Rayat Shikshan Sanstha's

SADGURU GADGE MAHARAJ COLLEGE, KARAD

(An Empowered Autonomous College)

Reaccredited by NAAC with 'A+' Grade.

Syllabus for Master of Science

Syllabus

M.Sc. Artificial Intelligence

Two Year Degree Program in Artificial Intelligence

(Faculty of Science)

As per NEP-2020

To be implemented from academic year 2025-26

Title of the Course: M.Sc. (Artificial Intelligence)

Preamble:

In today's tech-driven world, access to vast amounts of information and ways to interpret it have taken priority than ever before. Real time processing of this huge data is also a major requirement in every walk of life. It also means we need more people who can organize and analyze that information - people who can use data to make change and help businesses. Data science employs a variety of instruments, scientific procedures, methods, and algorithms to glean insights from both structured and unstructured data. This Data Science program integrates scientific methods from statistics, computer science and data-based business management to extract knowledge from data and drive decision making. Our curriculum provides students with a rigorous course of study in big data technologies, applications and practices a pathway for student internships and full-time employment. Students are prepared to meet the challenges at the intersection between big data, business analytics, and other emerging fields.

Eligibility:

- B.Sc. (Statistics / Mathematics / Electronics / Physics / Chemistry) from recognized Indian University.
- B.Sc.(Computer Science), B.C.S., B.Sc.(Entire Computer Science),

(BCA)Bachelor of Computer Application, B.E. from recognized Indian University.

Programme Outcomes (POs)

On completion of M.Sc. Artificial Intelligence program, students will be able

Deep Understanding of Core AI Concepts

- Machine learning, deep learning, natural language processing, computer vision, reinforcement learning.
- Mathematical foundations: linear algebra, probability, optimization.

Practical Skills

- Programming proficiency in Python, TensorFlow, PyTorch, etc.
- Building and deploying AI models.
- Working with large datasets, data wrangling, model evaluation.

Research Experience

- Ability to conduct independent research.
- Writing technical papers and possibly publishing in journals/conferences.
- Understanding of AI ethics, fairness, and interpretability.

Problem-Solving with AI

- Applying AI methods to real-world problems in fields like healthcare, finance, robotics, etc.

Duration

- The course shall be a full-time course.
- The course shall be for two years, consisting of four semesters.

Fee Structure

- **Entrance Examination fees:** as prescribed by the Institute.
- **Course Fee:** as prescribed by the Institute.

Medium of instruction: English

1. Structure of the Programme, Scheme of Teaching and Examination

Sem.	Course type	Course code	No. of credits	Teaching hours per week	Examination Scheme				
					University Assessment			Internal Assessment	
					Max Marks	Min mark for passing	Exam hours	Max Marks	Min mark for passing
I	Major Mandatory	MJ-MAIT25-101	4	4	80	32	3	20	8
		MJ-MAIT25-102	4	4	80	32	3	20	8
		MJ-MAIT25-103	2	2	40	16	1.5	10	4
		MJ-MAIP25-106	4	12	--	--	--	100	40
	Major Elective	GE-MAIT25-104	4	4	80	32	3	20	8
	Research Methodology	RM-MAIT25-105	4	4	80	32	3	20	8
II	Major Mandatory	MJ-MAIT25-201	4	4	80	32	3	20	8
		MJ-MAIT25-202	4	4	80	32	3	20	8
		MJ-MAIT25-203	2	2	40	16	1.5	10	4
		MJ-MAIPT25-206	4	12	--	--	--	100	40
	Major Elective	GE-MAIT25-204	4	4	80	32	3	20	8
	On Job Training/ Field Project	FP-MAI25-205	4	4	To be declared				

Evaluation pattern for M.Sc.-AI –I

SEMESTER – I

Course type	Course code	No. of credits	Course title
Major Mandatory	MJ-MAIT25-101	4	Artificial Intelligence
	MJ-MAIT25-102	4	Statistical learning for Artificial Intelligence
	MJ-MAIT25-103	2	Python programming
	MJ-MAIP25-106	4	Practical-I
Major Elective	GE-MAIT25-104a	4	AI Ethics and governance
	GE-MAIT25-104b		Data Science and Analytics
Research Methodology	RM-MAIT25-105	4	Research Methodology

SEMESTER – II

Course type	Course code	No. of credits	Course title
Major Mandatory	MJ-MAIT25-201	4	Machine Learning
	MJ-MAIT25-202	4	Computer Vision
	MJ-MAIT25-203	2	Natural Language processing
	MJ-MAIP25-206	4	Practical-II
Major Elective	GE-MAIT25-204a	4	Data Visualization
	GE-MAIT25-204b		Pattern Recognition
On Job Training/ Field Project	FP-MAI25-205	4	On Job Training industry / Field Projects/Internship

1. Clarification of Syllabus:

The syllabus committee should meet at least once in a year to study and clarify any difficulties from the Institutes. The workshop on syllabi should be organized at the beginning of every semester on request from Institutes.

2. Eligibility of Faculty:

MCA (under Science and Technology) with first class or equivalent with two years relevant experience.

3. Revision of Syllabus:

As the computer technology experience rapid rate of obsolescence of knowledge, revision of the syllabus should be considered every two/three years.

4. Backlog:

Students should not have more than Four (4) backlogs for second year admission.

5. Teaching and Practical Scheme:

a. Each contact session for teaching or practical should be 60 minutes each.
b. Minimum 40 periods should be conducted for each subject of 100 marks.
c. Minimum 24 periods should be conducted for each subject of 50 marks.
d. One practical batch should be of 30 students.
e. Practical evaluation should be conducted before the commencement of University Examination.

6. Guidelines for On Job Training (FP-MAI25-205)

a. Student must start the OJT immediately after semester-II examination during the summer vacation
b. Student is expected to complete the field project/OJT work minimum in between 120 hours assigned by company/ industry/ consultancy/ institution.
c. College should assign the mentor to monitor the progress throughout the OJT
d. Student has to submit the weekly progress report duly signed by the concern authorities of company to the mentor
e. At the end of OJT, student should prepare documentation and submit a report.
f. The final presentation and documentation will be evaluated by the examination panel.

7. Nature of Practical examination: -

Component	Max marks
Practical examination: Examination will be of 3 hours duration. There shall be 8 questions each of 12 marks, of which a student has to attempt any 5 questions.	60
Day-to-day practical performance and journal	20
Viva: Viva will be based on all practical's	20

8. Nature of Theory examination: -

Component	Max marks
Nature of the theory question papers (4 credits): a) There shall be 7 questions each carrying16 marks. b) Question No.1 is compulsory. It consists of 8 questions for 2 marks each. c) Students have to attempt any 4 questions from question No. 2 to 7. d) Question No. 2 to 6 shall contain 2 to 4 sub-questions. e) Question No.7 shall contain 4 short note type questions, each carrying 4 marks.	80
Nature of the theory question papers (2credits): a) There shall be 4 questions. b) Question No.1 is compulsory. It consists of 4 questions for 2 marks each. c) Question No. 2 to 4 shall be of 16 marks each. d) Students have to attempt any 2 questions from question No. 2 to 4. e) Question No. 2 to 4 shall contain 2 to 4 sub-questions.	40

Major Mandatory Syllabus

M.Sc. I- Semester-I

Theory: Course- I: MJ-MAIT25-101 Artificial Intelligence

Course Outcome:

1. To introduce the basic concepts and problem techniques of Artificial Intelligence.
2. Apply principles of AI in solutions that require problem solving, inference, Perception
3. Implement algorithms on simple and complex decision making.
4. Demonstrate an understanding of knowledge and reasoning under certainty and Uncertainty.

Credits:04	**SEMESTER-I** **MJ-MAIT25-101 Artificial Intelligence**	**No. of hours per unit/credits**
Unit I	**Introduction to AI**:	
	History of AI, Types of AI foundation of AI, Fields in AI, Components in AI, Application of AI, AI Problems And Techniques, Water jug problem, 8 puzzle problem, Travelling salesman problem, Tower of Hanoi Problem.	**15 Hours**
Unit II	**Intelligent System:**	
	Components of Intelligent system, Application of Intelligent system Intelligent Agent in AI, Types of Intelligent Agent, Structure of Intelligent Agent, Properties of Intelligent Agent, Examples of Intelligent Agents **Expert systems** Architecture of expert systems, Steps to build Expert Systems - Role of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, PROSPECTOR	**15 Hours**
Unit III	**Searching:**	
	Search algorithm Terminologies Properties of Search Algorithm Types of Search Algorithm: Uninformed/Blind Search- BFS, DFS, Informed Search- Best First Search Algorithm (Greedy Search) A* Search Algorithm, AO* Search Algorithm.	**15 Hours**
Unit IV	**Knowledge Representation**:	
	Architecture, Inference System , Knowledge Representation, Types of Knowledge, AI knowledge Cycle, Techniques of Knowledge Representation, Forward and backward chaining , Knowledge Representation Structure, Semantic Networks, Frames, Conceptual Dependencies, Scripts	**15 Hours**

References:

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A modern approach, 2022
2. Ethem Alpaydin, Introduction to Machine Learning, 2021
3. Mehryar Mohri, AfshinRostamizadeh, Ameet Talwalkar, Foundations of Machine Learning, 2019

Major Mandatory Syllabus

M.Sc. I- Semester-I

Theory: Course- II: MJ-MAIT25-102 Statistical learning for Artificial Intelligence

Course Outcome:

1. To describe the role of mathematics in AI, ML and Data Science
2. To explain the concept of vectors and matrices and apply them in machine learning.
3. To evaluate various AI techniques using dimension reduction, optimization and Probability.
4. To apply mathematical knowledge gained in the field of AI, Machine Learning and Data Science to solve real life problems.

Credits:04	**SEMESTER-I** **MJ-MAIT25-102 Statistical learning for Artificial Intelligence**	**No. of hours per unit/credits**
Unit I	**Special Distributions**	
	Random variable; discrete, continuous, expectation and variance of a random variable, pmf, pdf, cdf **Distributions:** Binomial Distribution, Uniform Distribution, Poisson Distribution, Negative Binomial Distribution, Geometric Distribution, Continuous Uniform, Distribution, Exponential Distribution, Normal Distribution, Log Normal Distribution, Gamma Distribution, Weibull Distribution, Pareto Distribution.	**15 Hours**
Unit II	**Sampling & Sampling Distributions**	
	Introduction to Sampling, Simple random Sampling, Stratified Random Sampling, Cluster Sampling, Concept of Sampling Error, Introduction to Sampling distributions, Student's t distribution, Chi square distribution, Snedecor's F distribution, Interrelations amongt, chi-square and F distributions, Central Limit Theorem (Various Versions) and its applications. Point estimation	**15 Hours**
Unit III	**Testing of hypothesis**	
	Definitions: population, statistic, parameter, standard error of estimator. Concept of null hypothesis and alternative hypothesis, critical region, level of significance, type I and type II error, onesided and two-sided tests, p-value. Large Sample Tests, Tests based on t, Chi-square and F-distribution.	**15 Hours**
Unit IV	**Analysis of Variance**	
	One Way ANOVA,Two Way ANOVA, Application of ANOVA to test the overall significance of Regression. **Basic nonparametric tests**: Sign test, Mann-Whitney U test, Kruskal-Wallis one way ANOVA,Kolmogorov-Smironov test	**15 Hours**

References:

1. Fundamentals of Applied Statistics (3rdEdition), Guptaand Kapoor, S. Chandand Sons, NewDelhi, 1987.
2. An Introductory Statistics, Kennedy and Gentle.
3. Statistical Methods, G.W.Snedecor, W.G.Cochran, John Wiley & sons, 1989.
4. An Introduction to Statistical Learning: with Applications in R, Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, Springer, 2011
5. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012

6. Probability, Statistics, Design of Experiments and Queuing theory with applications Computer Science, Trivedi K.S., Prentice Hall of India, New Delhi, 2001.
7. Mathematical Statistics and Data Analysis, John A. Rice, Duxbury Press, 1995

Major Mandatory Syllabus

M.Sc. I- Semester-I

Theory: Course- III: MJ-MAIT25-103 Python Programming

Course Outcome:

1. Develop Python program using basic syntactical constructs.
2. Implement Modules, Packages and Libraries in Python for given problem.

Credits:02	**SEMESTER-I** **MJ-MAIT25-103 Python Programming**	**No. of hours per unit/credits**
Unit I	**Introduction and Control Flow statements in Python**	
	Features of Python, Data type, Python Basic operators, Data Structures and Python operator precedence, Control structure, looping in python, Object-Oriented Programming (OOP), File Handling	**15 Hours**
Unit II	**Python Modules and Packages Modules, Libraries:**	
	Python Modules and Packages Modules, Libraries: Advanced Python, Python for Data Science, Web Development (Basics of web frameworks (e.g., Flask, Django), Building REST APIs, Template rendering)	**15 Hours**

Text Books:

1. Mark Lutz, Learning Python, O'Reilly, 5th Edition, June 2013.
2. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and I Python, O'Reilly, 3rd Edition, August 2022.

References:

1. Y. Daniel Liang, Introduction to Programming using Python, Pearson, 2012.
2. Wesley J. Chun, Core Python Applications Programming, 3rd Edition, Pearson, 2012.
3. R. Nageswara Rao, "Core Python Programming", Dreamtech Press; Third edition,2021
4. Reema Thareja, "Python Programming Using Problem Solving Approach", 2nd Edition, Oxford University Press, 2019.
5. Jake Vander Plas, Python Data Science Handbook O'Reilly, 2nd Edition, 2022.

Elective Major Syllabus

M.Sc. I- Semester-I

Theory: Course- IV: GE-MAIT25-104 AI Ethics and Governance

Course Outcome:

1. Understand the fundamental ethical issues that arise in the field of Artificial Intelligence
2. Understand the ethical implications of data collection, and decision-making Processes
3. Recognize and address privacy concerns related to data collection, storage, and Sharing
4. Reflect on the emerging ethical issues and future directions in Artificial Intelligence

Credits: 04	**SEMESTER-I** **GE-MAIT25-104 AI Ethics and Governance**	**No. of hours per unit/credits**
Unit I	**Introduction to AI Ethics**	
	Overview of AI's societal impact, Ethical frameworks for AI, The need for AI ethics and governance	**15 Hours**
Unit II	**Bias and Fairness in AI**	
	Types of bias in AI, Impact of bias on AI outcomes, Mitigation strategies for bias **Transparency, Accountability, and Explainability**: The importance of transparency in AI, Accountability mechanisms for AI, Explainable AI (XAI)	**15 Hours**
Unit III	**Privacy and Security in AI**	
	Data privacy concerns in AI, Security vulnerabilities of AI systems, Privacy-preserving AI techniques	**15 Hours**
Unit IV	**Governance of AI Systems**	
	Evolution of AI Ethics, Foundations of AI Governance, Key Drivers for Ethical AI, Role of Governance in AI Ecosystems, Ethical Considerations in AI Decision-making, Industry Best Practices in AI Governance, Building Effective AI Governance Structures, Integrating AI Governance into Organizational Frameworks, Aligning AI Governance with Corporate Values	**15 Hours**

References:

1. "Ethics of Artificial Intelligence and Robotics" by Vincent C. Müller
2. Big Data's Disparate Impact" by Solon Barocas and Andrew D. Selbst
3. "Algorithmic Bias Detectives" by Suresh Venkata subramanian et al.
4. "Explainable Artificial Intelligence (XAI)" by David Gunning
5. "Privacy and Data Protection in AI" by Paul De Hert and Vagelis Papakonstantinou
6. "Accountability in AI" by Ryan Calo and others

Elective Major Syllabus

M.Sc. I- Semester-I

Theory: Course- V: GE-MAIT25-104 Data Science and Analytics

Course Outcome:

1. To list the key concepts in data science
2. To understand the statistics and machine learning concepts that are vital for data science
3. To identify the relationships between data and describe it
4. To produce Python code to statistically analyze a dataset

Credits: 04	**SEMESTER-I** **GE-MAIT25-104 Data Science and Analytics**	**No. of hours per unit/credits**
Unit I	**Data Science**	
	Data Science: Benefits and uses – facets of data – Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation – Exploratory Data analysis – build the model– presenting findings and building applications – Basic Statistical descriptions of Data DESCRIBING DATA Types of Data – Types of Variables -Describing Data with Tables and Graphs – Describing Data with Averages – Describing Variability – Normal Distributions and Standard (z) Scores	**15 Hours**
Unit II	**Introduction to Data Analytics**	
	Introduction to Data Analytics - Data Analytics Overview - Importance of Data Analytics - Types of Data Analytics - Descriptive Analytics - Diagnostic Analytics- Predictive Analytics -Prescriptive Analytics- Benefits of Data Analytics -Data Visualization for Decision Making , Measure Of central tendency, Measures of Dispersion - Graphical Techniques, Skewness & Kurtosis, Box Plot	**15 Hours**
Unit III	**Describing Relationships**	
	Describing Relationships Correlation –Scatter plots –correlation coefficient for quantitative data – computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard error of estimate – interpretation of r2 –multiple regression equations –regression towards the mean	**15 Hours**
Unit IV	**Python Libraries**	
	Basics of Numpy arrays –aggregations –computations on arrays – comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection – operating on data – missing data – Hierarchical indexing . Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – Visualization with Sea born.	**15 Hours**

References:

1. Allen B. Downey, “Think Stats: Exploratory Data Analysis in Python”, Green Tea Press, 2014.
2. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
3. (Unit I) Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
4. (Units II and III) Jake Vander Plas, “Python Data Science Handbook”, O’Reilly, 2016. (Units IV and V)

Links:

1. https://www.coursesidekick.com/statistics/study-guides/boundless-statistics
2. https://open.maricopa.edu/psy230mm/chapter/chapter-6-z-scores/
3. https://www.geeksforgeeks.org/python

Major Syllabus

M.Sc. I- Semester-I

Theory: Course- VI: RM-MAIT25-105 Research Methodology

Course Outcome:

1. Develop analytical skills by applying scientific methods.
2. Review the existing research article on Machine learning & Business analytics
3. Survey the specific research areas in field of Computer Science
4. Test & validate the proposed methodology on research problems.

Credits: 04	**SEMESTER-I** **RM-MAIT25-105 Research Methodology**	**No. of hours per unit/credits**
Unit I	**Introduction:**	
	Meaning of research, objectives of research, motivation in research, types of research, research approaches, significance of research, research methods vs. methodology, research and Scientific method ,research process, criteria of good research, defining research problem, research design, Research Ethics, publication of research, Plagiarism, Intellectual property rights, Patents and its filing procedures.	**15 Hours**
Unit II	**Sampling techniques**	
	review of simple random sampling stratified random sampling, systematic random sampling, cluster sampling, two phase sampling, and ratio and regression method of estimation. Probability proportional to size sampling: Cumulative total method, Lahiri's method, Hansen-Horwitz estimator and its properties, Horwitz-Thompson estimator, Des Raj estimators for a general sample size. Non-sampling errors, techniques for handling non-response: Hansen–Horwitz and Demings model for the effect of call backs. Randomised response techniques, dichotomous population, Warners model, MLE in Warners model, unrelated question model.	**15 Hours**
Unit III	**Interpretation of Data and Paper Writing**	
	Interpretation and Report Writing Meaning of Interpretation, Why Interpretation? , Technique of Interpretation , Precaution in Interpretation Significance of Report Writing, Different Steps in Writing Report , Layout of the Research Report , Types of Reports (Research Proposal/Synopsis, Research Paper, and Thesis) ,Oral Presentation , Mechanics of Writing a Research Report , Precautions for Writing Research Reports	**15 Hours**
Unit IV	**Publication Ethics**	
	Definition,introductionandimportance,Bestpractices/standards setting initiatives and guidelines: COPE, WAME, etc. , Conflicts of interest ,Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types , Violation of publication ethics, authorship and contributor ship , Identification of publication misconduct, complaints and appeals , Predatory publishers and journal , Open access publications and initiatives , SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies, Software tool to identify predatory publications developed by SPPU , Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. E-Resources for research: GoogleScholar, ShodhGanaga, ShodhGangotri, SciHub, etc…	**15 Hours**

Text Books:

1. David V Thiel, "Research Methods- for Engineers", Cambridge University Press, ISBN: 978-1-107-61019-4
2. Kothari C.R., "Research Methodology. New Age International, 2004, 2 nd Ed; ISBN: 13: 978-81-224-1522-3

References:

1. Atkinson, K. E. (1989). An introduction to numerical analysis, John Wiley and Sons.
2. Chaudhuri, A. & Stenger, H. (2005).Survey sampling: theory and methods.CRC Press.
3. Cochran, W.G. (1977). Sampling techniques. John Wiley & Sons.
4. Devroye L. (1986).Non-Uniform Random Variate Generation. Springer-Verlag New York.
5. Efron, B., & Tibshirani, R.J. (1994).An introduction to the bootstrap. CRC press.
6. Kennedy, W.J., &Gentle, J.E. (2021).Statistical computing. Routledge.
7. Kothari, C.R.(2004) Research methodology: Methods and techniques. New Age International.
8. Morgan , B.J.(1984). Elements of simulation (Vol.4).CRC Press.
9. Mukho padhyay, P. (2008).Theory and methods of survey sampling. PHI Learning Pvt. Ltd..
10. Robert,C.P.,Casella.,& Casella,G.(1999). Monte Carlo statistical methods (Vol.2).New York: Springer.
11. Ross, S.M. (2022).Simulation. Academic Press.
12. Rubinstein, R.Y., & Melamed, B. (1998).Modern simulation and modeling (Vol.7). NewYork: Wiley.
13. Singh, D., &Chaudhary, F.S. (1986).Theory and analysis of sample survey designs John Wiley & Sons.
14. Sukhatme P.V., Sukhatme S. &Ashok C (1984).Sampling Theory of surveys and applications. Iowa university press and Indian society of agricultural statistics, New Delhi.

Links:

1. www.openintro.org/stat/down/OpenIntroStatFirst.pdf

MJ-MAIP25-106 – Lab Course

LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Subject 1: Artificial Intelligence

1. Write a Program to Implement Breadth First Search using Python
2. Write a Program to Implement Depth First Search using Python
3. Write a Program to Implement Tic-Tac-Toe game using Python.
4. Write a Program to Implement Water-Jug problem using Python.
5. Write a Program to Implement Traveling Salesman Problem using Python.
6. Write a Program to Implement Tower of Hanoi using Python.

Subject 2: Statistical Learning For Artificial Intelligence

1. Model Sampling and sketching PMF CDF for Discrete Distributions
2. Model Sampling and sketching PDF CDF for Continuous Distributions
3. Simple Random Sampling And Stratified Random Sampling Using R
4. Cluster Sampling Using R
5. Estimation of Parameters Using Maximum Likelihood Estimation (MLE) in R
6. Large sample hypothesis test susing R.
7. Test based on t-tests, chi-square tests, and F-tests using R
8. Perform One-Way ANOVA and Two-Way ANOVA using R

Subject 3: Python Programming

1.

a) Write a program to input two numbers and demonstrate arithmetic operators (+, -, *, /, %, //, **).

b) Write a program to demonstrate various data types used in Python.

2.

a) Write a program to print all even numbers between 1 and 50 using a for loop.

b) Demonstrate method overloading/overriding using classes.

3.

a) Write a program to create a text file and write some data into it.

b) Create a user-defined module math_utils.py containing functions for factorial, prime checking, And Fibonacci. Import this module into another Python script and test the functions.

4.

a) Using Pandas, create a DataFrame of student data (name, marks, grade). Perform operations like filtering students with marks > 60, calculating average marks, and sorting by grade.

b) Write a Flask program with two routes:

i) / → displays welcome message

ii) /about → displays "About Us" page

Major Syllabus

M.Sc. I- Semester-II

Theory: Course- I: MJ-MAIT25-201 Machine Learning

Course Outcome:

1. Recognize the characteristics of Machine Learning techniques that enable to solve real world problems
3. Apply various supervised learning methods to appropriate problems
4. Create probabilistic and unsupervised learning models for handling unknown pattern
5. Analyze the co-occurrence of data to find interesting frequent patterns.

Credits: 04	**SEMESTER-II** **MJ-MAIT25-201 Machine Learning**	**No. of hours per unit/credits**
Unit I	**Introduction to Machine learning**	
	Overview of machine learning: Definition, applications. Types of machine learning: Supervised, unsupervised, reinforcement learning. Machine learning process: Data collection, preprocessing, model training, evaluation, deployment. Terminology and concepts: Features, labels, instances. Data Preprocessing and Exploration Data cleaning and preprocessing technique	**15 Hours**
Unit II	**Supervised and Unsupervised Learning**	
	Decision Trees: ID3, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Neural Networks: Introduction, Perception, Multilayer Perception, Support Vector Machines: Linear and Non-Linear, Kernel Functions, K nearest Neighbors. Introduction to clustering, K-means clustering, K-Mode Clustering.	**15 Hours**
Unit III	**Ensemble and Probabilistic Learning Model Combination**	
	Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking. Gaussian mixture models - The Expectation-Maximization (EM) Algorithm, Information Criteria, Nearest neighbor methods - Nearest Neighbour Smoothing, Efficient Distance Computations: the KD-Tree, Distance Measures.	**15 Hours**
Unit IV	**Reinforcement Learning and Evaluating Hypotheses Introduction**	
	Learning Task, Q Learning, Non deterministic Rewards and actions, temporal-difference learning, Relationship to Dynamic Programming, Active reinforcement learning, Generalization in reinforcement learning. Motivation, Basics of Sampling Theory: Error Estimation and Estimating Binomial Proportions, the Binomial Distribution, Estimators, Bias, and Variance.	**15 Hours**

References:

1. Kevin Murphy, ―Machine Learning: A Probabilistic Perspective‖, MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, ―The Elements of Statistical Learning‖, Springer, 2009.
3. Christopher Bishop, ―Pattern Recognition and Machine Learning‖, Springer, 2007.

Text Books:

1. Ethem Alpaydin, ”Introduction to Machine Learning”, MIT Press, Prentice Hall of India, 3rd Edition2014.

2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar " Foundations of Machine Learning", MIT Press, 2012.
3. Tom Mitchell, "Machine Learning", McGraw Hill, 3rdEdition, 1997.
4. MACHINE LEARNING - An Algorithmic Perspective, Second Edition, Stephen Mars land, 2015.

Major Syllabus

M.Sc. I- Semester-II

Theory: Course- II: MJ-MAIT25-202 Computer Vision

Course Outcome:

1. Understand fundamentals of image processing and computer vision.
2. Understand and apply concepts of Image formation and Image Enhancement.
3. Understand and apply image segmentation and feature extraction methods.
4. Acquire knowledge about various Object Detection, Object Recognition, Motion estimation techniques and their applications

Credits: 04	**SEMESTER-II** **MJ-MAIT25-202 Computer Vision**	**No. of hours per unit/credits**
Unit I	**Introduction to Image Formation and Processing Computer Vision**	
	Geometric primitives and transformations - Photometric image formation - The digital camera - Point operators - Linear filtering - More neighborhood operators -Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization	**15 Hours**
Unit II	**Feature Detection**	
	Matching and Segmentation Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.	**15 Hours**
Unit III	**Feature-based alignment and motion estimation**	
	2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration -Triangulation - Two-frame structure from motion – Factorization - Bundle adjustment -Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion 3D RECONSTRUCTION Shape from X - Active range finding - Surface representations - Point-based representations-Volumetric representations - Model-based reconstruction - Recovering texture maps and albedosos.	**15 Hours**
Unit IV	**Image based rendering and recognition**	
	View interpolation Layered depth images - Light fields and Lumi graphs -Environment mattes - Video-based rendering-Object detection - Face recognition - Instance recognition -Category recognition - Context and scene understanding- Recognition databases and test sets.	**15 Hours**

Text Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications (2nd edition), Springer, 2022.

References:

1. D. L. Baggio et al., ―Mastering OpenCV with Practical Computer Vision Projects‖, Packt Publishing, 2012.
2. E. R. Davies, ―Computer & Machine Vision‖, Fourth Edition, Academic Press, 2012.
3. Jan Erik Solem, ―Programming Computer Vision with Python: Tools and algorithms for analyzing images‖, O'Reilly Media, 2012.
4. Mark Nixon and Alberto S. Aquado, ―Feature Extraction & Image Processing for Computer Vision‖, Third Edition, Academic Press, 2012.
5. R. Szeliski, ―Computer Vision: Algorithms and Applications‖, Springer 2011.
6. Simon J. D. Prince, ―Computer Vision: Models, Learning

Major Syllabus

M.Sc. I- Semester-II

Theory: Course- III: MJ-MAIT25-203 Natural Language Processing

Course Outcome:

1. Learners will learn about the concepts in natural language processing.
2. Learners will have a fair idea of different areas in NLP
3. Learners will appreciate the complexities involved in natural language processing.
4. Through lectures and practical assignments, students will learn the necessary tricks for making their models work on practical problems.

Credits:02	**SEMESTER-II** **MJ-MAIT25-203 Natural Language Processing**	**No. of hours per unit/credits**
Unit I	**Foundations of Natural Language Processing**	
	Introduction Natural Language Processing - Problems and perspectives ,Introduction/Recall to/of probability calculus, N-grams and Language Models, Markov Models ,Introduction to Machine Learning and Deep Learning , Recurrent Neural Network Language Models, The evaluation of NLP applications Corpora ,Corpora and their construction: representativeness, Concordances, collocations and measures of words association , Methods for Text Retrieval ,Regular expressions	**15 Hours**
Unit II	**Natural Language Processing**	
	Computational Phonetics and Speech Processing, Speech samples: properties and acoustic measures, Analysis in the frequency domain, Spectrograms, Applications in the acoustic-phonetic field. Speech recognition with HMM and Deep Neural Networks, Tokenization and Sentence splitting, Computational Morphology, Morphological operations, Grammars for natural language ,Natural language Parsing, Supplementary worksheet, Lexical semantics	**15 Hours**

References:

1. Allen, James. Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995.
2. Charniack, Eugene. Statistical Language Learning, MIT Press, 1993.
3. Deep Learning by Goodfellow, Bengio, and Courville (free online).
4. Jurafsky, Dan and Martin, James. Speech and Language Processing, Second Edition, Prentice Hall, 2008.
5. Machine Learning — A Probabilistic Perspective by Kevin Murphy (online).
6. Manning, Christopher and Heinrich, Schutze. Foundations of Statistical Natural Language Processing, MIT Press, 1999.
7. Natural Language Processing by Jacob Eisenstein (free online).
8. Speech and Language Processing by Dan Jurafsky and James H. Martin 25 (3rd ed. draft).
9. T. McEnery and A. Wilson. Corpus Linguistics, EUP. 2001.
10. Tamburini, F. Neural Models for the Automatic Processing of Italian, Bologna: Pàtron. 2022.

Links:

https://corpora.ficlit.unibo.it/NLP/

https://www.machinelearningplus.com/nlp/nlp-exercises

Elective Major Syllabus

M.Sc. I- Semester-II

Theory: Course- IV: GE-MAIT25-204 Data Visualization

Course Outcome:

1. Understand types of data and data visualization methods
2. Understand the need of data visualization.
3. Create and design visualizations and dashboards
4. Evaluate the performance of visualization technique

Credits: 04	**SEMESTER-II GE-MAIT25-204 Data Visualization**	**No. of hours per unit/credits**
Unit I	**Introduction to Data Visualization**	
	Need for data visualization. Visualization an aspect of business analytics, importance of data visualization. Types of Data, Stages of Data visualization, Fitts Law, Human visual perception and cognition Comparison between tableau and Power BI	**15 Hours**
Unit II	**Installation of Tableau**	
	Using the Workspace Control Effectively, Tableau Desktop Workspace, Navigation, Data Terminology, Data Types & Default Properties, different aggregation types, File Types **Data Connection:** Data Connection with Text File, Connection with Microsoft Excel, Extracting data, data joining, data blending, sorting and replacing data source.Tableau Calculation	**15 Hours**
Unit III	**Filter data**	
	Basic filter, filter operation, Extract filter, Quick Filters, Context filter, conditional filters, data source filters, Sort data, Build Groups, Hierarchy and sets **Tableau Charts and Graphs:** Bar chart, Line Graphs with Date & Without Date, Pie Chart, Tree maps, Scatter Plots, Individual Axes, Blended Axes, Dual Axes & Combination chart, Edit axis, Bins/Histograms, Parts of Views, Sorting, Trend lines, Reference Lines, Forecasting, View data & Actions (across sheets), latitude and longitude, Default location/Edit locations, Symbol Map & Filled Map	**15 Hours**
Unit IV	**Building Interactive Dashboards**	
	Combining multiple visualizations into a dashboard (overview), Making your worksheet interactive by using actions Filter URL, Highlight, Options in Formatting your Visualization, Working with Labels and Annotations, Effective Use of Titles and Captions	**15 Hours**

Text Book:

1. Learning Tableau 10 – Second Edition, by Joshua Milligan
2. Practical Tableau by Ryan Sleeper
3. Communicating Data with Tableau by Ben Jones

References:

1. Big data black book, Dream tech publication
2. Handbook for visualizing: a handbook for data driven design by Andy kirk

Links:

1. https://www.tutorialspoint.com/tableau/index.htm 2.
2. https://medium.com/analytics-vidhya/quick-notes-on-tableau-8596f1b6009

Elective Major Syllabus

M.Sc. I- Semester-II

Theory: Course- V: GE-MAIT25-204 Pattern Recognition

Course Outcome:

1. Analyze various type of pattern recognition techniques
2. Identify and apply various pattern recognition and classification approaches to solve the problems
3. Evaluate statistical and structural pattern recognition
4. Percept recent advances in pattern recognition confined to various applications

Credits: 04	**SEMESTER-II** **GE-MAIT25-204 Pattern Recognition**	**No. of hours per unit/credits**
Unit I	**Pattern Recognition**	
	Introduction of Pattern Recognition with its application, Pattern Recognition system, Design cycle of pattern recognition, Learning and adaption, Representation of Patterns and classes, Feature Extraction, pattern recognition models/approaches.	**15 Hours**
Unit II	**Error Estimation & Decision Theory**	
	Introduction, Error estimation methods, various distance measures (Euclidean, Manhattan, cosine, Mahalanobis) and distance based classifier, Feature selection based on statistical hypothesis testing, ROC curve.Bayesian decision theory-continuous and discrete features, two-category classification, minimum error rate classification, discriminant functions, Parametric Techniques:- Maximum Likelihood Estimation, Bayesian Parameter Estimation, Sufficient Statistics; Problems of dimensionality. Non-Parametric Techniques:-Density estimation, Parzen Window, Metrics and Nearest- Neighbor classification; Fuzzy classification	**15 Hours**
Unit III	**Structural pattern recognition**	
	Tree Classifiers-Decision Trees, Random Forests, Structural Pattern recognition: Elements of formal grammars, String generation as pattern description, Recognition of syntactic description, Parsing, Stochastic grammars and applications, Graph based structural representation, stochastic method: Boltzmann Learning.	**15 Hours**
Unit IV	**Clustering**	
	Introduction,Hierarchical Clustering,agglomerative clustering algorithm, the single linkage, complete, linkage and average, linkage algorithm. Ward's method,Partition clustering, K- means algorithm, clustering algorithms based on graph theory(Minimum spanning tree algorithm),Optimization methods used in clustering: clustering using simulating Annealing	**15 Hours**

Text Books:

1. R. O. Duda, P. E. Hart, D. G. Stork, "Pattern Classification", 2nd Edition, Wiley- Inter-science, John Wiley &Sons, 2001

2. S. Theodoridis and K. Koutroumbas, "Pattern Recognition", 4th Edition, Elsevier, Academic Press, ISBN: 978-1-59749-272-0

3. B.D. Ripley, “Pattern Recognition and Neural Networks”, Cambridge University Press. ISBN 0 521 46086 7

References:

1. Devi V.S.; Murty, M.N. (2011) Pattern Recognition: An Introduction, Universities Press, Hyderabad.
2. David G. Stork and Elad Yom-Tov, “Computer Manual in MATLAB to accompany Pattern Classification”, Wiley Inter-science, 2004, ISBN-10: 0471429775
3. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, PHI, ISBN- 978- 81-203-4091-6

e-Books :

1. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.320.4607&rep=rep1&type=pdf
2. https://cds.cern.ch/record/998831/files/9780387310732_TOC.pdf
3. https://darmanto.akakom.ac.id/pengenalanpola/Pattern%20Recognition%204th%20Ed.%20(2009).pdf
4. https://readyforai.com/download/pattern-recognition-and-machine-learning-pdf/

MJ-MAIP25-206 Lab Course

LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Subject1: Machine Learning

1. Implement a basic linear regression model using Python (scikit-learn).
2. Explore a dataset, visualize relationships using Matplotlib and Seaborn.
3. Write a Python program to implement multiple Linear Regression for a given dataset.
4. Write a Python program to implement Polynomial Regression for the given dataset.
5. Write a Python program to Implement Naïve Bayes.
6. Write a Python program to Implement Decision Tree whether or not to play tennis.
7. Write a Python program to implement linear SVM.
8. Write a Python program to transform data with Principal Component Analysis (PCA).
9. Write a Python program to implement the k-nearest Neighbors ML algorithm to build prediction model (Use Forge Dataset).
10. Write a Python program to implement the k-means algorithm on a synthetic dataset.
11. Write a Python program to implement Agglomerative clustering on a synthetic dataset.

Subject 2:Computer Vision

1. Program to change the Brightness of Image.
2. To Flip the image around the vertical and horizontal line.
3. Display the color components of the image.
4. Using histogram for image quality analysis
   a. Calculate the Histogram of a given image.
   b. Histogram Equalization.
5. Program for Image Filtering
   c. Low pass filter => 1)Average filter 2) Weighted Average filter 3)Median filter
   d. High pass filters using=>1) Sobel operator 2) Laplacian operator
6. Edge detection with gradient and convolution of an Image Finding Threshold of
   e. Images
   f. Program to find threshold of grayscale image.
   g. Program to find threshold of RGB image.
7. Program to estimate and subtract the background of an image.
8. Program to convert color image to gray and hsv.
9. Determination of edge detection using operators.
10. Program to implement image segmentation.