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ताळगांव पठार,
गोंय - ४०३ २०६
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(Accredited by NAAC with Grade A+)

GU/Acad –PG/BoS -NEP/2026-27/238 Date: 27.07.2026

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP/2025/477 dated 14.10.2025

In supersession to the above referred Circular, the syllabus for the Courses offered under specialization **Artificial Intelligence and Machine Learning** of **Bachelor of Engineering in Computer Engineering** Programme for Semester V to VII, as approved by the Academic Council in its meeting held on 20th February 2026, is attached.

The syllabus for Semester III & IV approved earlier by the Standing Committee of the Academic Council in its meeting held on 24th & 25th July 2025 is also attached.

The Dean, Faculty of Engineering and the Principals of the affiliated Engineering Colleges are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN V LAWANDE
Digitally signed by ASHWIN V LAWANDE
Date: 2026.07.27 17:23:42 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,
1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of Affiliated Engineering Colleges.

Copy to:
1. Chairperson, BoS in Computer Engineering, Goa University.
2. Controller of Examinations, Goa University.
3. Assistant Registrar Examinations (Technical and Allied), Goa University
4. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

Computer Engineering

Specialization: Artificial Intelligence and Machine Learning

Sr. No.	Semester	Course Code	Title of the Course	L	T	P	TCr
1	III	**CMP-281**	Mathematical Foundation for AI/ML	3	0	0	3
		CMP-282	Mathematical Foundation for AI/ML Lab	0	0	1	1
2	IV	**CMP-283**	Applied Machine Learning	3	0	0	3
		CMP-284	Applied Machine Learning Lab	0	0	1	1
3	V	**CMP-381**	Data Science and Analytics	3	0	0	3
		CMP-382	Data Science and Analytics Lab	0	0	1	1
4	VI	**CMP-383**	Neural Networks and Deep Learning	3	0	0	3
		CMP-384	Neural Networks and Deep Learning Lab	0	0	1	1
5	VII	**CMP-481**	Applications of Artificial Intelligence	3	0	0	3
		CMP-482	Applications of Artificial Intelligence Lab	0	0	1	1
			Total	**15**	**0**	**5**	**20**

SEMESTER III

Name of the Programme : **Computer Engineering (Artificial Intelligence and Machine Learning)**

Course Code : **CMP-281**

Title of the Course : **Mathematical Foundations for Artificial Intelligence and Machine Learning**

Number of Credits : **3(3L)**

Effective from AY : **2024-25**

Pre- requisites for the Course:	Basic Knowledge of classical definition of probability differentiation and Matrices	
Course Objectives:	This course will enable students to: • Understand probability spaces, discrete and continuous random variables, and special distributions in the context of artificial intelligence and machine learning. • Understand sampling distributions and the Central Limit Theorem's role in estimating means, and explore hypothesis testing concepts and various tests for means, in relation to artificial intelligence and machine learning. • Gain exposure to Vector and Matrix Calculus, which is an essential tool for solving optimization problems in artificial intelligence and machine learning. • Learn unconstrained and constrained optimization methods used in artificial intelligence and machine learning.	
Units	**Contents:**	**No of Hours**
Unit-1	**Probability Distributions:** Probability Space, Discrete and Continuous Random Variables and probability Distributions, Some Special Distributions (Bernoulli, Binomial, Poisson, Geometric, Exponential, Uniform, and Gaussian distributions), Moment Generating Function (computation of first two moments of specific probability distributions).	**11**
Unit-2	**Sampling Distributions:** Definition of Sampling distribution, Sampling distribution of the Mean with variance known, Central Limit Theorem (Sampling distribution of the Mean for a Large Sample when variance is not known). **Confidence Interval Estimation:** Concept, Confidence interval for the mean of a normal population with variance known, Large Sample Confidence interval for a population mean (variance not known). **Tests of Hypotheses:** Statistical Hypotheses, Null Hypothesis, alternative hypothesis, Type I and Type II Errors, Level of Significance, Test on the mean of a normal population with	**12**

	variance known, Large Sample Test on a Population mean (variance unknown).	
Unit-3	**Vector and Matrix Calculus:** Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices (only scalar valued functions of matrices), Higher-Order Derivatives, Linearization and Multivariate Taylor Series.	**11**
Unit-4	**Unconstrained Optimization:** Gradients and Stationary Points, Second Derivative Test for functions of several variables (up to three variables), Gradient Descent method. **Constrained Optimization:** Lagrange's Multiplier method, Standard form of linear programming problem, Basic Simplex algorithm.	**11**
Pedagogy	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	
References/ Readings:	Text Books 1. Douglas C. Montgomery, George C. Runger, "Applied Statistics and Probability for Engineers", Fourth Edition, Wiley-India, 2012. 2. E. K. P. Chong and S. H. Zak, "An Introduction to Optimization with applications to machine learning", 4th Edition, John Wiley and Sons Pvt. Ltd., 2013. 3. George B. Thomas, Maurice D. Weir Naval, Joel Hass, Christopher Heil "Thomas' Calculus - Early Transcendentals", Thirteenth Edition, Pearson, 2014. 4. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2020. Reference Books 1. Jay Dawani, "Hands-On Mathematics for Deep learning", First Edition, Packt Publishing Ltd., 2020. 2. Jorge Nocedal, Stephen J. Wright, "Numerical optimization", 2nd Edition, Springer, 2006. 3. Richard A. Johnson, Irwin Miller, John Freund, "Miller and Freund's Probability and Statistics for Engineers", Eight Edition, Pearson India Education services Pvt. Ltd., 2018.	
Course Outcomes:	On completion of the course students should be able to: 1. Apply various probability distributions to model uncertainties arising in artificial intelligence and machine learning. 2. Effectively formulate and test statistical hypotheses to validate artificial intelligence and machine learning models.	

	3. Apply vector and matrix calculus techniques to effectively compute gradients required to train modelsarising in artificial intelligence and machine learning, 4. Apply various optimization techniques to solve problems arising in artificial intelligence and machine learning.

Name of the Programme : **Computer Engineering (Artificial Intelligence and Machine Learning)**

Course Code : **CMP-282**

Title of the Course : **Mathematical Foundations for Artificial Intelligence and Machine Learning Lab**

Number of Credits : **1(1P)**

Effective from AY : **2024-25**

Pre- requisites for the Course:	The students should have knowledge on basics of Python programming.	
Course Objectives:	This course will enable students to: 1. Develop the ability to generate and visualize probability distributions using Python constructs. 2. Learn to construct confidence intervals and perform hypothesis testing for population means, using Python. 3. Gain proficiency in computing Jacobian matrices, and calculating higher-order derivatives using symbolic and numerical methods. 4. Gain hands-on experience in implementing optimization algorithms in Python.	
Units		**No of Hours**
Content:	1. Program to generate Binomial random variables and visualize the probability mass function. 2. Program to generate Poisson random variables and visualize the probability mass function. 3. Program to generate and plot the Gaussian distribution. 4. Program to construct a confidence interval for a normally distributed population with known variance. 5. Demonstrate the Central Limit Theorem with large sample sizes from a non-normal population. 6. Perform a hypothesis test on the population mean with known variance 7. Program to numerically compute the Jacobian matrix for a given vector-valued function. 8. Program to compute higher-order derivatives (e.g., second, third derivatives) of univariate and multivariate functions using symbolic differentiation 9. Program to compute and visualise the Taylor series for a function of two variables. Compare it with the original function. 10. Program to implement the Simplex algorithm.	**30**
Pedagogy	Constructive, Collaborative and Creativity Based Learning	

References/ Readings:	Text Books 1. Wes McKinney, "Python for Data Analysis", Second Edition, O'Reilly Media, Inc., 2017. 2. Robert Johansson, "Numerical Python: A Practical Techniques Approach for Industry", First Edition, Apress, 2015. 3. Francois Chollet, "Deep Learning with python", First Edition, Manning, 2017. 4. Rupesh Kumar Tipu, Vandna Batra, Suman Punia, "Efficient Coding with Python Mastering Optimization Techniques", 1st Edition, Lambert Academic Publishing, 2024. Reference Books 1. Samir Madhavan, "Mastering Python for Data Science", 1st Edition, Packt Publishing Ltd., 2015. 2. Dr. R. Nageswara Rao, "Core Python Programming", 3rd Edition, Dreamtech Press, 2018. 3. Kenneth. A. Lambert, "Fundamentals of Python: First Programs", 2nd Edition, Course Technology Cengage Learning, 2019. 4. Vamsi Kurama, "Python Programming: A Modern Approach", 1st Edition, Pearson India, 2017.
Course Outcomes:	On completion of this course students should be able to: 1. Generate and visualize probability distributions using Python. 2. Construct confidence intervals and perform hypothesis testing for population means, for real-world data analysis using Python. 3. Compute Gradients and calculate higher-order derivatives for univariate and multivariate functions using Python. 4. Implement optimization algorithms such as the Simplex algorithm, Lagrange's multiplier method and gradient descent, to solve optimization problems arising in artificial intelligence and machine learning.

Semester IV

Name of the Programme : **Computer Engineering**
(Artificial Intelligence and Machine Learning)
Course Code : **CMP-283**
Title of the Course : **Applied Machine Learning**
Number of Credits : **3(3L)**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Mathematical Foundation of AI/ML	
Course Objectives:	This course aims students to : 1. Understand the basic concepts of Machine learning. 2. Learn various supervised learning algorithms. 3. Understand data clustering, transformation and dimensionality reduction techniques. 4. Apply Decision tree learning algorithms.	
Contents:		**No of Hours**
Unit-1	Well-Posed Machine Learning Problems, Data Representation, Diversity of Data: Structured/Unstructured, Forms of Learning. **Supervised Learning:** Learning from Observations, Bias and Variance, Computational Learning Theory, Occam's Razor Principle and Overfitting Avoidance, Heuristic Search in Inductive Learning, Estimating Generalization Errors, Metrics for Assessing Regression accuracy, Metrics for Assessing Classification accuracy.	**12**
Unit-2	Statistical Learning: Descriptive Statistics in Learning Techniques, Bayesian Reasoning to Inference, k-Nearest Neighbor (k-NN) Classifier, Discriminant Functions and Regression Functions, Linear and Logistic regression. Fisher's Linear Discriminant, Minimum Description Length Principle. Support Vector Machines:	**11**
Unit- 3	**Data Clustering and Data Transformations:** Clustering, Engineering the Data, Different Clustering Methods such as Partitional Clustering, Hierarchical Clustering, Spectral Clustering, Clustering using Self-Organizing Maps, Fuzzy K-Means Clustering, Expectation-Maximization (EM) Algorithm and Gaussian Mixtures Clustering, Data transformation techniques.	**11**
Unit- 4	Decision Tree Learning: Introduction, Example of a Classification Decision Tree, Measures of Impurity for Evaluating Splits in Decision Trees, ID3, C4.5, and CART Decision Trees, Pruning the	**11**

	Tree, Strengths and Weaknesses of Decision-Tree Approach, Random Forest algorithm. Data Warehousing and Online Analytical Processing.	
Pedagogy:	The teaching-learning process shall integrate interactive, reflective, and inquiry-based methods, with a strong emphasis on critical thinking and problem-solving skills.	
References/ Readings:	**Text Books** 1. M. Gopal: Applied Machine Learning, 2nd Edition, Mc Graw Hill Publication, 2021. ISBN 9353160251 Reference Books 1. Siddhanta Bhatta: Applied Machine Learning Solutions with Python, 2nd Edition, BPB Publication, 2021, ISBN 9391030432 2. Tom M Mitchell: Machine Learning, Indian edition, McGraw Hill Publication, 1997, ISBN 1259096955 3. Ethem Alpaydin: Introduction to Machine Learning", 4th Edition, MIT Press, Prentice Hall of India, 2020, ISBN 0262043793.	
Course Outcomes:	On the successful completion of this course students should be able to: CO 1. Explain concepts of Machine learning. CO 2. Develop solutions to real world applications using supervised learning algorithms. CO 3. Apply data clustering, transformation and dimensionality reduction techniques for various applications CO 4. Demonstrate usage of logic functions, linear and non-linear separability concept and different training rules.	

Name of the Programme : **Computer Engineering (Artificial Intelligence and Machine Learning)**

Course Code : **CMP-284**

Title of the Course : **Applied Machine Learning Lab**

Number of Credits : **1(1P)**

Effective from AY : **2024-25**

Pre-requisites for the course:	Familiarity with Python programming.	
Course Objectives:	This course aims to: 1. Understand the concepts of Machine learning and learn about Python libraries. 2. Demonstrate the knowledge of various supervised learning algorithms. 3. Implement Python programs for data clustering, transformation and dimensionality reduction techniques. 4. Illustrate knowledge of logic functions, linear and non-linear separability concept and different training rules.	
Contents:	**List of Programs /Experiments**	**No. of Hours**
	1. Implementation of Linear Regression. 2. Implementation of Logistic Regression. 3. Implementation of KNN classifier. 4. Implementation of Decision tree classifier. 5. Implementation of Random Forest algorithm. 6. Implementation of Naive Bayes Classifier. 7. Implementation of Hierarchical clustering algorithm. 8. Implementation of EM algorithm. 9. Implementation of K-Means clustering. 10. Implementation of PCA.	**30**
Pedagogy:	Constructive, Collaborative and Inquiry Based Learning	
References/ Readings:	**Text Books** 1. M. Gopal: Applied Machine Learning, 2nd Edition, Mc Graw Hill Publication, 2021. ISBN 9353160251 Reference Books 1. Siddhanta Bhatta: Applied Machine Learning Solutions with Python, 2nd Edition, BPB Publication, 2021, ISBN 9391030432 2. Tom M Mitchell: Machine Learning, Indian edition, McGraw Hill Publication, 1997, ISBN 1259096955 3. Ethem Alpaydin: Introduction to Machine Learning", 4th Edition, MIT Press, Prentice Hall of India, 2020, ISBN 0262043793.	

Course Outcomes:	On the successful completion of this course students should be able to: CO 1. Demonstrate the knowledge of Machine learning and Python libraries. CO 2. Implement solutions to real world applications using supervised learning algorithms. CO 3. Demonstrate usage of data clustering, transformation and dimensionality reduction techniques for various applications CO 4. Implement logic functions, linear and non-linear separability concept.

Semester V

Name of the Programme : **Computer Engineering (Artificial Intelligence and Machine Learning)**
Course Code : **CMP-381**
Title of the Course : **Data Science and Analytics**
Number of Credits : **3 (3L)**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Basic mathematics for AI/ML and programming skills in Python.	
Course Objectives:	**This course will enable students to:** 1. To introduce the fundamental concepts, process models, and applications of Data Science and Analytics. 2. To develop proficiency in Python programming and data analysis libraries for handling and preprocessing data. 3. To enable students to perform exploratory data analysis, visualization, and dimensionality reduction techniques. 4. To provide foundational knowledge of supervised and unsupervised machine learning algorithms for data-driven decision making.	
	Contents	**No of Hours**
Unit – 1	Introduction to Data Science: Data Science, Brief History of Data Science, Increasing Attention to Data Science, Fundamental Fields of Study Related to Data Science, Data Science and Related Terminologies - Big Data, Business Intelligence, Data Mining, Artificial Intelligence, Machine Learning, Deep Learning, Types of Analytics-Descriptive Analytics, Diagnostic Analytics, Predictive Analytics, Prescriptive Analytics. Applications of Data Science, Data Science Process Model	**11**
Unit –2	Basics of Python: Python Libraries, NumPy Library, Pandas Library Exploratory Data Analysis: Introduction, Steps in Data Preprocessing, Understanding Data-Steps involved in EDA using Python programming, Looking at the Data, Visualizing Data-Histograms, Countplot, Boxplot, Treatment of Outliers - Dealing with Missing Values, Standardizing Data.	**12**
Unit –3	Dimensionality Reduction Techniques: Dimensionality Reduction, Independent and Dependent Variables, Relationship between Variables: Correlation, Multicollinearity, Factor Analysis - Eigen Value, Scree Plot, Unrotated Factor Matrix, Rotated Factor Matrix Types of Machine Learning Algorithms: Introduction, Supervised and Unsupervised Learning Algorithms, Supervised Learning	**11**

	Algorithm-Regression & Classification, Unsupervised Learning Algorithm-Clustering & Association Rule Mining	
Unit –4	Text Analytics: Introduction, Unstructured Data, Word Cloud, Sentiment Analysis, Web and Social Media Analytics Supervised Learning Algorithms – Linear and Logistic Regression: Introduction, Simple Linear Regression - Building Simple Linear Regression, Interpretation of Simple Linear Regression Coefficients, Validation of Simple Linear Regression, Multiple Linear Regression - Dummy Variables in Regression, Interpretation of Multiple Linear Regression Coefficients, Coefficient of Determination, Model Performance Measures.	**11**
Pedagogy	Interactive Teaching, Critical Thinking, Reflective Learning	
References/ Readings:	**TEXTBOOKS:** 1. Introduction to Data Science: Practical Approach with R and Python, B. Uma Maheswari and R. Sujatha, 1st Edition, Wiley India, 2021. ISBN: 978-9354640506 2. Doing Data Science, Cathy O'Neil and Rachel Schutt – 1st Edition, O'Reilly Media, 2013. ISBN: 978-1449358655 **REFERENCES:** 1. Data Science from Scratch - First Principles with Python, Joel Grus, O'Reilly Media, 1st Edition, 2015. ISBN: 1492041130 2. Practical Statistics for Data Scientists, Peter Bruce & Andrew Bruce, O'Reilly Media, 2nd Edition, 2020. ISBN: 149207294X	
Course Outcomes:	**After taking this course, the students will be able to:** CO 1. Explain core Data Science concepts, analytics types, and the Data Science lifecycle. CO 2. Apply Python and its libraries to preprocess data and perform exploratory data analysis. CO 3. Analyze relationships among variables and apply dimensionality reduction techniques. CO 4. Build and evaluate basic regression and classification models for predictive analytics.	

Name of the Programme : **Computer Engineering (Artificial Intelligence and Machine Learning)**

Course Code : **CMP-382**

Title of the course : **Data Science and Analytics Lab**

Number of Credits : **1(1P)**

Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic mathematics for AI/ML and programming skills in Python.	
Course Objectives:	**This course will enable students:** 1. To provide hands-on experience in Python programming and data analysis libraries for data science applications. 2. To train students in data preprocessing, cleaning, transformation, and exploratory data analysis using real datasets. 3. To enable practical understanding of machine learning techniques through implementation of regression, classification, and clustering models. 4. To expose students to text analytics and sentiment analysis using unstructured data sources.	
Contents	**List of Experiments**	**No of Hours**
	1. To perform data profiling and assess data quality by identifying missing, inconsistent, and incorrect data. 2. To apply data cleaning techniques for handling missing values and duplicate records. 3. To perform exploratory data analysis (EDA) using statistical summaries and visualizations. 4. To identify and treat outliers using statistical and graphical methods. 5. To apply data transformation and feature scaling techniques such as normalization and standardization. 6. To analyze relationships among variables using covariance and correlation measures. 7. To develop and evaluate regression models for prediction using Python. 8. To build and evaluate classification models using appropriate performance metrics. 9. To perform dimensionality reduction using Factor Analysis and interpret eigen values and scree plots. 10. To implement clustering techniques and analyze cluster quality using suitable metrics.	**30**
Pedagogy:	Constructive, collaborative and experimental	

References/ Readings:	**TEXTBOOKS:** 1. Introduction to Data Science: Practical Approach with R and Python, B. Uma Maheswari and R. Sujatha, 1st Edition, Wiley India, 2021. ISBN: 978-9354640506 2. Doing Data Science, Cathy O'Neil and Rachel Schutt – 1st Edition, O'Reilly Media, 2013. ISBN: 978-1449358655 **REFERENCES:** 1. Data Science from Scratch - First Principles with Python, Joel Grus, O'Reilly Media, 1st Edition, 2015. ISBN: 1492041130 2. Practical Statistics for Data Scientists, Peter Bruce & Andrew Bruce, O'Reilly Media, 2nd Edition, 2020. ISBN: 149207294X
Course Outcomes:	At the end of the course, students will be able to: CO 1. Implement Python programs using NumPy, Pandas, and visualization libraries for data analysis tasks. CO 2. Perform data preprocessing, exploratory data analysis, and outlier treatment on real-world datasets. CO 3. Develop and evaluate machine learning models including regression, classification, clustering, and dimensionality reduction techniques. CO 4. Apply basic text analytics and sentiment analysis techniques to extract insights from unstructured data.

Semester VI

Name of the Programme : **Computer Engineering (Artificial Intelligence and Machine Learning)**

Course code : **CMP-383**

Title of the Course : **Neural Networks and Deep Learning**

Number of Credits : **3 (3L)**

Effective from AY : **2024-25**

Pre-requisites for the Course:	Linear Algebra, Machine Learning	
Course Objectives:	**This course will enable students to:** 1. Understanding of neural network architectures, learning mechanisms, and activation functions. 2. Gain knowledge on multilayer neural networks, unsupervised learning algorithms, and associative memories. 3. Design and train deep learning models. 4. Develop a clear understanding of deep generative models, attention mechanisms, and transformer architectures.	
Units	**Contents:**	**No of Hours**
Unit-1	**Introduction:** Introduction to neural networks, structure of biological neuron, McCulloch Pitts neuron model, Logic network realization by using McCulloch Pitts neuron model, Neuron modelling for artificial neuron systems, Neural learning. **Single-layer network:** Concept of linear separability and non-linear separability. Training rules- Hebbian learning rule, perceptron learning rule, Delta learning rule, Widrow-Hoff learning rule and related problems. **Multilayer network:** Error back propagation algorithm or generalized delta rule.	**11**
Unit-2	**Multilayer network** Setting of parameter values and design considerations (Initialization of weights, Frequency of weight updates, Choice of learning rate, Momentum, Generalizability, Network size, Sample size, Non-numeric inputs), performance evaluation. **Unsupervised learning**: Clustering, simple competitive learning algorithm, LVQ algorithm, SOM, Adaptive Resonance Theory. **Associative memories:** Hopfield networks, Brain-state-in-a-box network, and problems.	**11**
	Deep Neural Networks: Introduction & Necessity of deep neural networks (DNN), Autoencoder and its types.	**11**

Unit-3	**Convolutional Networks:** The Convolution Operation - Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features - Xception, ResNeXt, MobileNetV3, EfficientNet. **Recurrent Neural Networks:** Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks	
Unit-4	**Recursive Neural Networks:** The Long Short-Term Memory and Other Gated RNNs. **Deep Generative Models:** Deep Belief Networks, Boltzmann Machines, Deep Boltzmann Machine, Generative Adversarial Networks. Attention: Limitations of RNN-based models, Attention Mechanism **Transformer: Self-Attention, Multi-Head Attention,** Positional Encoding, Transformer Encoder and Decoder, BERT, GPT	**12**
Pedagogy:	Experiential Learning	
References/ Readings:	**Text Books** 1. K. Mehrotra, C. K. Mohan, and S. Ranka, *Elements of Artificial Neural Networks*, 2nd ed. Mumbai, India: Penram International, 2009, ISBN 978-8187972204. 2. J. M. Zurada, Introduction to Artificial Neural Systems, 2nd ed., Jaico Publishing House, 2002., ISBN-10: 81-7224-650-1. 3. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016, ISBN 978-0-262-03561-3. **Reference Books** 1. A. Zhang, Z. C. Lipton, M. Li and A. J. Smola, Dive into Deep Learning. Cambridge, UK: Cambridge University Press, 2020. ISBN 978-1-009-38943-3. 2. Satish Kumar, Neural networks: a classroom approach, Second Edition, Tata McGraw-Hill. 3. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer International Publishing AG, ISBN 978-3-319-94462-3, 2018	
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Describe the fundamental concepts, architectures, and learning mechanisms of neural networks. CO 2. Design and implement deep learning models. CO 3. Apply neural network techniques to areas such as computer vision, natural language processing, and data analytics. CO 4. Analyze the working principles and applications of attention-based and transformer models in various AI tasks.	

Name of the Programme : **Computer Engineering (Artificial Intelligence and Machine Learning)**

Course code : **CMP-384**

Title of the course : **Neural Networks and Deep Learning Lab**

Number of Credits : **1(1P)**

Effective from AY : **2024-25**

Pre-requisites for the Course:	Linear Algebra, Machine Learning	
Course Objectives:	**This course will enable students to:** 1. Understanding of tools and frameworks like Python, TensorFlow, and PyTorch for deep learning experiments 2. Provide hands-on experience in designing and implementing neural network models. 3. Develop practical skills in training and evaluating deep learning architectures such as CNNs, RNNs, and autoencoders. 4. Apply neural network techniques to real-world datasets and problems.	
Contents	**List of Programs**	**No of Hours**
	1. Study of different libraries for ANN and DNN. 2. Design of logic gates using a neural network. 3. Implementation of the Perceptron learning rule. 4. Implementation of classifier using EBPA. 5. Implementation of clustering using SCL. 6. Design of associative memory using the Hopfield network. 7. Implementation of Autoencoders. 8. Implementation of Convolutional Neural Networks for an application. 9. Implementation of Recurrent and Recursive Neural Networks. 10. Case study on Attention and Transformers like BERT, GPT.	**30**
Pedagogy:	Constructive, collaborative and experimental	
References/ Readings:	**Text Books** 1. K. Mehrotra, C. K. Mohan, and S. Ranka, *Elements of Artificial Neural Networks*, 2nd ed. Mumbai, India: Penram International, 2009, ISBN 978-8187972204. 2. J. M. Zurada, Introduction to Artificial Neural Systems, 2nd ed., Jaico Publishing House, 2002., ISBN-10: 81-7224-650-1. 3. I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*. Cambridge, MA, USA: MIT Press, 2016, ISBN 978-0-262-03561-3.	

	Reference Books 1. A. Zhang, Z. C. Lipton, M. Li and A. J. Smola, Dive into Deep Learning. Cambridge, UK: Cambridge University Press, 2020. ISBN 978-1-009-38943-3. 2. Satish Kumar, Neural networks: a classroom approach, Second Edition, Tata McGraw-Hill. 3. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer International Publishing AG, ISBN 978-3-319-94462-3, 2018
Course Outcomes:	**After going through this course, the students will be able to:** CO 1. Demonstrate proficiency in using deep learning frameworks and libraries for practical model development and experimentation. CO 2. Implement and test various neural network architectures for supervised and unsupervised learning tasks. CO 3. Apply deep learning techniques to solve practical problems in areas like image recognition, NLP, and time-series analysis. CO 4. Analyze and evaluate the performance of models, optimizing hyperparameters and addressing issues like overfitting.

Semester VII

Name of the Programme : **Computer Engineering (Artificial Intelligence and Machine Learning)**
Course code : **CMP-481**
Title of the Course : **Applications of Artificial Intelligence**
Number of Credits : **3 (3L)**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Basic programming skills in Python and introductory knowledge of Data Science, Machine Learning, and Neural Networks.	
Course Objectives:	**This course will enable students to:** 1. Introduce the fundamental concepts of Artificial Intelligence, Machine Learning, Neural Networks, and programming foundations used in AI systems. 2. Explain the basic principles and applications of Natural Language Processing and language-based AI systems. 3. Develop understanding of image formation, image filtering, and feature-based recognition techniques. 4. Provide conceptual knowledge of motion estimation, optical flow, and video analysis methods for real-world applications.	
Contents:	**Topics**	**No of Hours**
Unit – 1	Introduction to Artificial Intelligence, Machine Learning, Neural Networks, and Deep Learning. Programming Languages for AI: Role of Programming Languages in AI, Python Programming Language. Python Libraries for AI: NumPy, Pandas, Matplotlib	**11**
Unit –2	Introduction to Natural Language Processing: Text Processing, Tokenization, Stop Words Removal, Stemming and Lemmatization. NLP Applications: Text Classification, Sentiment Analysis, Information Extraction. Prompt-Based Interaction with Language Models: Interaction with Language Models, Prompt-based Querying	**12**
Unit –3	**Image Formation:** Image Formation Process**,** Digital Image Representation. **Image Filtering:** Linear Filtering**,** Non-linear Filtering**. Feature Detection and Description:** Feature Detection, Feature Descriptors. **Recognition:** Object Recognition**,** Image Classification	**11**
Unit –4	**Motion Models:** Motion Representation**,** Parametric Motion Models. **Optical Flow:** Optical Flow Estimation, Applications of Optical Flow. **Video Analysis:** Motion Detection, Tracking**. Applications of Video Processing:** Surveillance, Activity Recognition	**11**

Pedagogy	Interactive Teaching, Critical Thinking, Reflective Learning
References/ Readings:	**Text Books** 1. Reema Thareja, **Artificial Intelligence: Beyond Classical AI**, Oxford / Pearson, 2024. ISBN: 978-9357053778 2. Richard Szeliski, **Computer Vision: Algorithms and Applications**, Springer, 2022. ISBN: 978-3030343712 **Reference Books** 1. Ian Goodfellow, Yoshua Bengio & Aaron Courville, Deep Learning, MIT Press, 2024. ISBN: 9780262035613 2. Shukla, A., Tiwari, R., Kala, R. Real Life Applications of Soft Computing. United States: CRC Press, 2010. ISBN: 9781439822890 3. Sebastian Raschka & Vahid Mirjalili, *Python Machine Learning*, Packt Publishing, 2017. ISBN: 9781787126022 4. Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson, 2018. ISBN: 978-9353062989
Course Outcomes:	**After taking this course, the students will be able to:** CO 1. Explain the basic concepts of Artificial Intelligence, Machine Learning, Neural Networks, and Python-based AI tools. CO 2. Explain the principles of Natural Language Processing and its applications in language-based systems. CO 3. Analyze image formation, image filtering, and feature detection techniques used in image-based recognition systems. CO 4. Analyze motion models, optical flow, and video analysis techniques used in video processing applications.

Name of the Programme : **Computer Engineering (Artificial Intelligence and Machine Learning)**

Course code : **CMP-482**

Title of the course : **Applications of Artificial Intelligence Lab**

Number of Credits : **1(1P)**

Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic programming skills in Python and introductory knowledge of Data Science, Machine Learning, and Neural Networks.	
Course Objectives:	**This course will enable students to:** 1. Enable students to use Python programming and standard libraries for basic AI-related tasks. 2. Provide hands-on experience with Natural Language Processing techniques using pretrained models. 3. Develop practical understanding of image processing and image-based recognition techniques. 4. Introduce basic video processing and motion analysis techniques through simple implementations	
Contents	**List of Programs**	**No of Hours**
	1. Implement basic Python programming and array operations using NumPy for simple AI-related computations. 2. Implement data handling and visualization using Pandas and Matplotlib on a small sample dataset. 3. Implement text preprocessing techniques (tokenization, stop-word removal, stemming) using NLTK library. 4. Implement sentiment analysis using a pretrained TextBlob / NLTK sentiment analyzer. 5. Implement prompt-based text generation using a pretrained Large Language Model (API or local interface) with different prompts. 6. Implement basic image processing operations such as image reading, grayscale conversion, and filtering using OpenCV. 7. Implement edge detection and feature detection using OpenCV (Canny edge detector / ORB features). 8. Implement image classification using a pretrained CNN model (MobileNet / VGG16) on sample images. 9. Implement basic video processing operations such as video loading, frame extraction, and frame display using OpenCV. 10. Implement motion detection in video using frame differencing or background subtraction technique. ***Note : The dataset to be used and precise tasks to be implemented under each experiment (methodology) can be decided by the faculty in-charge for the practical.***	**30**

Pedagogy:	Constructive, collaborative and experimental
References/ Readings:	**Text Books** 1. McKinney, W**..** Python for data analysis: Data wrangling with pandas, NumPy, and IPython (2nd ed.). O'Reilly Media, 2018 ISBN: 9781491957639, 2. Bird, S., Klein, E., & Loper, E. Natural language processing with Python**.** O'Reilly Media, 2009. ISBN: 9780596555719 3. Rosebrock, A Practical Python and OpenCV. PyImageSearch, 2017. ISBN: B075D6FLFZ (ASIN)
Course Outcomes:	**After taking this course, the students will be able to:** CO 1. Implement Python progr, ams using standard libraries for data handling and basic AI applications. CO 2. Implement Natural Language Processing tasks using pretrained language models and prompt-based interaction. CO 3. Implement image processing and image classification techniques using pretrained models. CO 4. Implement basic video processing and motion detection techniques using standard tools.