearson Ed., ISBN- 978-81-317-1288-7
R 2	Mark Merkow, “Information Security-Principles and Practices”, Pearson Ed., ISBN- 978-81-317-1288-7
Useful Links	
1	https://nptel.ac.in/courses/106/105/106105173/
2	https://onlinecourses.nptel.ac.in/noc20_cs17/preview
3	https://nptel.ac.in/content/syllabus_pdf/106105173.pdf

	Course Outcomes	**PO/PSO**	**CL**	**Class Sessions**
MAI1203.1	Use cryptographic techniques in secure application development.	PO1,PO2,PO3	4	9
MAI1203.2	Apply methods for authentication, access control, intrusion detection and prevention.	PO1,PO2,PO3	4	9
MAI1203..3	To apply the scientific method for security assessment	PO1,PO2,PO3	4	9
MAI1203.4	Use and apply advance cryptography technique	PO1,PO2,PO3	5	9
MAI1203.5	To develop computer forensics awareness	PO1,PO2,PO3	6	9

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Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II | **MAI1207**: Elective-III(Pattern Recognition)

Teaching Scheme		Examination Scheme	
Theory	**3 Hrs/week**	CT-I	15 Marks
Tutorial	**-**	CT-II	15 Marks
Total Credits	**3**	CA	10 Marks
Duration of ESE: 3Hrs		ESE	60 Marks
		Total Marks	100 Marks

Pre-Requisites: Machine learning ,Artificial Intelligence , Class-invariance ,Discrete Mathematics

Course Objectives:

1.	Student shall be able to understand the Probability & Estimation minimum risk estimators.
2.	Student shall be able to understand the Statistical Pattern Recognition.
3.	Student shall be able to understand the Parameter Estimation Methods.
4.	Student shall be able to understand the Non-Parameter methods.
5.	Student shall be able to understand the Unsupervised learning and clustering.

Course Contents

Unit I	**Introduction:** Definition, Applications, Datasets , Different paradigms , Data structures for Pattern Recognition, Introduction to probability, events ,random variables, Joint distributions and densities, moments. Estimation minimum risk estimators, problems, Representation of clusters, proximity measures, size of patterns, Abstraction of Data set, Feature extraction, Features election, Evaluation
Unit II	**Statistical Pattern Recognition:** Review of probability theory, Gaussian distribution, Bayes decision theory and Classifiers, Optimal solutions for minimum error and minimum risk criteria, Normal density and discriminate functions, Decision surfaces.
Unit III	**Parameter Estimation Methods:** Maximum-Likelihood Estimation: Gaussian case. Maximum Posteriori estimation, Bayesian estimation, Gaussian case. Unsupervised learning and clustering – Criterion functions for clustering, Algorithms for clustering, K-Means, Hierarchical and other methods. Cluster validation. Gaussian mixture models, Expectation-Maximization method for parameter estimation. Maximum entropy estimation, Sequential Pattern Recognition. Hidden Markov Models, Non parametric techniques for density estimation.
Unit IV	**Non-Parameter methods:** Non-parametric techniques for density estimation, Parzen-window method, K-NearestNeighbourmethod,Non-metricmethodsforpatternclassification,Non-numeric data or nominal data Decision trees, Concept of construction, splitting of nodes, choosing of attributes, over fitting, pruning.
Unit V	**Unsupervised learning and clustering:** Unsupervised maximum-likelihood estimates, Unsupervised Bayesian learning, Criterion functions for clustering, Algorithms for clustering: Kmeans, Hierarchical and other methods, Cluster validation, Low-dimensional representation and multidimensional scaling (MDS).

Text Books

T.1	R.O.Duda,P.E.Hart andD.G.Stork,PatternClassification,JohnWiley,2001

T.2	S.TheodoridisandK.Koutroumbas,PatternRecognition,4thEd., AcademicPress,2009
T3	C.M.Bishop,PatternRecognitionandMachineLearning,Springer,2006
Reference Books	
R.1	DudaRO, HartPE ,and StorkDG,Patternclassification,JohnWileyandSons,2001.
R 2	Robert J. Schalkoff, Pattern Recognition : Statistical, Structural and Neural Approaches, John Wiley &Sons Inc.,NewYork, 2007.
R 3	Ethem Alpaydin, "MachineLearning: The New AI", MIT Press,2016.
Useful Links	
1	https://nptel.ac.in/courses/106/106/106106046/
2	https://www.geeksforgeeks.org/pattern-recognition-introduction/
3	https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-ee56/

	Course Outcomes	PO/PSO	CL	Class Sessions
MAI1207(1).1	**Differentiate** a variety of pattern classification, structural pattern recognition and pattern classifier combination techniques.	PO1,PO2,PO3	5	9
MAI1207 (1).2	**Summarize** the pattern recognition area verbally and in writing.	PO1,PO2,PO3	5	9
MAI1207(1).3	**Apply** performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.	PO1,PO2,PO3	4	9
MAI1207(1).4	**Identify** pattern recognition techniques to real-world problems such as document analysis and recognition.	PO1,PO2,PO3	5	9
MAI1207(1).5	**Implement** simple pattern classifiers, classifier combinations, and structural pattern recognizers.	PO1,PO2,PO3	3	9

Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II | **MAI1208**: Elective-III(Reinforcement Learning)

Teaching Scheme		Examination Scheme	
Theory	**3 Hrs/week**	CT-I	15 Marks
Tutorial	**-**	CT-II	15 Marks
Total Credits	**3**	CA	10 Marks
Duration of ESE: 3Hrs		ESE	60 Marks
		Total Marks	100 Marks

Pre-Requisites: Supervised Learning , Search Methods in AI, Linear Algebra, calculus, Probability Theory

Course Objectives:

1.	Student shall be able to understand the reinforcement learning problem
2.	Student shall be able to understand the dynamic programming
3.	Student shall be able to understand the temporal difference learning
4.	Student shall be able to understand the function approximation
5.	Student shall be able to understand the hierarchical RL.

Course Contents

Unit I	Evaluative feedback, non associative learning, Rewards and returns, Markov Decision Processes, Value functions, optimality and approximation **Bandit Problems**: Explore-exploit dilemma, Binary Bandits, Learning automata, exploration schemes
Unit II	Value iteration, policy iteration, asynchronous DP, generalized policy iteration **Monte-Carlo methods**: Policy evaluation, roll outs, on policy and off policy learning, importance sampling
Unit III	TD prediction, Optimality of TD(0), SARSA, Q-learning, R-learning, Games and after states **ELIGIBILITY TRACES** n-step TD prediction, TD(lambda), forward and backward views, Q(lambda), SARSA(lambda), replacing traces and accumulating traces.
Unit IV	Value prediction, gradient descent methods, linear function approximation, Control algorithms, Fitted Iterative Methods **POLICY GRADIENT METHODS** non-associative learning - REINFORCE algorithm, exact gradient methods, estimating gradients, approximate policy gradient algorithms, actor-critic methods
Unit V	MAXQ framework, Options framework, HAM framework, Option discovery algorithms **Case studies:** Elevator dispatching, Samuel's checker player, TD gammon, Acrobot, Helicopter piloting, Computational Neuroscience

Text Books

T.1	R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. Second edition 2017.
T.2	K. S. Narendra and M. A. L. Thathachar. Learning Automata - An Introduction. Prentice-Hall, USA. 1989

T 3	D. P. Bertsikas and J. N. Tsitsiklis. Neuro-dynamic programming. Athena Scientific. 1996.
Reference Books	
R.1	A. G. Barto and S. Mahadevan, Recent Advances in Hierarchical Reinforcement Learning, Discrete Event Systems Journal, Volume 13, Special Issue on Reinforcement Learning, pp. 41-77. 2003.
R 2	R. J. Williams, Simple Statistical Gradient-following algorithms for Connectionist Reinforcement Learning, Machine Learning, 8:229-256. 1992
R 3	J. Baxter, P. L. Bartlett, Infinite-Horizon Gradient-Based Policy Search, Journal of Artificial Intelligence Research, 15: 319-350. 2001.
Useful Links	
1	https://www.guru99.com/reinforcement-learning-tutorial.html
2	https://neptune.ai/blog/best-reinforcement-learning-tutorials-examples-projects-and-courses
3	https://nptel.ac.in/content/syllabus_pdf/106106143.pdf

	Course Outcomes	PO/PSO	CL	Class Sessions
MAI1208(2).1	**Analyze** the reward function and Markov Decision Process	PO1,PO2,PO3	4	9
MAI1208(2).2	**Solve** problems using Dynamic Programming.	PO1,PO2,PO3	5	9
MAI1208(2).3	**Evaluate** temporal difference (TD) learning method for reinforcement learning problem	PO1,PO2,PO3	5	9
MAI1208(2).4	**Criticize** Gradient methods for Reinforcement Learning	PO1,PO2,PO3	5	9
MAI1208(2).5	**Implement** Hierarchical Reinforcement Learning Algorithms	PO1,PO2,PO3	3	9

Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II	**MAI1209**: Elective-III (Optimization Techniques)

Teaching Scheme			**Examination Scheme**	
Theory	**3 Hrs/week**		CT-I	15 Marks
Tutorial	**-**		CT-II	15 Marks
Total Credits	**3**		CA	10 Marks
Duration of ESE: 3Hrs			ESE	60 Marks
			Total Marks	100 Marks

Pre-Requisites: Compile Time Evaluation, Requirements Selection , Basics of Linear Programming & Non Linear Programming

Course Objectives:

1.	Student shall be able to understand the Linear Programming
2.	Student shall be able to understand the Simplex Method
3.	Student shall be able to understand the Duality and Sensitivity Analysis
4.	Student shall be able to understand the Non-linear Programming
5.	Student shall be able to understand the Dynamic programming

Course Contents

Unit I	**Linear Programming**: Introduction and need for optimization in engineering design, formulating linear programs, graphical solution of linear programs, special cases of linear programming.
Unit II	**The Simplex Method:** Converting a problem to standard form, the theory of the simplex method, the simplex algorithm, special situations in the simplex algorithm, obtaining initial feasible solution.
Unit III	**Duality and Sensitivity Analysis:** Sensitivity analysis, shadow prices, dual of a normal linear program, duality theorems, dual simplex method. Integer Programming: Formulating integer programming problems, the branch-and-bound algorithm for pure integer programs, the branch and bound algorithm for mixed integer programs.
Unit IV	**Non-linearProgramming:**Introductiontonon-linearprogramming(NLP),Convexandconcave functions, NLP with one variable, Line search algorithms, Multivariable unconstrained problems, constrained problems, Lagrange Multiplier, The Karush-Kuhn-Tucker (KKT) conditions, the method of steepest ascent, convex combination method, penalty function, Quadratic programming.
Unit V	**Dynamic programming:** Evolutionary algorithms: Genetic Algorithm, concepts of multi objective optimization, Markov Process, Queuing Models.

Text Books

T.1	S.S. Rao, Engineering Optimization: Theory and Practice, Wiley &Sons, New Jersey, 2009.
T.2	F.H. Hillerand G.J. Liberman, Introductionto Operations Research,Tata-McGraw-Hill,2010.
T 3	K.Deb,Multi-Objective Optimization using evolutionary algorithms, John Wileyand Sons,2009

Reference Books

R.1	W.L.Winston,Operations Research: ApplicationsandAlgorithm,4thEdition,CengageLearning,1994.
R 2	K.Deb,OptimizationforEngineeringDesign,PrenticeHall,2013.
R 3	M.C.JoshiandK.M.Moudgalay,Optimization:TheoryandPractice,Narosa,2004.
Useful Links	
1	https://nptel.ac.in/courses/105/108/105108127/
2	https://nptel.ac.in/courses/111/105/111105039/
3	https://nptel.ac.in/courses/108/103/108103108/

	Course Outcomes	PO/PSO	CL	Class Sessions
MAI1203(3).1	Illustrate the importance of optimization of industrial process management	PO1,PO2,PO3	5	9
MAI1203(3).2	Implement the basic concept of mathematics to formulate an optimization problem	PO1,PO2,PO3	5	9
MAI1203(3).3	Analyze and Appreciate variety of performance measures for various optimization problems	PO1,PO2,PO3	4	9
MAI1203(3).4	Design the model engineering minima/maxima problems as optimization problems	PO1,PO2,PO3	5	9
MAI1203(3).5	Apply Dynamic programming techniques	PO1,PO2,PO3	3	9

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Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II	**MAI1210**: Elective-III Artificial Neural Network(Deep Learning)

Teaching Scheme			Examination Scheme	
Theory	**3 Hrs/week**		CT-I	15 Marks
Tutorial	**-**		CT-II	15 Marks
Total Credits	**3**		CA	10 Marks
Duration of ESE: 3Hrs			ESE	60 Marks
Pre-Requisites: Machine Learning, Mathematics, Statistics, Probability, Linear Algebra, Calculus , Programming Languages .			Total Marks	100 Marks

Course Objectives:

1.	Student shall be able to understand the Reinforcement learning problem.
2.	Student shall be able to understand the Dynamic programming.
3.	Student shall be able to understand the Temporal difference learning.
4.	Student shall be able to understand the Function approximation.
5.	Student shall be able to understand the Hierarchical RL.

Course Contents

Unit I	**Introduction:** Introduction to machine learning- Linear models (SVMs and Perceptrons, logistic regression), Introduction to Neural Nets: What a shallow network computes- Training a network: loss functions, back propagation and stochastic gradient descent- Neural networks as universal function approximates.
Unit II	**Convolutional Neural Networks** CNN Architectures, Convolution Pooling Layers, Transfer Learning, Image Classification using Transfer Learning, Recurrent and Recursive Nets, Recurrent Neural Networks, Deep Recurrent Networks, Recursive Neural Networks, Applications.
Unit III	**Dimensionality Reduction:** Linear (PCA, LDA) and manifolds, metric learning, Auto encoders and dimensionality reduction in networks, Introduction to Convent, Architectures, Alex Net, VGG, Inception, Res Net- Training a Convent: weights initialization, batch normalization, hyper parameter optimization.
Unit IV	**Optimization and Generalization:** Optimization in deep learning– Non -convex optimization for deep networks- Stochastic Optimization Generalization in neural networks- Spatial Transformer Networks-Case Study of Image net, Detection-Audio Wave Net.
Unit V	**Recurrent Neural Network:** Recurrent networks, LSTM - Recurrent Neural Network Language Models- Word-Level RNNs & Deep Reinforcement Learning, Computational & Artificial Neuro science Case study on Natural Language ProcessingWord2Vec, Joint Detection Bio informatics, Face Recognition.

Text Books

T.1	R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. Second edition 2017.
T.2	K. S. Narendra and M. A. L. Thathachar. Learning Automata - An Introduction. Prentice-Hall, USA. 1989
T 3	D. P. Bertsikas and J. N. Tsitsiklis. Neuro-dynamic programming. Athena Scientific. 1996.

Reference Books	
R.1	A. G. Barto and S. Mahadevan, Recent Advances in Hierarchical Reinforcement Learning, Discrete Event Systems Journal, Volume 13, Special Issue on Reinforcement Learning, pp. 41-77. 2003.
R 2	R. J. Williams, Simple Statistical Gradient-following algorithms for Connectionist Reinforcement Learning, Machine Learning, 8:229-256. 1992
R 3	J. Baxter, P. L. Bartlett, Infinite-Horizon Gradient-Based Policy Search, Journal of Artificial Intelligence Research, 15: 319-350. 2001.
Useful Links	
1	https://www.guru99.com/reinforcement-learning-tutorial.html
2	https://neptune.ai/blog/best-reinforcement-learning-tutorials-examples-projects-and-courses
3	https://nptel.ac.in/courses/108/105/108105103/

	Course Outcomes	**PO/PSO**	**CL**	**Class Sessions**
MAI1210(4).1	**Analyze** the reward function and Markov Decision Process	PO1,PO2,PO3	4	9
MAI1210(4).2	**Solve** problems using Dynamic Programming.	PO1,PO2,PO3	5	9
MAI1210(4).3	**Evaluate** temporal difference (TD) learning method for reinforcement learning problem	PO1,PO2,PO3	5	9
MAI1210(4).4	**Criticize** Gradient methods for Reinforcement Learning	PO1,PO2,PO3	5	9
MAI1210(4).5	**Implement** Hierarchical Reinforcement Learning Algorithms	PO1,PO2,PO3	3	9

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Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II	**MAI1211**: Elective – IV (Computer Vision)

Teaching Scheme			**Examination Scheme**	
Theory	**3 Hrs/week**		CT-I	15 Marks
Tutorial	**-**		CT-II	15 Marks
Total Credits	**3**		CA	10 Marks
Duration of ESE: 3Hrs			ESE	60 Marks
Pre-Requisites: Deep Learning, Fundamental Convolution Networks, 3D Geometry, Convolution Neural Networks			Total Marks	100 Marks

Course Objectives:

1.	Student shall be able to understand the Computer Vision & Image analysis.
2.	Student shall be able to understand the Image Formation Models.
3.	Student shall be able to understand the Object Recognisition and Tracking.
4.	Student shall be able to understand the Visual surveillance.
5.	Student shall be able to understand the 3D Vision.

Course Contents

Unit I	**Introduction:** Purpose of computer vision, State-of-the-art, history of computer vision, some typical applications of computer vision in surveillance, computer imaging systems, lenses, Image formation and sensing, Image analysis, pre-processing and Binary image analysis.
Unit II	**Image Formation Models:** Monocular imaging system, orthographic & perspective projection, camera model and camera calibration, binocular imaging systems, Image Processing and Feature Extraction, Image representations color representations, edge detection, some important texture representation, Motion Estimation, Regularization theory, optical flow computation, stereo vision, motion estimation, structure from motion.
Unit III	**Object Recognition and Tracking:** Shape representation, shape descriptors, object localization, object representation using low level and high level features; Object Tracking: Basics of object tracking, single object tracking, multiple object tracking, slow moving and fast moving objects and related algorithms, object trajectory analysis
Unit IV	**Visual Surveillance:** Basics of surveillance, single camera based surveillance, multiple camera guided surveillance, surveillance using moving camera ,public place surveillance, health care surveillance.
Unit V	**3D Vision:** Projective geometry, single perspective camera, stereopsis, the fundamental matrix –its estimation from image point correspondences, applications of epipolargeometry in vision, correlation based and feature based stereo correspondence, shape from motion, optical flow.

Text Books

T.1	Computer Vision -A Modern Approach by D. A. Forsyth and J. Ponce, Pearson, 2nd edition, 2012
T.2	Schalkoff, John Wiley and Sons, “Digital Image Processing &Computer Vision”, 1989, John

	Wiley and Sons.
Reference Books	
R.1	Sonka, Hlavac and Boyle Brooks/Cole, “Image Processing, Analysis, and Machine Vision”, 1999, Thomson Asia Pte Ltd Singapore.
R 2	Jain and Rangachar, “Machine Vision”, 1999, McGraw Hill International Edition.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc21_ee23/preview
2	https://nptel.ac.in/courses/106/105/106105216/
3	https://nptel.ac.in/content/syllabus_pdf/106105216.pdf

	Course Outcomes	PO/PSO	CL	Class Sessions
MAI1211(1).1	**Identify** basic concepts, terminology, theories, models and methods in the field of computer vision.	PO1,PO2,PO3	5	9
MAI1211(1).2	**Discriminate** the basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.	PO1,PO2,PO3	5	9
MAI1211(1).3	**Analyze** and demonstrate various image segmentation techniques.	PO1,PO2,PO3	4	9
MAI1211(1).4	**Distinguish** the methods to use for solving a given problem, and analyze the accuracy	PO1,PO2,PO3	4	9
MAI1211(1).5	**Utilize** the techniques, skills and modern computer Engineering tools, Software and techniques necessary for Engineering practice.	PO1,PO2,PO3	4	9

Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II	**MAI1212**: Elective – IV (Data Visualization Techniques)

Teaching Scheme		Examination Scheme	
Theory	**3 Hrs/week**	CT-I	15 Marks
Tutorial	**-**	CT-II	15 Marks
Total Credits	**3**	CA	10 Marks
Duration of ESE: 3Hrs		ESE	60 Marks
		Total Marks	100 Marks

Pre-Requisites: Big Data, data visualization tools and technologies, Histogram Plot, Box and Whisker Plot for Large Data.

Course Objectives:

1.	Student shall be able to understand the Data-Visualization-Design.
2.	Student shall be able to understand the Data-Driven documents (D3).
3.	Student shall be able to understand the Design Studio &Text visualization.
4.	Student shall be able to understand the Color processing.
5.	Student shall be able to understand the Data visualization system.

Course Contents

Unit I	**Introduction:** Data-Visualization-Design, Data & Tasks-Data Types, Dataset Types, Spatial Data, Scivis and Infovis, Graphic Design, Graphical Integrity, Data-Ink Ratio, Aspect Ratios & Scales.
Unit II	**Data-Driven documents (D3):** Introduction to D3-Relative vs. Absolute Judgments-Luminance Perception-D3 Key Features-Concepts Visualization Process. Design Iterations. Sketching, Data Types. Statistical Graphs. Interaction Design. Overview & Detail, Dynamic Queries. Brushing & Linking, Animation, Trees & Networks, Radial Layouts. Tree maps, Linear Layouts, Maps, Choropleth Maps, Cartograms, Symbol Maps, Flow Maps, Real-Time Maps.
Unit III	**Design Studio &Text visualization:** Design Studio High-Dimensional Data Filtering. Parallel Coordinates, Glyphs, Aggregation, Text Visualization, Document Visualization, Images & Video, Maps. Choropleth Maps, Cartogram, Symbol Maps, Flow Maps. Real-Time Maps, Perception, Visual Channels. Weber's Law, Pre-attentive Processing, Visual Channel Rankings.
Unit IV	**Color processing:** Color Spaces. Color Aesthetics. Colors for Visualization Cognition. Looking vs Seeing, Image Gist, Gestalt Principles, Visual Attention, Visual Working & Long-Term Memory.
Unit V	**Data visualization system:** Visual Story Telling, Messaging. Effective Presentations. Design for Information Visualization and Arts, Visualization Systems, Database Visualization, Visualization of volumetric data, vector fields, processes and simulations, Visualization of maps, geographic information, GIS systems, collaborative visualizations, evaluating visualizations.

Text Books	
T.1	BenFry "Visualizing Data: Exploring and Explaining Data with the Processing Environment" O'Reilly Media, 2007.
T.2	Ward, Grinstein Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick: A K Peters, Ltd
Reference Books	
R.1	Edward Tufte "The Visual Display of Quantitative Information" 2001.
R 2	Colin Ware, “Visual Thinking for Design”, Morgan Kaufman Series, 2008.
Useful Links	
1	https://nptel.ac.in/courses/110/107/110107092/
2	https://onlinecourses.nptel.ac.in/noc20_mg24/preview
3	https://nptel.ac.in/courses/106/106/106106179/

	Course Outcomes	PO/PSO	CL	Class Sessions
MAI1212(2).1	**Design and create** data visualizations and Conduct exploratory data analysis using visualization.	PO1,PO2,PO3	4	9
MAI1212(2).2	**Modify** existing visualizations based on data visualization theory and principles.	PO1,PO2,PO3	5	9
MAI1212(2).3	**Demonstrate** knowledge of perception and cognition to evaluate visualization design alternatives.	PO1,PO2,PO3	4	9
MAI1212(2).4	**Design** opportunities for application of data visualization in various domains.	PO1,PO2,PO3	4	9
MAI1212(2).5	**Develop** the appropriate data visualization technique.	PO1,PO2,PO3	4	9

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Semester-II	**MAI1213**: Elective – IV (Block chain Technology)

Teaching Scheme			**Examination Scheme**	
Theory	**3 Hrs/week**		CT-I	15 Marks
Tutorial	**-**		CT-II	15 Marks
Total Credits	**3**		CA	10 Marks
Duration of ESE: 3Hrs			ESE	60 Marks
Pre-Requisites: Fundamental skill and Knowledge in Technical Field, Distributed systems and Networking, Cryptography, Data Structures			Total Marks	100 Marks

Course Objectives:

1.	Student shall be able to understand the Basic Cryptographic primitives used in Block chain.
2.	Student shall be able to understand the technologies borrowed in Block chain.
3.	Student shall be able to understand the Abstract Models For Block chain.
4.	Student shall be able to understand the Ethereum.
5.	Student shall be able to understand the Block chain application development.

Course Contents

Unit I	**Introduction:** Basic Cryptographic primitives used in Block chain –Secure, Collison-resistant hash functions, digital signature, public key cryptosystems, zero-knowledge proof systems. Need for Distributed Record Keeping, Modelling faults and adversaries, Byzantine Generals problem, Consensus algorithms and their scalability problems, Why Nakamoto Came up with Block chain based crypto currency?
Unit II	**Technologies Borrowed in Block chain:** hash pointers, Consensus, Byzantine Models of fault tolerance, digital cash etc.Bitcoin block chain - Wallet - Blocks - Merkley Tree - hardness of mining,transaction verifiability , anonymity ,forks , double spending ,mathematical analysis of properties of Bitcoin. Bitcoin, the challenges, and solutions.
Unit III	**Abstract Models For Block chain:** GARAY model, RLA Model, Proof of Work (PoW) as random oracle, formal treatment of consistency, liveness and fairness - Proof of Stake (PoS) based Chains, Hybridmodels (PoW + PoS), Bitcoin scripting language and their use.
Unit IV	**Ethereum:** Ethereum Virtual Machine, Wallets for Ethereum, Solidity -Smart Contracts, The Turing Completeness of Smart Contract Languages and verification challenges, using smart contracts toe nforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts. Some attacks on smart contracts.
Unit V	**Block chain application development:** Hyper ledger Fabric-Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyper ledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda.

Text Books

T.1	Blockchain: Blueprint for a New Economyby Melanie Swan, O "Reilly, 2015
T.2	Blockchain Technology: Cryptocurrency and Applications, S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, Oxford University Press, 2019.
T 3	Blockchain Basicsby Daniel Drescher, Apress; 1stedition, 2017

Reference Books	
R.1	Research perspectives and challenges for Bitcoin and cryptocurrency Joseph Bonneauet al, SoKIEEE Symposium on security and Privacy2015.
R 2	The bitcoin backbone protocol -analysis and applicationsJ.A.Garay et al, EUROCRYPT LNCS VOl 9057, (VOLII), pp 281-3102015
Useful Links	
1	https://nptel.ac.in/courses/106/105/106105184/
2	https://nptel.ac.in/courses/106/104/106104220/
3	https://onlinecourses.nptel.ac.in/noc20_cs01/preview

	Course Outcomes	PO/PSO	CL	Class Sessions
MAI1213(3).1	**Analyze** the clustering applications like Market segmentation and Social network analysis	PO1,PO2	4	9
MAI1213(3).2	**Discriminate** between clustering and classification problems.	PO1,PO3	4	9
MAI1213(3).3	**Evaluate** data reduction and data pre-processing techniques for clustering	PO1,PO2,PO3	5	9
MAI1213(3).4	**Appraise** feature extraction methods and identify the suitable method for a given problem	PO1,PO2,PO3	4	9
MAI1213(3).5	**Demonstrate** the Block chain application development	PO1,PO2,PO3	4	9

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Program: M. Tech. Artificial Intelligence & Machine Learning

Semester-II | **MAI1214**: Elective-IV(Advance Data Mining)

Teaching Scheme	
Theory	**3 Hrs/week**
Tutorial	**-**
Total Credits	**3**
Duration of ESE: 3Hrs	

Examination Scheme	
CT-I	15 Marks
CT-II	15 Marks
CA	10 Marks
ESE	60 Marks
Total Marks	100 Marks

Pre-Requisites: Learn R and Python, data analysis tools, especially SQL, NoSQL, SAS, and Hadoop, Java, Python, and Perl, LINUX

Course Objectives:

1.	Student shall be able to understand the data mining and preprocessing.
2.	student shall be able to understand the classification algorithms
3.	student shall be able to understand the Bayesian belief networks
4.	student shall be able to understand the clustering
5.	student shall be able to understand the outlier detection

Course Contents

Unit I	**INTRODUCTION TO DATA MINING AND PREPROCESSING** Data mining - Related technologies - Machine Learning, DBMS, OLAP, Statistics - Data Mining Goals - Stages of the Data Mining Process - Data Mining Techniques - Knowledge Representation Methods – Applications. **Data preprocessing-** Data cleaning- Data transformation - Data reduction - Discretization and generating concept hierarchies
Unit II	**CLASSIFICATION ALGORITHMS** **Association rules:** Basic idea: item sets **-** Generating item sets and rules efficiently - Correlation analysis **Classification:** Basic learning/mining tasks - Inferring rudimentary rules: 1R algorithm - Decision trees - Bayes Classification Methods - Rule-Based Classification - Model Evaluation and Selection - Techniques to Improve Classification Accuracy
Unit III	**CLASSIFICATION ALGORITHMS** Bayesian Belief Networks - Classification by Back propagation - Support Vector Machines - Classification Using Frequent Patterns - k-Nearest-Neighbor Classifiers - Case-Based Reasoning- Multiclass Classification - Semi-Supervised Classification- Mining Time series Data, Periodicity Analysis for time related sequence data
Unit IV	**CLUSTERING** Basic issues in clustering - First conceptual clustering system: Cluster/2 - Partitioning methods: k-means, expectation maximization (EM) - Hierarchical methods: distance-based agglomerative and divisible clustering - Conceptual clustering: Cobweb
Unit V	**OUTLIER DETECTION** Outliers and Outlier Analysis, Outlier Detection Methods, Statistical Approaches, Proximity-Based Approaches, Clustering-Based Approaches, Classification-Based Approaches, Mining Contextual and Collective Outliers, Outlier Detection in High-Dimensional Data

Text Books

T.1	Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Fourth Edition), Morgan Kaufmann, 2016

	Techniques (Fourth Edition), Morgan Kaufmann, 2016
T.2	Jiawei Han, MichelineKamber, Jian Pei, "Data Mining Concepts and Techniques", Morgan Kaufman Publications, Third Edition, 2011.
T 3	Pang-NingTan,Michael Steinbach, Vipin Kumar," Introduction to Data Mining",Pearson,2016
Reference Books	
R.1	Introduction to Data Mining – Tan, Steinbach, Vipin Kumar, Pearson Education.
R 2	Fundamentals of Data Warehouses, Jarke, Vassiliou, 2nd Edition, Springer.
R 3	Data Warehousing - Paulraj Ponniah
Useful Links	
1	https://ocw.mit.edu/courses/sloan-school-of-management/15-062-data-mining-spring-2003/lecture-notes/
2	https://nptel.ac.in/courses/106/105/106105174/
3	https://onlinecourses.nptel.ac.in/noc20_cs12/preview

	Course Outcomes	PO/PSO	CL	Class Sessions
MAI1204(4).1	**Explain** the techniques for data pre processing	PO1,PO2,PO3	3	9
MAI1204(4).2	**Demonstrate** association rules algorithm for correlation analysis	PO1,PO2,PO3	5	9
MAI1204(4).3	**Discuss** decision tree algorithm for classification	PO1,PO2,PO3	4	9
MAI1204(4).4	**Evaluate** Bayesian networks algorithm for classification	PO1,PO2,PO3	5	9
MAI1204(4).5	**Estimate** the classifier accuracy with training, testing and cross validation datasets	PO1,PO2,PO3	5	9

BoS Chairman

Head of Dept. (Information Technology)
Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur.

Dean Academics

Dean Academics
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Principal

Principal
Tulsiramji Gaikwad Patil College Of Engineering and Technology, Nagpur