(AMARAVATI, AMRITAPURI, BANGALORE, COIMBATORE, CHENNAI)

Minor in Artificial Intelligence & Machine Learning

CURRICULUM 2022

GENERAL INFORMATION

ABBREVIATIONS USED IN THE CURRICULUM

Cat	-	Category
L	-	Lecture
T	-	Tutorial
P	-	Practical
Cr	-	Credits
ENGG	-	Engineering Sciences (including General, Core and Electives)
AIE	-	Computer Science and Engineering - Artificial Intelligence
MAT	-	Mathematics
CGPA	-	Cumulative Grade Point Average

Course Outcome (CO) – Statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.

Program Outcomes (POs) – Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the Program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the Program Outcomes for each discipline.

PROGRAM OUTCOMES FOR ENGINEERING

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM DESCRIPTION - PROGRAM SPECIFIC OUTCOMES FOR AI & ML MINOR

This minor program in AI & ML aims at developing fundamental skills pertinent to AI. AICTE has identified AI as an emerging area and insists to train students across different streams of engineering in AI. AI minor will enable the students to apply the AI tools and techniques for solving current technical challenges identified in their major discipline.

After completing the minor in AI & ML, the students will,

1. **PSO1:** Have a foundation in mathematics and programming required for understanding and implementing AI techniques.
2. **PSO2:** Have the ability to apply ML techniques to solve problems pertinent to signal and image processing.
3. **PSO3:** Have the ability to apply DL techniques to solve problems pertinent to signal and image processing.

PREREQUISITES FOR PURSUING AI & ML MINOR

Students who have a CGPA of 7.5 or above at the end of their second semester are eligible to register for this minor. Students interested in mathematics and coding will have an additional advantage.

Curriculum Table

Cat.	Code	Title	L T P	Credit
ENGG	23AIE231M	Introduction to AI and Data Science	2 0 3	3
SCI	23AIE232M	Python for AI	2 1 3	4
ENGG	23MAT231M	Mathematics for AI	2 1 3	4
ENGG	23AIE233M	Introduction to Machine Learning	2 1 3	4
ENGG	23AIE234M	Introduction to Deep Learning	2 1 3	4
		TOTAL	29	19

SYLLABUS

23AIE231M Introduction to AI and Data Science 2 0 3 3

Course Objectives

- To introduce fundamentals of AI.
- To introduce fundamentals of Data Science.
- To introduce different tools and techniques used in AI and Data Science.

Course Outcomes

After completing this course, students will be able to

CO1: Analyse different elements of an AI system.

CO2: Analyse different types of data representation.

CO3: Apply concepts of AI and Data Science to solve canonical problems.

CO4: Implement basic computational tools pertinent to AI and Data Science to solve canonical problems.

CO-PO Mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	2	2	2	3	2	2	2	2	2	-	2	3	2	3
CO2	2	2	2	2	3	-	-	-	2	2	-	2	3	2	3
CO3	2	2	2	2	3	-	-	-	2	2	-	2	3	2	3
CO4	3	2	2	2	3	-	-	-	2	2	2	2	3	2	3

Syllabus

Unit 1
History and Foundations of AI and Data Science, Applications of AI and Data Science, Career paths pertinent to AI and Data Science.

Unit 2

Rational Intelligent Agents, Agents and Environments, Nature of Environments, Structure of Agents. Introduction - Overview of Data Science – Introduction to Statistics: Sampling, Sample Means and Sample Sizes - Descriptive statistics: Central tendency, dispersion, variance, covariance, kurtosis, five-point summary.

Unit 3
Basic tools for AI and Data Science, Introduction to Data Science process pipeline, Different representations of Data, Importance of pre-processing the data, Elementary Applications of AI and Data Science.

Text Books & References:

- *Russell, Stuart Jonathan, Norvig, Peter, Davis, Ernest. Artificial Intelligence: A Modern Approach. United Kingdom: Pearson, 2010.*
- *Deepak Khemani. A First Course in Artificial Intelligence. McGraw Hill Education (India), 2013.*
- *Denis Rothman. Artificial Intelligence by Example, Packt, 2018.*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 2)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

23MAT231M Mathematics for AI 2 1 3 4

Course Objectives

- The course will lay down the basic concepts and techniques of linear algebra, calculus and basic probability theory needed for subsequent study.
- It will explore the concepts initially through computational experiments and then try to understand the concepts/theory behind it.
- At the same time, it will provide an appreciation of the wide application of these disciplines within the scientific field.
- Another goal of the course is to provide connection between the concepts of linear algebra, differential equation and probability theory.

Course Outcomes

After completing this course, students will be able to

CO1: Apply matrix decomposition techniques to solve elementary problems.

CO2: Apply the concepts of linear algebra and differential calculus to solve elementary optimization problems.

CO3: Analyze data using fundamental techniques of probability.

CO4: Implement the concepts and techniques of linear algebra, optimization and probability for signal and image processing.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	-	-	-	2	2	-	2	3	-	1
CO2	3	2	1	1	3	-	-	-	2	2	-	2	3	-	1
CO3	3	2	1	1	3	-	-	-	2	2	-	2	3	-	1
CO4	3	2	1	1	3	-	-	-	2	2	-	2	3	1	1

Syllabus

Unit 1

Basics of Linear Algebra - Diagonalizability of matrices, Eigenvalues and Eigenvectors of Symmetric matrices, Eigenvalues and Eigen vectors of A^TA, AA^T, Relationship between vector spaces associated with A, A^TA, AA^T, Singular Value Decomposition. Projection matrix and Regression, Convolution sum, Convolution Integral.

Unit 2

Taylor series expansion of multivariate functions, conditions for maxima, minima and saddle points, Concept of gradient and hessian matrices, Multivariate regression and regularized regression. Theory of convex and non-convex optimization, Newton method for unconstrained optimization. Signal processing with regularized regression.

Unit 3

Random variables and distributions, Expectation, Variance, Moments, Cumulants, Sampling from univariate distribution- various methods, Bayes theorem, Concept of Jacobian, and its use in finding pdf of functions of Random variables (RVs), box-muller formula for sampling normal distribution, Concept of correlation and Covariance of two linearly related RVs.

Textbooks

- *Gilbert Strang, Linear Algebra and Learning from Data, Wellesley, Cambridge press, 2019.*
- *William Flannery, "Mathematical Modeling and Computational Calculus", Vol-1, Berkeley Science Books, 2013.*
- *Stephen Boyd and Lieven Vandenberghe, "Convex Optimization ", Cambridge University Press, 2018.*
- *Douglas C. Montgomery and George C. Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc.*

References Books

- *Stephen Boyd and Lieven Vandenberghe, "Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares", Cambridge University Press, 2018.*
- *Papoulis, and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Fourth Edition, McGraw Hill, 2002.*
- *Introduction to Probability, D. Bertsekas and J. Tsitsiklis, 2nd Edition, Athena Scientific, 2008.*

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

23AIE232M Python for AI 2 1 3 4

Course Objectives

- To acquire programming skills in core Python for AI.
- To understand how to write functions and pass arguments in Python for AI applications.
- To develop a fundamental understanding of how to use Python packages for AI applications.

Course Outcomes

After completing this course, students will be able to

CO1: Solve problems using Python conditionals and loops.

CO2: Apply Python functions and function calls to solve problems pertinent to AI.

CO3: Apply Python data structures to represent complex data.

CO4: Develop AI Applications using Python Packages.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	-	-	-	3	2	3	3	1	1	1
CO2	3	3	3	3	3	-	-	-	3	2	3	3	1	1	1
CO3	3	2	3	3	3	-	-	-	3	2	3	3	1	1	1
CO4	3	2	3	3	3	-	-	-	3	2	1	3	1	1	1

Syllabus

Unit 1

Introduction to Python basics- variables, Datatypes and Operators. Coding Standards. Formatting Inputs and Outputs in Python. Collections - Lists, Strings, Tuple, Set, Dictionary. Control Structures. Functions- Definition, Arguments and Recursion.

Unit 2

Python Object Oriented-Exceptions.Python Regular Expressions. Databases in Python- Connecting SQL with Python, Performing Insert, Update, Delete Queries using Cursor. Web Scraping in Python. Graphical User Interface. Django Web Framework in Python. Interface of python with an SQL database.

Unit 3

Introduction to essential libraries in Python, Numpy library, operation using numpy array, Pandas library: Creation of dataFrame using pandas, operation on data frames using pandas, subsetting, indexing, groupby.

Unit 4

Libraries for data visualisation and AI Model building: Matplotlib- Bar graph, scatterplot, histogram. Seaborn Scikit-learn - Machine learning APIs

Textbooks

Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.

Reference Books

Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.

Eric Matthes, "Python Crash Course, A Hands – on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.

https://www.python.org/,numpy.org

Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

David Beazley, Brian Jones., "Python Cookbook", Third Edition, Orelly Publication, 2013, ISBN 978-1449340377

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

23AIE233M Introduction to Machine Learning 2 1 3 4

Course Objectives

- This course dives into the basics of Machine learning.
- This course will enable the students to work with various types of data and its pre-processing techniques.
- The students will learn about Supervised and Unsupervised Learning.
- The students will enrich themselves with hands-on experience to implement various machine learning algorithms.

Course Outcomes

After completing this course, the students will be able to

CO1: Apply pre-processing techniques to prepare the data for machine learning applications
CO2: Implement supervised machine learning algorithms for different datasets
CO3: Implement unsupervised machine learning algorithms for different datasets
CO4: Identify the appropriate machine learning algorithms for different applications

CO – PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	3	3	-	-	1	3	3	1	3	3	3	-
CO2	3	2	3	-	3	-	-	1	3	3	1	3	3	3	3
CO3	3	2	3	-	3	-	-	1	3	3	1	3	3	3	3
CO4	3	3	-	-	3	-	-	1	3	3	1	3	-	3	-

Syllabus

Unit 1
Introduction to Machine Learning – Data and Features – Machine Learning Pipeline: Data Preprocessing: Standardization, Normalization, Missing data problem, Data imbalance problem – Data visualization - Setting up training, development and test sets – Cross validation – Problem of Overfitting, Bias vs Variance - Evaluation measures – Different types of machine learning: Supervised learning, Unsupervised learning.
Unit 2
Supervised learning - Regression: Linear regression, logistic regression – Classification: K-Nearest Neighbor, Naïve Bayes, Decision Tree, Random Forest, Support Vector Machine, Perceptron.
Unit 3
Unsupervised learning – Clustering: K-means, Hierarchical, Spectral, subspace clustering, Dimensionality Reduction Techniques, Principal component analysis, Linear Discriminant Analysis.

Text Books:
Andrew Ng, Machine learning yearning, URL: http://www. mlyearning. org/(96) 139 (2017).
Kevin P. Murphey. Machine Learning, a probabilistic perspective. The MIT Press Cambridge, Massachusetts, 2012.
Christopher M Bishop. Pattern Recognition and Machine Learning. Springer 2010
Reference Books:
Richard O. Duda, Peter E. Hart, David G. Stork. Pattern Classification. Wiley, Second Edition;2007
Sutton, Richard S., and Andrew G. Barto. Reinforcement learning: An introduction. MIT press, 2018.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30

23AIE234M Introduction to Deep Learning 2 1 3 4

Course Objectives

- This course provides the basic concepts of deep learning and implementation using Matlab/Python.
- This course provides the application of deep learning algorithms in signal and image data analysis.
- This course covers the concept of deep learning algorithms such as transfer learning and attention models for signal and image analysis.

Course Outcomes

After completing this course, the students will be able to

CO1: Apply the fundamentals of deep learning.

CO2: Apply deep learning algorithms using Matlab/Python.

CO3: Apply deep learning models for signal analysis.

CO4: Implement deep learning models for image analysis.

CO-PO Mapping

PO/PSO / CO	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	
CO1	3	2	2	-	3	2	-	-	3	3	-	3	2	3	2
CO2	3	2	2	2	3	3	-	-	3	3	2	3	3	3	2
CO3	3	2	2	2	3	3	-	-	3	3	2	3	3	3	2
CO4	3	3	2	2	3	3	-	-	3	3	2	3	3	3	3

Syllabus

Unit 1

Introduction to neural networks – Gradient Descent Algorithm - Deep Neural Networks (DNN) –Convolutional Neural Network (CNN) – Recurrent Neural Network (RNN): Long-Short- Term-Memory (LSTM).

Unit 2

Pre-processing: Noise Removal using deep learning algorithms - Feature Extraction - Signal Analysis: Time Series Analysis, CNNs, Auto encoders.

Unit 3

Image Analysis: Transfer Learning, Attention models- Ensemble Methods for Signal and Image Analysis.

Textbooks & References:

Bishop C.M, "Pattern Recognition and Machine Learning", Springer, 1st Edition, 2006.

Goodfellow I, Bengio Y, Courville A, & Bengio Y, "Deep learning", Cambridge: MIT Press, 1st Edition, 2016.

Soman K.P, Ramanathan. R, "Digital Signal and Image Processing – The Sparse Way", Elsevier, 1st Edition, 2012.

Evaluation Pattern

Assessment	Internal/External	Weightage (%)
Assignments (Minimum 3)	Internal	30
Quizzes (Minimum 2)	Internal	20
Mid-Term Examination	Internal	20
Term Project/ End Semester Examination	External	30