Course Structure of M. Tech. (Artificial Intelligence and Machine Learning)

National Education Policy (NEP-2020)

W.E.F Session 2025-26

COURSE	CREDIT	NEP
Total Credit	80	**100**
CBCS Course	08	77.5% (62Credits)
Discipline Specific/Research Based	54	
Skill Development	18	22.5% (18 Credits)
MPDC (Audit Course)	--	

1st SEMESTER **Total Credit=20**

Sn	Paper Code	Course Type	SUBJECT	CREDIT
1	MTAL-101	CBCS Course/MOOCS	AI Ethics and Responsible AI	4
2	MTAL-102	Discipline Specific Course	Mathematics for AIand ML	5
3	MTAL-103	Discipline Specific Course	Foundation of Artificial Intelligence	4
4	MTAL-104	Discipline Specific Course	Machine Learning Techniques	5
5	MTAL-105	Skill Enhancement Course	Elective-I	2
6	MPDC-105	MPDC (Audit Course)	Remedial Language-English	--

2nd SEMESTER **Total Credit=20**

Sn	Paper Code	Course Type	SUBJECT	CREDIT
1	MTAL- 201	CBCS Course/MOOCS	Research Methodology and IPR	4
2	MTAL-202	Discipline Specific Course	Neural Networks andDeep Learning	5
3	MTAL-203	Discipline Specific Course	Computational Intelligence	5
4	MTAL-204	Skill Enhancement Course	Elective-II	4
6	MTAL-205	Skill Enhancement Course	Machine and Deep Learning Lab	2
7	MPDC-207	MPDC (Audit Course)	Ambedkar Studies	--
Choice of exit with Award of Postgraduate Diploma in AI & ML (PGDAIML) – with 40 Credits				

3rd SEMESTER **Total Credit=20**

Sn	Paper Code	Course Type	SUBJECT	CREDIT
1	MTAL-301	Research Based	Dissertation Phase-I	12
2	MTAL-302	Skill Enhancement Course	Seminar	6
3	MTAL-303	Skill Enhancement Course	SWAYAM Online Course/MOOCs	2
4	MPDC-304	MPDC (Audit Course)	Gender Studies	--

4th SEMESTER **Total Credit=20**

Sn	Paper Code	Course Type	SUBJECT	CREDIT
1	MTAL-401	Research Based	Dissertation Phase-II and Viva-Voce	20
2	MPDC-402	MPDC (Audit Course)	Community Service	--

Note:

- A course of 01 Credit shall consider as 01 hours for the lecture.
- Contact Hours (Teacher-Student)-**15 Hours**
  - Lecture / Classroom Activity-**10 Hours**.

LIST OF ELECTIVES

Elective-I		**Elective-II**	
MTAL-105(A)	Python Programming Lab	MTAL-204(A)	Natural Language Processing
MTAL-105(B)	R Programming Lab	MTAL-204(B)	Pattern Recognition
MTAL-105(C)	C/C++ Programming	MTAL-204(C)	Graph Neural Networks
MTAL-105(D)	Data Analytics Lab	MTAL-204(D)	Time Series Analysis
MTAL-105(E)	Artificial Intelligence Lab	MTAL-204(E)	AI and ML for Robotics
		MTAL-204(F)	Quantum Machine Learning
		MTAL-204(G)	AI and ML Techniques for Cyber Security

SEMESTER-I

COURSE TYPE: CBCS COURSE	**CREDIT: 04**

MTAL-101: AI ETHICS AND RESPONSIBLE AI

Unit I: Introduction to AI and Ethics

Introduction to Artificial Intelligence – Evolution and Applications of AI – Importance of Ethics in AI – Moral Values and Human-Centered AI – Ethical Dilemmas in AI Systems – Real-world Case Studies of Ethical and Unethical AI.

Unit II: Fairness, Bias, and Transparency in AI

Concept of Fairness and Bias – Sources of Bias in Data and Algorithms – Social and Cultural Impacts of Biased AI – Transparency and Explainability – Interpretable vs. Black-Box Models – Building Trustworthy AI Systems.

Unit III: Privacy, Accountability, and Data Ethics

Data Privacy and Protection – Informed Consent and Data Ownership – Ethical Data Collection and Usage – Accountability and Responsibility in AI Systems – Data Governance and Security – Overview of Global Data Regulations (GDPR, etc.).

Unit IV: AI and Society – Human Rights, Employment, and Law

Impact of AI on Employment and Automation – Human Rights and AI – AI in Law Enforcement and Surveillance – Ethical and Legal Challenges of Autonomous Systems – Social Justice and Inclusivity – Global AI Governance and Policy Frameworks (UNESCO, IEEE, EU Guidelines).

Unit V: Responsible AI Design and Future Challenges

Principles of Responsible and Human-Centered AI – Ethical Frameworks and Guidelines – Safety, Reliability, and Sustainability in AI Systems – Collaboration between Technologists and Policymakers – Emerging Issues: Generative AI, Deepfakes, and Autonomous Decision-Making – Future Directions for Ethical AI.

Textbooks:

1. Jobin, A., Ienca, M., & Vayena, E. – The Global Landscape of AI Ethics Guidelines, Springer, 2020.

Reference Books:

1. Floridi, L. – Ethics of Artificial Intelligence, Oxford University Press, 2023.
2. Dignum, V. – Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way, Springer, 2019.
3. O'Neil, C. – Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy, Penguin Books, 2017.
4. Crawford, K. – Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence, Yale University Press, 2021.
5. Leslie, D. – Understanding Artificial Intelligence Ethics and Safety: A Guide for the Responsible Design

and Implementation of AI Systems, The Alan Turing Institute, 2019.

COURSE TYPE: DISCIPLINE SPECIFIC	**CREDIT: 05**

MTAL-102 MATHEMATICS FOR AI and ML

Unit I: Linear Algebra

Vector spaces, bases, linear transformations, eigenvalues, eigenvectors, eigen decomposition, Singular Value Decomposition, inner product, orthogonality, matrices, rank, inverse, determinant. Applications: PCA, embeddings, dimensionality reduction.

Unit II: Probability Theory

Random variables: discrete & continuous, probability distributions and densities, joint, marginal & conditional distributions, independence and Bayes' theorem, expectation, variance, covariance. Common distributions: Gaussian, Bernoulli, Poisson, etc. Law of Large Numbers, Central Limit Theorem.

Unit III: Statistics

Descriptive statistics, estimation: Maximum Likelihood Estimation (MLE), Maximum A Posteriori Estimation (MAP), hypothesis testing, confidence intervals, correlation & covariance matrices, decision theory, sampling theory & bootstrapping.

Unit IV: Optimization Fundamentals

Convex sets & convex functions, convexity tests, gradient descent, stochastic gradient descent (SGD), convergence properties, learning rates & step-size control, Newton's method (concept), Lipschitz continuity, smoothness.

Unit V: Numerical Methods

Numerical linear algebra: conditioning & stability, numerical differentiation & integration, root finding: Newton–Raphson, iterative solvers, error analysis: truncation & round-off.

Text Books

1. **Deisenroth, M. P., Faisal, A. A., & Ong, C. S.** (2020). *Mathematics for Machine Learning*. Cambridge University Press.

Reference Books

1. **Strang, G.** (2016). *Introduction to Linear Algebra* (5th ed.). Wellesley Cambridge Press.
2. **Ross, S. M.** (2014). *A First Course in Probability* (9th ed.). Pearson Education.
3. **Boyd, S., & Vandenberghe, L.** (2004). *Convex Optimization*. Cambridge University Press.

COURSE TYPE: DISCIPLINE SPECIFIC COURSE	**CREDIT: 04**

MTAL-103: Foundations of Artificial Intelligence

Unit I: INTRODUCTION

Introduction–Definition –Agent based approach - Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems – AI Environments.

Unit II: PROBLEM SOLVING METHODS

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Backtracking Search – A* Search – Mini-max search - Performance of search algorithms.

Unit III: KNOWLEDGE REPRESENTATION

First Order Predicate Logic –Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation using First order Predicate logic - Reasoning Systems – Second Order Logic.

Unit IV: SOFTWARE AGENTS

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

Unit V: APPLICATIONS

AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing - Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning – Moving

Textbooks:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2009.
2. Bratko, ―Prolog: Programming for Artificial Intelligence, Fourth edition, Addison- Wesley Educational Publishers Inc., 2011.

Reference Books:

1. M. Tim Jones, ―Artificial Intelligence: A Systems Approach(Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2008

2. Nils J. Nilsson, ―The Quest for Artificial Intelligence, Cambridge University Press, 2009.

COURSE TYPE: DISCIPLINE SPECIFIC	CREDIT: 05

MTAL-104 MACHINE LEARNING TECHNIQUES

Unit I: Introduction to Machine Learning & Data Preprocessing

Types of learning: Supervised, Unsupervised, Semi-Supervised, Reinforcement.

ML Pipeline & problem formulation: Data Cleaning, Encoding, Imputation, Feature scaling, Feature Engineering & Feature Selection, Train-Test Split, Cross-Validation.

Unit II: Supervised Learning Techniques – Regression Models

Linear regression – gradient descent & normal equation. Polynomial regression. Regularization: Ridge, Lasso, Elastic Net. Logistic regression. Evaluation metrics: RMSE, MAE, R^2, precision, recall, F1, ROC-AUC.

Unit III: Supervised Learning Techniques – Classification Models

Decision Trees. Random Forests. K-Nearest Neighbors. Naïve Bayes. Support Vector Machines. Bias-variance tradeoff, model selection.

Unit IV: Unsupervised Learning

Clustering: K-Means, Hierarchical, DBSCAN. Dimensionality reduction: PCA, ICA, t-SNE. Anomaly detection fundamentals.

Unit V: Ensemble Methods & Advanced Techniques

Bagging & Random Forest. Boosting: AdaBoost, Gradient Boosting, XGBoost. Stacking & Voting. Hyperparameter tuning: grid search & random search.

Text Books

1. Bishop, C. M. (2006). *Pattern recognition and machine learning*. Springer.
2. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The elements of statistical learning: Data mining, inference, and prediction* (2nd ed.). Springer.

SEMESTER –II

COURSE TYPE: CBCS COURSE	CREDIT: 04

MTAL-201: RESEARCH METHODOLOGY and IPR

UNIT I: INTRODUCTION TO RESEARCH METHODOLOGY

Introduction – Definition – Objectives of Research – Importance of Research – Types of Research – Fundamental Research – Applied Research – Descriptive and Analytical Research – Qualitative and Quantitative Research – Research Process – Steps in Research – Research Ethics – Integrity in Research – Identification of Research Problem – Formulation of Hypothesis – Review of Literature – Research Gap Identification.

UNIT II: RESEARCH DESIGN AND DATA COLLECTION

Research Design – Meaning – Need – Types of Research Design – Experimental – Descriptive – Exploratory – Sampling Design – Sampling Methods – Sample Size Determination – Measurement and Scaling Techniques – Validity and Reliability – Data Collection Methods – Primary and Secondary Data – Questionnaire Design – Interview and Observation Techniques – Case Study Method – Data Preparation – Coding and Tabulation – Overview of Data Analysis – Statistical Tools and Techniques – Correlation – Regression – ANOVA (Conceptual).

UNIT III: RESEARCH REPORT WRITING AND PUBLICATION ETHICS

Structure of Research Report – Layout of Dissertation and Thesis – Components of a Research Paper – Technical Writing Skills – Language and Style in Scientific Writing – Reference Management Tools – Mendeley – Zotero – EndNote – Citation Styles – IEEE – APA – MLA – Plagiarism – Detection Tools – Ethical Publishing Practices – Peer Review Process – Journal Selection – Impact Factor – UGC CARE List – Authorship Ethics – Copyright in Research Publications.

UNIT IV: INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)

Definition – Need for IPR – Importance in Academia and Industry – Types of Intellectual Property – Patents – Trademarks – Copyrights – Industrial Designs – Geographical Indications – Trade Secrets – International IPR Framework – WIPO – WTO – TRIPS Agreement – Indian IPR System – Patentable and Non-Patentable Inventions – Patent Filing Procedure – Provisional and Complete Specification – Patent Search and Prior Art – Patent Publication and Examination – Patent Grant and Maintenance.

UNIT V: IPR APPLICATIONS AND TECHNOLOGY COMMERCIALIZATION

IPR Management – Licensing and Technology Transfer – Innovation and Startups – Role of Incubation Centers – Academic Patents – University–Industry Collaboration – Case Studies on Patent Commercialization – Open Access and Open Source Licensing – Creative Commons – Patent Infringement – Enforcement and Litigation – Technology Valuation – Emerging Trends – AI Generated Inventions – Digital Rights Management – Ethics in IP Utilization.

Textbooks:

1. C.R. Kothari & Gaurav Garg, Research Methodology: Methods and Techniques, 3rd Edition, New Age International.
2. Deborah E. Bouchoux, Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, Cengage Learning.

3. R. Subramanian, Professional Ethics and IPR, Oxford University Press.

Reference Books:

1. Ranjit Kumar, Research Methodology: A Step by Step Guide for Beginners, Sage Publications.
2. Prabuddha Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, McGraw Hill.
3. WIPO Publications, Understanding Industrial Property, Geneva.

COURSE TYPE: DISCIPLINE SPECIFIC COURSE	**CREDIT: 05**

MTAL-202: NEURAL NETWORKS AND DEEP LEARNING

UNIT I: INTRODUCTION TO NEURAL NETWORKS

Introduction – Definition – Biological Neuron and Artificial Neuron – Perceptron Model – Learning Processes – Supervised – Unsupervised – Reinforcement Learning – Learning Rules – Hebbian – Delta – Perceptron Learning – Competitive Learning – Adaptive Learning – Error Correction – Linear Separability – Limitations of Perceptron – Multilayer Perceptron Introduction.

UNIT II: FEEDFORWARD AND BACKPROPAGATION NETWORKS

Feedforward Neural Networks – Architecture – Activation Functions – Sigmoid – Tanh – ReLU – Softmax – Forward Propagation – Error Function – Backpropagation Algorithm – Gradient Descent – Momentum – Weight Initialization – Bias Handling – Overfitting and Regularization – Dropout – Batch Normalization – Optimization Techniques – Stochastic Gradient Descent – Adam – RMSProp.

UNIT III: DEEP NEURAL NETWORKS AND REPRESENTATION LEARNING

Deep Feedforward Networks – Universal Approximation Theorem – Vanishing and Exploding Gradient Problem – Solutions using Initialization and Normalization – Representation Learning – Autoencoders – Denoising Autoencoders – Sparse Autoencoders – Variational Autoencoders – Deep Belief Networks – Restricted Boltzmann Machines – Layerwise Pretraining – Transfer Learning Concepts.

UNIT IV: CONVOLUTIONAL AND RECURRENT NEURAL NETWORKS

Convolutional Neural Networks – Convolution Operation – Padding – Pooling – Stride – Feature Maps – CNN Architectures – LeNet – AlexNet – VGG – ResNet – Applications in Image Classification – Object Detection – RNN Fundamentals – Sequence Modeling – Vanishing Gradient in RNN – LSTM – GRU – Bidirectional RNN – Applications in NLP and Time Series Prediction.

UNIT V: ADVANCED TOPICS AND APPLICATIONS

Generative Models – Generative Adversarial Networks (GANs) – Encoder–Decoder Models – Attention Mechanism – Transformers – BERT – GPT Models – Reinforcement Learning with Neural Networks – Deep Q-Learning – Policy Gradient Methods – Ethical and Responsible AI – Interpretability – Explainable AI – Case Studies – Applications in Vision – Speech – Healthcare – Autonomous Systems.

Textbooks:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
2. Simon Haykin, Neural Networks and Learning Machines, 3rd Edition, Pearson Education.
3. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.
4. Manel Martínez-Ramón, Meenu Ajith & Aswathy Rajendra Kurup, Deep Learning: A Practical Introduction, Wiley, 2024.
5. Aurélien Géron, Neural Networks and Deep Learning, O'Reilly Media, 2018.
6. Charu C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer, 2023.

Reference Books:

1. François Chollet, Deep Learning with Python, Manning Publications, 2021.
2. Rajalingappaa Shanmugamani, Deep Learning for Computer Vision, Packt Publishing, 2018.
3. Charu C. Aggarwal, Neural Networks and Deep Learning: A Textbook, Springer, 2018.

COURSE TYPE: Discipline Specific	**CREDIT: 05**

MTAL- 203 COMPUTATIONAL INTELLIGENCE

Unit I: Introduction to Computational Intelligence

Hard vs. Soft Computing. Need for Computational Intelligence (CI): uncertainty and approximation. CI techniques overview: evolutionary computing, swarm intelligence, fuzzy systems, artificial immune systems (AIS), hybrids. Applications in robotics, smart grids, communications.

Unit II: Fuzzy Logic

Fuzzy sets, membership functions. Fuzzy rules & inference systems. Mamdani and Takagi–Sugeno models. Defuzzification techniques. Applications in control and decision systems.

Unit III: Evolutionary Computation

Genetic Algorithm: core concepts (chromosome, fitness function, selection, crossover, mutation). GA applications: solving combinatorial optimization problems (e.g., Traveling Salesperson Problem – TSP). Evolution strategies. Genetic programming.

Unit IV: Swarm Intelligence

Particle Swarm Optimization. Ant Colony Optimization. Artificial Bee Colony. Hybrid CI systems: integrating components (e.g., Neuro-Fuzzy Systems (ANFIS), GA-tuned Neural Networks). Applications in ML optimization and robotics.

Unit V: Hybrid CI Systems

ANFIS and learning rules. Fuzzy-evolutionary hybrids. Swarm-neural hybrids. Applications in control

and forecasting. Artificial Immune Systems. Membrane Computing. Chaos-based optimization.

Text Books

1. Sivanandam, S. N., & Deepa, S. N. (2007). *Principles of soft computing* (1st ed.). Wiley India.
2. Kennedy, J., & Eberhart, R. C. (2001). *Swarm intelligence*. Morgan Kaufmann.
3. Goldberg, D. E. (1989). *Genetic algorithms in search, optimization, and machine learning*. Addison-Wesley.
4. Jang, J.-S. R., Sun, C.-T., & Mizutani, E. (1997). *Neuro-fuzzy and soft computing: A computational approach to learning and machine intelligence*. Prentice Hall.