**MKSSS's Cummins College of Engineering for Women, Pune**
(An Empowered Autonomous Institute, affiliated to Savitribai Phule Pune University)

# An Autonomous Programmed Structure for
# M. Tech. Electronics and Telecommunication Engineering
# Specialization: Artificial Intelligence (AY: 2024-2025 Onwards)

## First Year | Semester-I

| Course Code | Course Title | Teaching Scheme Hours / Week | | | Cr | Examination Scheme | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | ISE | ESE | Pr/Or | |
| 24PCMEC101 | Mathematics for Artificial Intelligence | 3 | 1 | 0 | 4 | 50 | 50 | 0 | 100 |
| 24PCMEC102 | Artificial Intelligence | 3 | 1 | 0 | 4 | 50 | 50 | 0 | 100 |
| 24PCMEC103 | Machine Learning | 3 | 0 | 0 | 3 | 50 | 50 | 0 | 100 |
| 24PCMEC104 | Optimization Techniques | 3 | 1 | 0 | 4 | 50 | 50 | 0 | 100 |
| 24OEM101 | Open Elective | 3 | 0 | 0 | 3 | 50 | 50 | 0 | 100 |
| 24PCMEC102L | Artificial Intelligence Lab | 0 | 0 | 2 | 1 | 25 | 0 | 25 | 50 |
| 24PCMEC103L | Machine Learning Lab | 0 | 0 | 2 | 1 | 25 | 0 | 25 | 50 |
| | **Total** | **15** | **3** | **4** | **20** | **300** | **250** | **50** | **600** |

## First Year | Semester-II

| Course Code | Course Title | Teaching Scheme Hours / Week | | | Cr | Examination Scheme | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | ISE | ESE | Pr/Or | |
| 24PCMEC201 | Big Data Analytics | 3 | 0 | 0 | 3 | 50 | 50 | 0 | 100 |
| 24PCMEC202 | Deep Learning | 3 | 0 | 0 | 3 | 50 | 50 | 0 | 100 |
| 24PCMEC203 | AI in Wireless Communication | 3 | 1 | 0 | 4 | 50 | 50 | 0 | 100 |
| 24PCMEC204 | Computer Vision | 3 | 1 | 0 | 4 | 50 | 50 | 0 | 100 |
| 24PEMEC201 | Program Elective | 3 | 0 | 0 | 3 | 50 | 50 | 0 | 100 |
| 24PCMEC201L | Data Analytics Lab | 0 | 0 | 2 | 1 | 25 | 0 | 25 | 50 |
| 24PCMEC202L | Deep Learning Lab | 0 | 0 | 2 | 1 | 25 | 0 | 25 | 50 |
| 24PEMEC201L | Program Elective Lab | 0 | 0 | 2 | 1 | 25 | 0 | 25 | 50 |
| | Total = | **15** | **2** | **6** | **20** | **325** | **250** | **75** | **650** |

*L=Lecture, T=Tutorial, P= Practical, Cr= Credits, ISE =In Semester Evaluation, ESE =End Semester Examination, Pr/Or = Practical/Oral*

Program Elective: -

1. 24PEMEC201A Natural Language Processing
2. 24PEMEC201B Soft Computing

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# Curriculum for PG Degree Course in M. Tech.
# Electronics and Telecommunication Engineering

(Academic Year: 2024-25 Onwards)

## Second Year | Semester-I

| Course Code | Course Title | Teaching Scheme Hours / Week | | | Cr | Examination Scheme | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | ISE | ESE | Pr/Or | |
| 24VSECMME301 | Skill Enhancement Course# | 4 | 0 | 0 | 4 | 50 | 50 | - | 100 |
| 24INTRM301 | Internship based project | -- | -- | 12* Weeks | 16 | 100 | - | 100 | 200 |
| | Total = | 4 | 0 | 0 | 20 | 150 | 50 | 100 | 300 |

- This course can be learned in online self-learning mode *[of Min. 8 weeks duration & available on NPTEL platform]* #
- Minimum duration for Internship 12 weeks *

## Second Year | Semester-II

| Course Code | Course Title | Teaching Scheme Hours / Week | | | Cr | Examination Scheme | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | L | T | P | | ISE | ESE | Pr/Or | |
| 24VSECMME401 | Technical / Research Report / Paper writing | 4 | 0 | 0 | 4 | 50 | 50 | - | 100 |
| 24INTRM401 | Internship based project | -- | -- | 14* Weeks | 16 | 100 | - | 100 | 200 |
| | Total = | 4 | 0 | 0 | 20 | 150 | 50 | 100 | 300 |

- Minimum duration for Internship 14 weeks *
- *L=Lecture, T=Tutorial, P= Practical, Cr= Credits, ISE =In Semester Evaluation, ESE =End Semester Examination, Pr/Or = Practical/Oral*

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# 24PCMEC101 Mathematics for Artificial Intelligence

**Teaching Scheme**
Lectures: 3 Hours / Week
Tutorial: 1 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 4**

**Prerequisite:** First course in Engineering Mathematics

**Course Objectives:**

1. To interpret the types and operations on matrices and various methods of solving systems of linear equations
2. To recognize the concepts of vector space, linear independence, basis, dimension and its applications
3. To explore probability to analyze and test data
4. To explore statistical methods to analyze and test data
5. To learn multivariate calculus

**Course Outcomes:**

After completion of the course, students will be able to

CO1 Determine and analyze transformations of matrices and apply multiple methods to solve the systems of linear equations
CO2 Apply and analyze the concepts of vector space and subspace
CO3 Apply probability and Statistical methods for Data Analysis
CO4 Apply multivariate calculus to solve given problems

**Unit I: Linear Algebra**

Matrices and Tensors, Basics of Matrix Algebra, Special Matrices and Properties, Determination of rank of a matrix, Low Rank Approximations, Least square approximations, determination of solution of linear equations using matrix method, QR and LU decomposition, Tensor-Flow operations.

**Unit II: Vector Spaces**

Vector Space, sub-space, basis and dimension, Linear dependence and independence of vectors, orthogonality, Orthogonal Projections, Gram-Schmidt orthogonalization Procedure, Eigenvalues and Eigenvectors, Principal Component Analysis (PCA), Singular Value Decomposition (SVD)

**Unit III: Probability and Random Variables**

Review of Probability, joint probability and covariance, Bayes theorem, Maximum Likelihood, Estimation (MLE), Maximum A Posteriori estimation (MAP), Random variables, variance, expectation, Probability density function, Cumulative distribution function, standard probability density functions, probability distributions.

**Unit IV: Multivariate Calculus**

Basic concepts of differential and integral Calculus, gradient descent, Jacobian and Hessian approach, Lagrange's multiplier method

**Reference Books:**

1. Howard A, Chris R**, "Elementary Linear Algebra Applications Version",** *Wiley-India,* (10th Edition), (2016).
2. Gilbert Strang**, "Linear Algebra and its Applications",** 4th Ed., 2008 (10th Indian reprint), Cengage Learning, (2011).
3. P. Z. Peebles**, "**Probability, Random Variables and Random Signal Principle**",** *Tata McGraw-Hill*, (4th Edition), (2013).
4. David C. Lay**, "Linear Algebra and Its Application",***Pearson Education*, (3rd Edition), (2002).
5. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong**, "Mathematics for Machine Learning",** *Cambridge University Press*, (1st Edition), (2020)
6. Seymour Lipschutz, Marc Lars Lipson**, "Linear Algebra",** *Schaum's Outline, McGraw-Hill*, (4th Edition)
7. S. M. Ross, '**Introduction to Probability and Statistics for Engineers and Scientists**', *Academic Press*, (3rd Edition), (2005)

**Online Resources:**

1. NPTEL Course **"Essential Mathematics for Machine Learning"**
   https://onlinecourses.nptel.ac.in/noc21_ma38/preview

2. NPTEL Course **"Applied Linear Algebra in AI and ML"**
   https://onlinecourses.nptel.ac.in/noc23_ma31/preview

# 24PCMEC102 Artificial Intelligence

**Teaching Scheme**
Lectures: 3 Hours / Week
Tutorial: 1 Hours/ Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 4**

**Prerequisite:** Basics of calculus

**Course Objectives:**

1. To explain the basics of Artificial Intelligence (AI)
2. To introduce various types of algorithms useful in AI
3. To explain the types of reasoning
4. To explain the concept of cloud and integration of cloud with AI

**Course Outcomes:**

After completion of the course, students will be able to

**CO Statement:**

CO1. Explain the components of intelligent agents
CO2. Apply knowledge representation techniques and problem-solving strategies to AI applications
CO3. Analyze the search and learning algorithm
CO4. Design and explain the expert systems for real world applications

## Unit I: Basics of AI, Problem Solving and Search Algorithms

Categories of AI, Applications of AI, turing test, Types of agents, Nature of environment, Properties of task environment

Problem Solving by searching: Problem solving agents, toy problems, 8 puzzle problem, 8 queens problem and water jug problem. Searching for solutions, Measuring problem-solving performance uninformed search strategies, Breadth first search, Depth First search, depth limited and iterative deepening depth first search algorithms, bidirectional search algorithm, Informed (heuristic) search strategies, Greedy Best First search, A* search, Memory-bounded heuristic search, local search algorithms and optimistic problems, hill climbing search algorithm, optimal decisions in games, MINIMAX algorithm, Alpha Beta Pruning, Constraint satisfaction problems (CSP)

## Unit II: Knowledge Based Agents

Knowledge-Based Agents, Logic, Propositional logic, inferences and proofs, Horn clauses and definite clauses, Forward and backward chaining, First order logic, syntax and semantics of first-order logic, knowledge engineering in first-order logic, inference in first order logic, propositional vs. first-order inference, unification and lifting, forward and backward chaining, Resolution , Conjunctive normal form for first-order logic, uncertain knowledge and reasoning, uncertainty and methods, Bayes rule and its use, representing knowledge in an uncertain domain, bayesian network.

## Unit III: Reasoning and Learning

Types of Reasoning, inductive and deductive reasoning, Non-monotonic Inference Methods Non-monotonic Reasoning, Truth Maintenance Systems, Case-based Reasoning Systems, Model-based Reasoning Systems, Rule-based Reasoning, Diagnosis Reasoning, Reasoning with Fuzzy Logic, Fuzzy Sets, Fuzzy Reasoning, Fuzzy Systems, Fuzzy Neural Systems Learning from examples: Supervised learning, decision tree learning, ensemble learning Association Learning: Hidden Markov Models, Apriori Algorithm, Eclat Algorithm.

**Unit IV: Expert systems and Ethics for AI**

Introduction to Expert System, Architecture and functionality, Examples of Expert system, Basic steps of pattern recognition system, Object Recognition- Template Matching theory, Prototype Matching Theory, Pattern Mining.

Ethics of AI : Privacy and Surveillance, Manipulation of Behavior, Opacity of AI Systems, Bias in Decision Systems, Human-Robot Interaction, Automation and Employment, Autonomous Systems, Machine Ethics, Artificial Moral Agents Privacy

**Reference Books:**

1. Nils J. Nilsson, **"Artificial Intelligence: A new Synthesis"**, *Morgan Kaufmann Publishers,* (1st Edition), (1998).
2. George F. Luger, **"Artificial Intelligence: Structures and Strategies for Complex Problem Solving ",** *Pearson Education***,** (6th Edition), (2008).
3. Mike Loukides, Hilary Mason, and DJ Patil, "**Ethics and Data Science**", O'reilly Media Inc., (1st Edition) (2024).
4. Stuart Russell, Peter Norvig, **'Artificial Intelligence", A Modern Approach '**, *Pearson Education/Prentice Hall of India,* (3rd Edition), (2010)
5. Deepak Khemani , "**A First Course in Artificial Intelligence** ", *McGraw Hill Publication*, (1st edition) (2008).
6. Paula Boddington**, "Towards a Code of Ethics for Artificial Intelligence",** *Springer international Publishing***,** (1st Edition), (2017).

**Online Resources:**

1. NPTEL Lectures on AI : http://nptel.ac.in/courses/106105077/
2. https://plato.stanford.edu/entries/ethics-ai/

# 24PCMEC103 Machine Learning

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisites:** Linear Algebra, Probability, Programming skills

**Course Objectives:**
1. To learn machine learning paradigms used for regression and classification
2. To examine various machine learning algorithms
3. To use software tools for the implementation of machine learning algorithms

**Course Outcomes:**
After completion of the course, students will be able to
CO1 Illustrate the use of modern tools for data analysis and implementing machine learning models.
CO2 Apply data visualization methods for interpretation and feature selection.
CO3 Select machine learning models for classification, clustering and prediction problems.
CO4 Apply various dimensionality reduction methods to extract important features.
CO5 Analyze the performance of various machine learning techniques.

**Unit I: Foundations of Machine Learning**

Key aspects of Machine Learning (ML) problems, Designing a learning system, Machine learning applications across different industries, Types of Machine learning, Basic concepts and terminology in machine learning- Parametric and non-parametric methods, Overfitting and Underfitting, Bias and Variance, Optimization and Cost function, Performance measures, Explainability and Interpretability in ML, Machine learning tools and libraries.

**Unit II: Data Analysis and Interpretation**

Machine learning pipeline, Feature Engineering, Data types- numerical and categorical, Data wrangling- filtering, pre-processing, typecasting, transformation, feature selection, Data visualization- Descriptive statistics, Frequency tables, Creating graphs, Data analysis- Univariate and Bivariate analysis, Statistical methods- Central tendencies and variance, Boxplot, Outliers, Introduction to Data Engineering.

**Unit III: Supervised Machine Learning**

Two-class and Multiclass learning problems, Regression- linear and logistic, Model selection and generalization, Outlier detection, Cross-validation, Classification: k-Nearest Neighbour algorithm, Support Vector Machines, Decision trees, Random Forests, Naïve Bayes classifier, Neural Networks, Ensemble learning, Applications of regression and classification in finance, e-commerce, healthcare.

**Unit IV: Unsupervised Machine Learning**

Dimensionality reduction- Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Clustering: k-Means, Mean-shift, Hierarchical Clustering, Expectation–Maximization (EM), Gaussian Mixture Models (GMM), Applications of clustering- Predictive analysis in

Automotive, Healthcare.

**Unit V: Building Machine Learning Applications**

Introduction to Web ML, Machine Learning Models for Web Applications, Deploying ML Models on the Web (Streamlit/Flask/Django frameworks), Cloud services- GCP, AWS, Cloud ML and Edge ML implementation case studies.

**Text Books:**

1. Andreas C. Miller and Sarah Guido, **'Introduction to Machine Learning with Python- A Guide for Data Scientists'**, *O'Reilly Media*, (1st Edition), (2017).
2. Aurélien Géron, **'Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems'**, *O'Reilly Media*; (2nd Edition), (2019).

**Reference Books:**

1. Christopher Bishop, **Pattern Recognition and Machine Learning**, *Springer*, (1st Edition), (2007).
2. Tom Mitchell, **'Machine Learning'**, *McGraw Hill Education Ltd.*, (1st Edition), (2013)
3. Michael Bowles, **'Machine Learning in Python: Essential Techniques for Predictive Analysis'**, *John Wiley & Sons, Inc.*, (1st Edition), (2015).
4. Chris Albon, **'Machine Learning with Python Cookbook'**, *O'Reilly Media, Inc.,* (1st Edition), (2018).
5. Pramod Singh, **'Deploy Machine Learning Models to Production: With Flask, Streamlit, Docker, and Kubernetes on Google Cloud Platform'**, *Apress India*, (1st Edition), (2022).

**Online Resources:**

1. NPTEL Course on "**Introduction to Machine Learning**" https://onlinecourses.nptel.ac.in/noc21_cs85/preview
2. NPTEL Course on **"Machine Learning And Deep Learning - Fundamentals And Applications"** https://onlinecourses.nptel.ac.in/noc23_ee87/preview

# 24PCMEC104 Optimization Techniques

**Teaching Scheme**
Lectures: 3 Hours / Week
Tutorial: 1 Hour/Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 4**

**Prerequisite:** A understanding of vector calculus along with Python programming language

**Course Objectives:**

1. To understand the basics of optimization techniques and problem formulation for optimization
2. To understand one-dimensional Optimization Algorithms
3. To understand solution techniques for unconstrained optimization problems with multiple Variables
4. To understand linear programming to perform optimization
5. To understand Guided Random Search Methods and it's solution techniques based on random searches in locating the optima

**Course Outcomes:**
After completion of the course, students will be able to

CO1. Interpret the necessary and sufficient condition for optimization
CO2. Formulate the optimization problem
CO3. Solve optimization problems for various applications
CO4. Analyze solutions for optimization problems

**Unit I: Introduction**
Optimization Problem, Modeling of the Optimization Problem, Solution with the Graphical Method, Convexity, Gradient Vector, Directional Derivative, Hessian Matrix, Linear and Quadratic Approximations.

**Unit II: Optimization Algorithms**
Introduction, Solution Techniques, Bisection Method, Newton–Raphson Method, Secant Method, Cubic Polynomial Fit, Golden Section Method.

**Unit III: Unconstrained Optimization**
Unidirectional Search, Solution Techniques, Steepest Descent Method, Newton's Method, Modified Newton's Method, Levenberg–Marquardt Method, Powell Method.

**Unit IV: Linear Programming**
Introduction, Solution with the Graphical Method, Standard Form of an LPP, Basic Solution, Simplex Method - Multiple Solutions, Degeneracy, Interior-Point Method, Portfolio Optimization.

**Unit V: Guided Random Search Methods**
Introduction, Genetic Algorithms - Initialize Population, Fitness Evaluation, Reproduction, Crossover and Mutation, Multimodal Test Functions, Particle Swarm Optimization, Ant Colony Optimization.

**Reference Books:**

1. Rajesh Kumar Arora, **'Optimization: Algorithms and Applications'**, *CRC Press Taylor & Francis Group, New York,* (1st Edition), (2015)
2. Rao.S.S., **'Engineering Optimization Theory and Practice'**, *A Wiley Interscience Publication, Canada*, (4th Edition), (2009)
3. Reklaitis, G.V., A. Ravindran, and K.M. Ragsdell, **'Engineering Optimization: Methods and Applications'**, *John Wiley, New York*, (2nd Edition), (2006)

**Online Resources:**

1. NPTEL Course "**Optimization"**
   https://archive.nptel.ac.in/courses/111/105/111105039/

# 24PCMEC201 Big Data Analytics

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Course Objectives:**

1. To understand the concepts, challenges and techniques of Big Data and Big Data Analytics
2. To introduce the concepts of Hadoop, Map Reduce framework, "R" for Big Data Analytic along with software like MS EXCEL / Tableau / Power BI
3. To teach students to apply data analytics life cycle for real world applications

**Course Outcomes:**
After completion of the course, students will be able to

**CO Statement:**

CO1. Explain and compare structured, unstructured data and Big data
CO2. Identify and Explain Hadoop and its ecosystem
CO3. Describe and design real world application using data analytics lifecycle
CO4. Apply Big Data Analytics tools for data analysis and visualization
CO5 Explain the basics of cloud and its integration with big data

## Unit I: Data and its types

Database Management Systems, structured data, SQL, Big data overview, characteristics of Big Data, applications of Big Data, Unstructured data, NOSQL, advantages of NOSQL, Comparative study of SQL and NOSQL.

## Unit II: Big Data Architecture, Hadoop and ecosystem

Challenges enabling real time big data processing, Hadoop – Introduction, building blocks of hadoop, Installing and configuring Hadoop. Map Reduce Working, the Mapper and Reducer, and Output Formats, Introduction to Hive HBASE, Sqoop, Spark, Mahot.

## Unit III: Data Analytics lifecycle

Data Analytical architecture, drivers of Big Data, Emerging Big Data Ecosystem and new approach, Data Analytic Life Cycle: Discovery, Data preparation, Model planning, Model Building, communicate results, Operationalize, Case Study: Global Innovation Network and Analysis (GINA).

## Unit IV: Data analysis and Visualization tools

R Programming: R Fundamentals: Math, variables, strings, vectors, factors, vector operations, Data structures in R: Arrays and amp, Matrices, lists, data frames, R programming fundamentals: Conditions and loops, functions in R, Objects and Classes, working with data in R: Reading CSV and Excel files, reading text files, writing and saving data objects to file in R.
Data analysis and visualization using software like MS Excel / Tableau / PowerBI

## Unit V: Integrating Big Data with cloud:

Introduction to Cloud Computing: Cloud service models (IaaS, PaaS, SaaS), Cloud deployment models (public, private, hybrid), Cloud Infrastructure: Virtualization and containerization, Storage and networking in the cloud, Benefits of integrating cloud computing with big data, Technologies

and tools for implementing architectures: AWS, Google Cloud Platform, Azure, etc. Storing big data in the cloud: data lakes, data warehouses, etc. Data management techniques: data governance, data security, data integration, etc. Tools for managing and accessing big data in the cloud, Processing big data in the cloud: batch processing, real-time processing, stream processing, etc., Security challenges in cloud-based big data environments: data breaches, unauthorized access, etc., Security measures and best practices for securing cloud-based big data solutions.

**Reference Books:**

1. Vignesh Prajapati, "**Big Data Analytics with R and Hadoop**", *Packt Publishing*, (1st Edition), (November 2013)
2. "**Data Science and Big Data Analytics**", *Wiley*, (1st Edition), (January 2015)
3. Abraham Silberschatz, Henry Korth, S. Sudarshan, "**Database Systems Concepts**", *McGraw Hill Education (India) Pvt Ltd,* (6th Edition), (December 2013)
4. Dr. Vijay Kumar Sharma, Jyoti Khandelwal, Tarun Jain, Jaya Krishna R and Horesh Kumar , "**Artificial Intelligence and Cloud Computing Basics"**, Rubicon Publications, (1st Edition), (2020).
5. Viktor Mayer-Schonberger, Kenneth Cukier, "**Big Data: A Revolution that will transform how we live, work, and think**", *Hodder and Stoughton*, (October 2013)
6. J. Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, "**Big Data for Dummies**", *John Wiley & Sons, Inc.* (1st Edition), (April 2013)
7. Tom White, "**Hadoop: The Definitive Guide**", *O'Reilly*, (3rd Edition), (June 2012)

# 24PCMEC202 Deep Learning

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** Students should have experience working with and/or knowledge of the following topics: • Derivatives • Numpy, Pandas, Google Colab, Jupyter notebooks

**Course Objectives:**
1. To learn basics of neural networks and deep learning
2. To understand training of deep neural networks and L-layers
3. To introduce various CNN and RNN architectures/Models

**Course Outcomes:**
After completion of the course, students will be able to
CO1. Explain basic concepts of neural networks and its learning algorithms
CO2. Calculate feature map dimensions and learnable parameters in Convolutional Neural Network (CNN)
CO3. Solve image recognition and classification problems using pre-trained CNN architectures
CO4. Solve image segmentation, object detection problems using Autoencoders
CO5. Compare recurrent neural networks, their types for sequence data processing and explain gradient issues
CO6. Design deep neural network architectures to solve real-world problems

**Unit I: Artificial Neural Networks/Introduction to Deep learning** **(12)**

Neural Networks-Perceptron Theory, Activation functions, Minimizing the Error Function with Gradient Descent, Training Neural Networks, loss function, optimization method, overfitting and underfitting problem, Optimize the training process using early stopping, regularization, dropout, learning rate decay, and momentum. Distinguish between batch and stochastic gradient descent. Deep learning frameworks (Keras, TensorFlow, PyTorch, Caffe, Theano), Tensor representation, Building neural network architecture using TensorFlow, Role of GPU in deep learning.

**Unit II: Convolutional Neural Network** **(11)**

limitations of MLPs for images, basic concepts of CNNs that make them great at tasks involving images, build a CNN from scratch, classify images using a CNN, the performance Improve parameters of CNN, Transfer Learning, key CNN architectures and their innovations. Apply multiple ways of adapting pre-trained networks using transfer learning, Fine-tune a pre-trained network on a new dataset.

**Unit III: Autoencoders** **(09)**

Understand linear and CNN-based autoencoders. Design and train a autoencoder for anomaly detection and image denoising, Object Detection and Segmentation, Understand the architecture of an object detection model. Train and evaluate an object detection model. Understand the architecture of a semantic segmentation model. Train and evaluate a semantic segmentation model.

**Unit IV: Recurrent Neural Networks** **(10)**

Recurrent Neural Network, perform backpropagation on an RNN, Fine tune RNN models using hyperparameters, limitations of simple RNNs, Long short term memory networks (LSTMs) and GRU, Applications like Machine translation, NLP, Introduction to GAN

**Reference Books:**

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, 'Deep Learning', MIT Press, (1st Edition), (2016)
2. Francois Chollet, 'Deep Learning with Python', Manning Publications, (1 st Edition), (2018)
3. Phil Kim, 'MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence', Apress, (1 st Edition), (2017)
4 Josh Patterson and Adam Gibson, 'Deep Learning- A Practitioner's Approach', O'Reilly Media, (1 st Edition), (2017)
5 Laurene Fausett, 'Fundamentals of Neural Networks: Architectures, Algorithms and applications', Pearson Education, (1 st Edition), (2008)

**Online Resources:**

1. NPTEL Course "**Deep Learning" by Prof. Prabir Kumar Biswas IIT Kharagpur**
https://onlinecourses.nptel.ac.in/noc20_cs11/course

# 24PCMEC203 Artificial Intelligence in Wireless Communications

**Teaching Scheme**
Lectures: 3 Hours / Week
Tutorial: 1 Hour/Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 4**

**Prerequisite:** Digital Communication

**Course Objectives:**

1. To understand the cognitive radio systems in wireless communication
2. To understand artificial intelligence techniques applied in wireless communications
3. To understand the functions of the software-defined radio
4. To understand the multi-objective optimization of Radio Resources

**Course Outcomes:**

After completion of the course, students will be able to

CO1. Describe Cognitive radio architecture, Cognitive engine design, and its components
CO2. Discuss artificial intelligence techniques applied in Wireless Communications
CO3. Interpret basics of Software Defined Radio
CO4. Analyze multi-objective Optimization of Radio Resources

**Unit I: Cognitive Radio and the Cognitive Engine**

Concept of Cognitive Radio, Cognitive Radio history, The Cognitive Engine: Cognitive Radio, Radio Design, Cognitive Engine Design, Component Descriptions – Sensors, Optimizer, Decision Maker, Policy Engine, Radio Framework, User Interface, Cognitive Controller Configuration.

**Unit II: Artificial Intelligence for Wireless Communications**

Artificial Intelligence Techniques- Neural Networks, Hidden Markov Models (HMM), Fuzzy Logic, , Evolutionary Algorithms, Case-Based Reasoning

**Unit III: Overview and Basics of Software-Defined Radios (SDR)**

Background, Benefits of Using SDR, Problems Faced by SDR, GNU Radio Design - The Universal Software Radio Peripheral, The USRP Version 2, Flow Graphs, Parallel Programming in GNU Radio, Flow Graph for Simulation and Experimentation.

**Unit IV: Optimization of Radio Resources**

Objective Space, Multi-objective Optimization: Objective Functions, Bit Error Rate (BER), Bandwidth, Spectral Efficiency, Interference, Signal to Interference Plus Noise Ratio (SINR), Throughput, Power, Computational Complexity. Multi-objective Optimization: A Different Perspective, Multi-objective Analysis- Utility Functions, Population-Based Analysis.

**Unit V: Genetic Algorithms for Radio Optimization**

Multi-objective Genetic Algorithms, Wireless System Genetic Algorithm – Details of Chromosome Structure, Objective Function Definition, Optimal Individual Selection.

**Reference Books:**

1. Thomas W. Rondeau and Charles W. Bostian, "**Artificial Intelligence in Wireless Communications"** Artech House, (1 st Edition), (2009)

2. Joseph Mitola III, **"Software Radio Architecture: Object-Oriented Approaches To Wireless System Engineering"**, John Wiley & Sons Ltd., (1 st Edition), (2000)

3. Simon Haykin, **"Cognitive Radio: Brain –Empowered Wireless Communications",** IEEE Journal on Selected Areas in Communications, (Feb 2005)
4. D. E. Goldberg, **"Genetic Algorithms in Search, Optimization, and Machine Learning, Reading",** MA: Addison-Wesley, (1 st Edition), (1989)

**Online Resources:**

1. NPTEL Course "Artificial Intelligence : Search Methods For Problem solving", **https://onlinecourses.nptel.ac.in/noc24_cs88/preview**
2. NPTEL Course "Digital Communication using GNU Radio", https://onlinecourses.nptel.ac.in/noc24_ee51/preview

# 24PCMEC204 Computer Vision

**Teaching Scheme**
Lectures: 3 Hours / Week
Tutorial: 1 Hour/ Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 4**

**Prerequisite:** Digital image processing

**Course Objectives:**
1. To understand computer vision fundamentals and applications
2. To understand computer feature detection, matching and recognition algorithms
3. To learn image segmentation, motion estimation and activity task recognition

**Course Outcomes:**
After completion of the course, students will be able to
CO1. Explain computer vision systems and its applications.
CO2. Apply computer vision algorithms for feature extraction, segmentation, object detection, motion estimation and classification for a given application.
CO3. Analyze the performance of computer vision systems.
CO4. Design /develop computer vision systems for given applications.

**Unit I: Computer Vision for Disease Diagnosis**
Introduction to medical imaging, computer vision algorithms for medical image segmentation and classification, case studies.

**Unit II: Computer Vision for Video Surveillance**
Video surveillance - concept, need, computer vision system block diagram for surveillance, foreground/background separation: different techniques and challenges, computer vision algorithms for moving object detection and tracking, activity recognition.

**Unit III: Computer Vision for Autonomous Vehicles**
Self-Driving car, ADAS - concepts, tasks, challenges, computer vision algorithms for lane detection, pedestrian/obstacle detection

**Unit IV: Computer Vision for Biometric**
Computer vision algorithms for Fingerprint recognition, Iris recognition and Face recognition algorithms. Case studies

**Reference Books:**
1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer-Verlag London Limited, (1st Edition), (2011).
2. D. Forsyth, J. Ponce, "Computer Vision, A Modern Approach", Prentice Hall, (2 nd Edition), (2003).
3. L. G. Shapiro, George C. Stockman, "Computer Vision", Prentice Hall, (1st Edition), (2001).
4. E. Trucco, A. Verri, "Introductory Techniques for 3-D Computer Vision", Prentice Hall (1st Edition), (1998)
5. M. Shah, "Fundamentals of Computer Vision", Online book (1997)

# 24PEMEC201A Natural Language Processing

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** Basic knowledge of Python for programming assignment

**Course Objectives:**

1. To understand various aspects of Natural Language Processing
2. To learn Phonological, Morphological, Syntactic and Semantic processing
3. To understand issues related to ambiguity of Natural Language
4. To understand the advanced applications of Natural Language Processing

**Course Outcomes:**

After completion of the course, students will be able to

CO1. Explain the importance of Natural Language Processing
CO2. Identify the fundamental concepts and techniques of Natural Language Processing
CO3. Analyze ambiguous structure of Natural Language
CO4. Summarize the advanced applications of Natural Language Processing

**Unit I: Introduction to Natural Language Processing (09)**

Need of NLP, components of NLP (NLU and NLG), The Study of Language, evaluating language Understanding Systems, Different levels of Language Analysis, Block diagram of NLP system (NLP pipeline), Ambiguity and Uncertainty in Language, evaluating language understanding system, NLP APIs, NLP libraries, Application of Question Answering Systems

**Unit II: Fundamentals of Syntax and Lexical analysis (09)**

The elements of Noun Phrases, Verb Phrases, Adjective Phrases, Adverbial Phrases and Simple Sentences, Grammars and Sentence Structure, Construction of a Good Grammar, Word tokenization, types of tokenization, Byte pair encoding, word piece tokenization, stemming, lemmatization, A Top-Down Parser, A Bottom-Up Chart Parser, Top-Down Chart Parsing, Part-of-Speech Tagging, NER, chunking, syntactical analysis, lexical analysis,

**Unit III: Fundamentals of Semantics and Discourse analysis (10)**

Word Senses, Relations between Senses, WordNet, Word Sense Disambiguation, The Need for Discourse Structure, Segmentation and Cue Phrases, Discourse Structure and Reference, Relating Discourse Structure and Inference, Discourse Structure, Tense, and Aspect, Managing the Attentional Stack, Concept of Pragmatics.

**Unit IV: Applications of Natural Language Processing (08)**

Machine Translation, Sentiment Analysis, Cross Lingual Information Retrieval, Natural Language Interface to Database, Extractive and Abstractive Summarization Systems, Indian Language WordNets.

**Reference Books:**

1. Jurafsky, David, James H. Martin, "**Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition**", *Pearson Education Limited, Dorling Kindersley(India) Pvt. Ltd.,* (2014)
2. James Allen, „**Natural Language Understanding**", *Pearson Education Limited, Dorling indersley (India) Pvt. Ltd. (Indian Subcontinent Version)* (2007).
3. Manning, Christopher D., Hinrich Schütze, „**Foundations of Statistical Natural Language Processing**", *Cambridge Publication,* (1999)
4. Steven Bird, ewan Klein, and Edward Loper, „**Natural Language Processing with Python**", *O'Reilly Media*, (2009)

**Online Resources:**

1. NPTEL Course "**Natural Language Processing"**
https://onlinecourses.nptel.ac.in/noc23_cs45/preview

# 24PEMEC201B Soft Computing

**Teaching Scheme**
Lectures: 3 Hours / Week

**Examination Scheme**
In Semester: 50 Marks
End Semester: 50 Marks
**Credits: 3**

**Prerequisite:** Programming Skills in C, C++, JAVA, Matlab

**Course Objectives:**

1. To explain the concept of biological neuron and artificial neuron model
2. To introduce the soft computing technique namely, artificial neural networks and fuzzy logic
3. To explain the areas of application of soft computing techniques
4. To explain the alternative solutions to the conventional problem-solving techniques in the image/signal processing, pattern recognition/classification, control system

**Course Outcomes:**

After completion of the course, students will be able to

CO1. Explain the concepts of Artificial Neural Networks and its application for classification and regression
CO2. Describe the concepts of fuzzy logic and fuzzy inference system
CO3. Explain and analyze fuzzy control system
CO4. Apply soft computing techniques to solve real world problems

**Unit I: Artificial Neural Network (14)**

Biological Neuron, Artificial Neuron Model, Concept of Bias and Threshold, Topologies of NN, Learning Paradigms : Supervised, Unsupervised, reinforcement, Linear Neuron Model : Gradient decent algorithm, Application of linear neuron regression, Multilayer Perceptron and Back Propagation Algorithm, Applications of MLP for classification and regression, Self Organizing Feature maps, K-Means clustering, Learning Vector Quantization, Radial Basis Function network

**Unit II: Fundamentals of Fuzzy Logic (11)**

Concept of fuzzy number, fuzzy set theory –continuous and discrete, Operations on fuzzy sets, Fuzzy membership Functions -core, boundary and support, primary and composite linguistic terms, Concept of fuzzy relation, Composition operation- T-norm and T-conorm, fuzzy if-then rules, Fuzzification, Membership value assignment Techniques, Defuzzification- Max membership principle, Centroid method, weighted average method, Concept of fuzzy inference, Implication rules – Dienes Rescher Implication, Mamdani Implication, Zadeh Implication, Fuzzy Inference System (FIS) – Mamdani fuzzy model, Sugeno fuzzy model, Tsukamoto fuzzy model, Implementation of single Output FIS employing Mamdani Model Computing

**Unit III: Fuzzy Control System (05)**

Control System Surface, Assumptions in Fuzzy control system design, Fuzzy controllers and comparison with traditional PID controllers, Advantages of Fuzzy Logic Controller (FLC), Architecture of FLC: Mamdani type

**Unit IV: Adaptive Neuro-Fuzzy Inference Systems (ANFIS) (06)**

Machine Translation, Sentiment Analysis, Cross Lingual Information Retrieval, Natural Language Interface to Database, Extractive and Abstractive Summarization Systems, Indian Language WordNets ANFIS Architecture, Hybrid learning Algorithm, Advantages and Limitations of ANFIS, Applications of ANFIS for regression.

**Reference Books:**

1. Laurene Fausett, **'Fundamentals of Neural Network: Architectures, Algorithms and Applications',** *Pearson Education inc*., (1st Edition), (2008)
2. S. N. Shivanandam, S. N. Deepa, **'Principles of Soft Computing'**, *John Wiley and sons*, (1st Edition),(2007)
3. Thomas , Timothy, Ross, **'Fuzzy Logic with engineering Applications'**, *John Wiley and sons*, (1st Edition), (2010)
4. J. S. Jang, C.T. Sun, E. Mizutani, **'Neuro Fuzzy and Soft Computing'**, *PHI Learning Pvt. Ltd*, (1st edition), (2015)

**Online Resources:**

1. NPTEL Course
   http://www.nptelvideos.in/2012/11/intelligent-systems-and-control.html