# MINOR DEGREES OFFERED UNDER SVEC-19 REGULATIONS

| Offering Dept. | Title of the Minor | Students of Eligible Branches |
|---|---|---|
| CSE | Artificial Intelligence and Machine Learning | All branches except CSE, IT and CSSE |
| IT | Internet of Things | All branches except IT |
| CSSE | Cyber Security | All branches except CSE, IT and CSSE |
| ECE | VLSI and Embedded Systems | All branches except ECE |
| EEE | Power Systems and Drives | All branches except EEE |
| EIE | Instrumentation and Control Engineering | All branches except EIE |
| ME | Robotics | All branches except ME |
| CE | Sustainable Engineering | All branches except CE |

**Academic Regulations for Minor Degree:**

The concept of Minor degree is introduced in the curriculum of all B.Tech. programs offering a Major degree. The main objective of Minor degree in a discipline is to provide additional learning opportunities for academically motivated students and it is an optional feature of the B.Tech. Program. To earn a Minor degree in a discipline, a student has to earn 18 extra credits (By studying FIVE theory & THREE laboratory courses or SIX Theory Courses) from the core courses of the minor discipline.

a. Students having a CGPA of 8.0 or above up to II B.Tech I-Semester without any backlogs shall be permitted to register for a Minor degree by paying the requisite fee.

b. In the subsequent semesters, the student has to pass all the courses registered for Major and Minor Degrees in the first attempt i.e., regular examinations without any backlog to keep the Minor Degree registration active or else it shall be cancelled.

c. If a student becomes ineligible for continuing the Minor Degree, the earned credits under Minor Degree cannot be transferred to Major

Degree; they will remain extra. These additional courses will be mentioned in the transcript. However, they are eligible to receive B.Tech. Degree after satisfying its requirements.

d. The evaluation pattern of the courses shall be similar to the evaluation of regular program courses.

e. Minimum strength required for offering Minor Degree in a discipline is 40 students.

f. A student registered for Minor degree shall pass in all subjects that constitute the requirement for the Minor degree program. No class/division (i.e., second class, first class and distinction, etc.) shall be awarded for Minor degree program.

g. The Minor degree shall be mentioned in the degree certificate as Bachelor of Technology in XXX with Minor in YYY. For example, Bachelor of Technology in Computer Science & Engineering with Minor in Title of the Minor Pursued. This shall also be mentioned in the transcripts, along with the list of courses taken for Minor degree program. However, the performance of the student in the Minor courses will not be considered for the calculation of SGPA and CGPA for the award of Major Degree.

h. Separate course/class work and time table shall be arranged for the various Minor degree programs. Attendance regulations for these Minor discipline programs shall be as per regular courses.

i. Students aspiring for Minor degree must register from III B.Tech I-Semester onwards and must opt for a Minor in a discipline other than the discipline he is registered in.

j. A Student shall register for Minor with the following combinations:

Offering Theory and Laboratory Courses: SEVEN credits in a semester starting from III B.Tech I-Semester to III B.Tech II-Semester (TWO theory & ONE laboratory courses) and FOUR credits in IV B.Tech I-Semester (ONE theory & ONE laboratory courses).

Offering Theory Courses only: SIX credits in a semester starting from III B.Tech I-Semester to IV B.Tech I-Semester (TWO theory courses).

**NOTE:** Interested meritorious students shall be permitted to register either for a Minor degree in a discipline (or) Honors Degree in a discipline only, but not both.

## MINOR DEGREE IN

# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

**Offering Department:** COMPUTER SCIENCE AND ENGINEERING

**Students of Eligible Branches:** ECE, EEE, EIE, ME and CE

## COURSE STRUCTURE

| Year & Semester | Course Code | Course Title | Contact Periods per week | | | | C | Scheme of Examination Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | Total | | Int. Marks | Ext. Marks | Total Marks |
| III B.Tech. I-Sem (2 Theory + 1 Lab) | 19BM50501 | Artificial Intelligence | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50502 | Soft Computing | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50503 | Python for Data Science | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM50531 | Python for Data Science Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| III B.Tech. II-Sem (2 Theory + 1 Lab) | 19BM60501 | Data Science | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60502 | Nature Inspired Algorithms | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60503 | Machine Learning | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM60531 | Machine Learning Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |
| IV B.Tech. I-Sem (1 Theory + 1 Lab) | 19BM70501 | Deep Learning | 3 | - | - | 3 | 3 | 40 | 60 | 100 |
| | 19BM70531 | Deep Learning Lab | - | - | 2 | 2 | 1 | 50 | 50 | 100 |

**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

# III B. Tech. – I Semester

## (19BM50501) **ARTIFICIAL INTELLIGENCE**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:** Introduction to artificial intelligence, Designing intelligent agents, Solving general purpose problems, Search in complex environments, Probabilistic reasoning, Represent knowledge and reason under uncertainty, Robotics, Ethics and safety in AI.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Architect intelligent agents using artificial intelligence techniques and principles.

CO2. Analyze and interpret the problem, identify suitable solutions using heuristic functions, optimization algorithms and search algorithms.

CO3. Select and apply appropriate knowledge representation to build Bayesian network models to reason under uncertainty.

CO4. Investigate robot hardware and frameworks for intelligent robotic perception.

CO5. Demonstrate knowledge on ethical implications of intelligent machines for providing privacy, trust, security and safety.

**DETAILED SYLLABUS:**

**UNIT–I: INTRODUCTION TO ARTIFICIAL INTELLIGENCE (10 periods)**

Foundations of artificial intelligence, History of artificial intelligence, State of the art, Risks and benefits of AI, Intelligent agents – Agents and environments, The concept of rationality, Structure of agents.

**UNIT–II: PROBLEM SOLVING BY SEARCHING (9 periods)**

Problem solving agents, Search algorithms, Uninformed search strategies, Informed search strategies – Greedy best-first search, A* search; Heuristic functions.

**UNIT–III: SEARCH IN COMPLEX ENVIRONMENTS (9 periods)**

Local search algorithms and optimization problems – Hill-climbing search, Simulated annealing, Local beam search, Evolutionary algorithms; Optimal decisions in games – The minimax search algorithm, Optimal decisions in multiplayer games, Alpha-Beta pruning, Move ordering; Monte Carlo tree search.

**UNIT–IV: PROBABILISTIC REASONING (9 periods)**

Representing Knowledge in an uncertain domain, Semantics of Bayesian networks, Probabilistic reasoning over time – Time and uncertainty, Inference in temporal models, Hidden Markov models, Kalman Filter.

**UNIT–V: ROBOTICS, ETHICS AND SAFETY IN AI (8 periods)**

**Robotics:** Robots, Robot hardware, Robotic perception, Alternative robotic frameworks, Application domains.

**Ethics and Safety in AI:** Limits of AI, Ethics of AI – Surveillance, security and privacy, Fairness and bias, Trust and transparency, AI safety.

***Total Periods: 45***

***Topics for self-study are provided in the lesson plan***

**TEXT BOOK:**

1. Stuart Russell, Peter Norvig, *Artificial Intelligence: A Modern Approach*, Prentice Hall, 4th Edition, 2020.

**REFERENCE BOOKS:**

1. Stephen Lucci, Danny Kopec, *Artificial Intelligence in the 21st Century*, Mercury Learning and Information, 3rd Edition, 2018.
2. Rich, Knight, Nair, *Artificial intelligence*, Tata McGraw Hill, 3rd Edition, 2009.
3. Deepak Khemani, *A First Course in Artificial Intelligence*, McGraw Hill, 2017.
4. Saroj Kaushik, *Artificial Intelligence,* Cengage Learning, 2011.

**ADDITIONAL RESOURCES:**

- https://searchenterpriseai.techtarget.com/definition/AI-Artificial-Intelligence
- http://aima.cs.berkeley.edu/
- https://ai.google/education/
- https://www.coursera.org/courses?query=artificial%20intelligence
- https://www.edureka.co/blog/artificial-intelligence-with-python/

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 1 | | | | | | | | | | | | | | |
| CO2 | 3 | 3 | 2 | | | | | | | | | | | | | |
| CO3 | 3 | 3 | 2 | | | | | | | | | | | | | |
| CO4 | 3 | | | | | 1 | | | | | | | | | | |
| CO5 | | | | | | 1 | | 2 | | | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low

## III B. Tech. – I Semester

## (19BM50502) **SOFT COMPUTING**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:** Soft computing technique concepts, Supervised learning networks, Unsupervised learning networks, Genetic algorithms, Fuzzy logic, Hybrid soft computing techniques and applications.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Investigate soft computing techniques for solving computational problems.

CO2. Design efficient neural architectures to model patterns for a given learning problem.

CO3. Investigate and solve optimization problems using genetic algorithms.

CO4. Apply fuzzy logic and reasoning to handle uncertainty in engineering problems.

CO5. Develop intelligent solutions using hybrid soft computing techniques to solve problems of multidisciplinary domains.

**DETAILED SYLLABUS:**

**UNIT–I: INTRODUCTION TO SOFT COMPUTING AND SUPERVISED LEARNING NETWORKS (10 periods)**

**Introduction to Soft Computing:** Neural networks, Application scope of neural networks, Fuzzy logic, Genetic algorithm, Hybrid systems, Soft computing.

**Artificial Neural Networks:** Fundamentals, Basic Models, Terminologies, Linear Separability, Hebb network.

**Supervised Learning Networks:** Perceptron Networks- Theory, Perceptron learning rule, Architecture, Flowchart for training process, Perceptron training algorithm for single and multiple output classes, Perceptron network testing algorithm; Back-Propagation Network - Theory, Architecture, Flow chart for training process, Training algorithm, Learning factors of back-propagation network, Testing algorithm for back-propagation network.

**UNIT–II: UNSUPERVISED LEARNING NETWORKS (8 periods)**

Fixed weight competitive nets – Maxnet, Mexican Hat Net, Hamming network; Kohonen self-organizing feature maps – Theory, Architecture, Flowchart, Training algorithm; Learning vector quantization – Theory, Architecture, Flowchart, Training algorithm, Variants; Counterpropagation networks – Theory, Full counterpropagation Net, Forward-only counterpropagation Net; Adaptive resonance theory network – Fundamental architecture, Fundamental operating principle, Fundamental algorithm.

**UNIT–III: GENETIC ALGORITHMS (9 periods)**

Genetic algorithms - Biological background, Traditional optimization and search techniques, Genetic algorithm and search space, Genetic algorithms vs. traditional algorithms, Basic terminologies in genetic algorithm, Simple GA, General genetic algorithm, Operators in genetic algorithm, Stopping condition for genetic algorithm flow,

Constraints in genetic algorithm, Problem solving using genetic algorithm, Adaptive genetic algorithms, Hybrid genetic algorithms, Advantages and limitations of genetic algorithm, Applications of genetic algorithm.

**UNIT–IV: FUZZY LOGIC** **(11 periods)**

Introduction to fuzzy logic, Classical sets, Fuzzy sets, Membership function – Features, Fuzzification, Methods of membership value assignments; Fuzzy arithmetic and measures – Fuzzy arithmetic, Extension principle, Fuzzy measures, Measures of fuzziness, Fuzzy integrals; Fuzzy rule base and approximation reasoning - Truth values and tables in fuzzy logic, Fuzzy propositions, Formation of rules, Compound rules, Aggregation of fuzzy rules, Fuzzy reasoning, Fuzzy inference systems, Overview of fuzzy expert system; Fuzzy decision making, Fuzzy logic control systems.

**UNIT–V: HYBRID SOFT COMPUTING TECHNIQUES AND APPLICATIONS**

**(7 periods)**

**Hybrid Soft Computing Techniques:** Genetic neuro hybrid systems, Genetic fuzzy hybrid and fuzzy genetic hybrid systems.

**Applications of Soft Computing:** Optimization of traveling salesman problem using genetic algorithm approach, Genetic algorithm-based internet search technique, Soft computing-based hybrid fuzzy controllers, Soft computing-based rocket engine control.

***Total Periods: 45***

***Topics for self-study are provided in the lesson plan***

**TEXT BOOK:**

1. S. N. Sivanandam and S. N. Deepa, *Principles of Soft Computing*, Wiley, 3rd Edition, 2019.

**REFERENCE BOOKS:**

1. S. Rajasekaran and G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic and Genetic Algorithms:* Synthesis and Applications, PHI Learning Private Ltd, 2011.
2. Udit Chakraborty, Samir Roy, *Soft Computing: Neuro-Fuzzy and Genetic Algorithms,* Pearson, 2013.
3. Saroj Kaushik, Sunita Tewari, *Soft Computing: Fundamentals, Techniques and Applications*, McGraw Hill, 2018.

**ADDITIONAL LEARNING RESOURCES:**

- https://nptel.ac.in/courses/106105173/

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | | | | | | | | | | | | | | | |
| CO2 | 3 | 3 | 3 | 1 | | | | | | | | | | | | |
| CO3 | 3 | 2 | | | | | | | | | | | | | | |
| CO4 | 3 | 2 | | | | | | | | | | | | | | |
| CO5 | 3 | 3 | 3 | | | 2 | | | | | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low

## III B. Tech. – I Semester

## (19BM50503) **PYTHON FOR DATA SCIENCE**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:** Basics of Data Science, Computation using NumPy, Data exploration using Pandas, Data transformation, Plotting and visualization using Matplotlib, Time series analysis.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Demonstrate knowledge on the concepts of data science to perform mathematical computations using efficient storage and data handling methods in NumPy.

CO2. Apply data preparation and exploration methods using Pandas to perform data manipulation.

CO3. Create data visualization using charts, plots and histograms to identify trends, patterns and outliers in data using Matplotlib and Seaborn.

CO4. Develop methods to analyze and interpret time series data to extract meaningful statistics.

**DETAILED SYLLABUS:**

**UNIT–I: INTRODUCTION (10 periods)**

Basic terminologies of data science, Types of data, Five steps of data science, The NumPy ndarray, Fast element-wise array functions, Array-oriented programming with arrays, File input and output with arrays, Linear algebra, Pseudorandom number generation.

**UNIT–II: DATA EXPLORATION WITH PANDAS (10 periods)**

Process of exploring data, Pandas data structures – Series, Data frame, Index objects; Essential functionality, Summarizing and computing descriptive statistics, Data loading, storage, and file formats – Reading and writing data in text format, Reading text files in pieces, Writing data to text format; Reading Microsoft Excel files.

**UNIT–III: DATA CLEANING AND PREPARATION (8 periods)**

Handling missing data – Filtering out missing data, Filling in missing data; Data transformation – Removing duplicates, Transforming data using a function or mapping, Replacing values, Renaming axis indexes, Discretization and binning, Detecting and filtering outliers, Permutation and random sampling, Computing indicator/dummy variables; String manipulation – String object methods, Regular expressions, Vectorized string functions in Pandas.

**UNIT–IV: DATA VISUALIZATION WITH MATPLOTLIB (8 periods)**

Plotting with Matplotlib – Figures and subplots, Colors, markers and line styles, Ticks, labels and legends, Annotations and drawing on a subplot, Saving plots to file; Plotting

with Pandas and Seaborn – Line plots, Bar plots, Histograms and density plots, Scatter plots, Facet grids and categorical data.

**UNIT–V: TIME SERIES ANALYSIS (9 periods)**

Date and time data types and tools, Time series basics, Date ranges, frequencies, and shifting, Time zone handling, Periods and period arithmetic, Resampling and frequency conversion, Moving window functions.

***Total Periods: 45***

***Topics for self-study are provided in the lesson plan***

**TEXT BOOK:**

1. Wes McKinney, *Python for Data Analysis*, O'Reilly, 2nd Edition, 2017.

**REFERENCE BOOKS:**

1. Sinan Ozdemir, *Principles of Data Science*, Packt Publishers, 2nd Edition, 2018.
2. John Paul Mueller, Luca Massaron, Python for Data Science for Dummies, 2nd Edition, Wiley, 2015.
3. Rachel Schutt, Cathy O'Neil, *Doing Data Science: Straight Talk from the Frontline*, O'Reilly, 2014.

**ADDITIONAL LEARNING RESOURCES:**

- https://swayam.gov.in/nd1_noc19_cs60/preview
- https://towardsdatascience.com/
- https://www.w3schools.com/datascience/
- https://github.com/jakevdp/PythonDataScienceHandbook
- https://www.kaggle.com

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 1 | 1 | 3 | | | | | | | | | | | |
| CO2 | 3 | 3 | 2 | 2 | 3 | | | | | | | | | | | |
| CO3 | 3 | 3 | 2 | 2 | 3 | | | | | | | | | | | |
| CO4 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low

## III B. Tech. – I Semester

## (19BM50531) **PYTHON FOR DATA SCIENCE LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:** A Course on "Python for Data Science"

**COURSE DESCRIPTION:** Hands on practice on the concepts of data science using Python - Computations using NumPy, Data manipulation using Pandas, Data cleaning and preparation, Data visualization using Matplotlib and Seaborn, Time series analysis.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Demonstrate efficient storage and data handling methods in NumPy to perform mathematical computations vital for data science.

CO2. Apply data preparation and data exploration methods using Pandas to perform data manipulation.

CO3. Create data visualization using charts, plots and histograms to identify trends, patterns and outliers in data importing Matplotlib and Seaborn.

CO4. Develop methods to analyze and interpret time series data to extract meaningful statistics.

CO5. Work independently to solve problems with effective communication.

**LIST OF EXERCISES:**

1. Array Computations using NumPy
    a) Perform arithmetic operations using array.
    b) Perform slicing and indexing on multi-dimensional arrays.
    c) Perform computations on multi-dimensional array using universal functions (ufunc).
    d) Compute arithmetic mean, standard deviation, variance, percentile, minimum and maximum, cumulative sum and product using statistical functions in NumPy.
    e) Perform set theory operations such as union, intersection, symmetric difference and fetching unique values.
2. Linear Algebra and Random Number generation using linalg and random module in NumPy
    a) Compute dot product, vector product and inner product of two arrays.
    b) Perform matrix operations such as multiplication, determinant, sum of diagonal elements and inverse.
    c) Compute eigenvalues, eigenvectors and singular value decomposition for a square matrix.
    d) Generate random samples from uniform, normal, binomial, chi-square and Gaussian distributions using numpy.random functions.

e) Implement a single random walk with 1000 steps using random module and extract the statistics like minimum and maximum value along the walk's trajectory.

3. Data Manipulation using pandas
   a) Create DataFrame from List, Dict, List of Dicts, Dicts of Series and perform operations such as column selection, addition, deletion and row selection, addition and deletion.
   b) Create a DataFrame and perform descriptive statistics functions such as sum, mean, median, mode, standard deviation, skewness, kurtosis, cumulative sum, cumulative product and percent changes.
   c) Implement the computation of correlation and covariance by considering the DataFrames of stock prices and volumes obtained from Yahoo Finance! Using pandas-datareader package.

4. Working with different data formats using pandas
   a) Perform reading and writing data in text format using read_csv and read_table considering any online dataset in delimited format (CSV).
   b) Perform reading and writing of Microsoft Excel Files (xslx) using read_excel.

5. Data Cleaning and Preparation
   a) Perform data cleaning by creating a DataFrame and identifying missing data using NA(Not Available) handling methods, filter out missing data using dropna function, fill the missing data using fillna function and remove duplicates using duplicated and drop_duplicates functions.
   b) Perform data transformation by modifying set of values using map and replace method and create transformed version of original dataset without modification using rename method.
   c) Create a DataFrame with normally distributed data using random sampling and detect possible outliers.

6. Perform Data Visualization with Matplotlib and Seaborn considering online dataset for processing.
   a. Create a Line Plot by setting the title, axis labels, ticks, ticklabels, annotations on subplots and save to a file.
   b. Create Bar Plots using Series and DataFrame index.
      i. Create bar plots with a DataFrame to group the values in each row together in a group in bars side by side for each value.
      ii. Create stacked bar plots from a DataFrame.
   c. Create Histogram to display the value frequency and Density Plot to generate continuous probability distribution function for observed data.
   d. Create Scatter Plot and examine the relationship between two one-dimensional data series.
   e. Create Box plots to visualize data with many categorical variables.

7. Time Series Analysis
   a) Create time series using datetime object in pandas indexed by timestamps.
   b) Use pandas.date_range to generate a DatetimeIndex with an indicated length.

c) Perform period arithmetic such as adding and subtracting integers from periods and construct range of periods using period_range function.

d) Convert Series and DataFrame objects indexed by timestamps to periods with the to_period method.

e) Perform resampling, downsampling and upsampling for the time series.

**REFERENCE BOOKS**:


1. Wes McKinney, *Python for Data Analysis*, O'Reilly, 2nd Edition,2017.
2. John Paul Mueller, Luca Massaron, Python for Data Science For Dummies, 2nd Edition, Wiley, 2015.


**SOFTWARE/TOOLS:**

- Python 3.8
- Python Libraries – NumPy, Pandas, Matplotlib,
- Anaconda Framework

**ADDITIONAL LEARNING RESOURCES:**

- https://swayam.gov.in/nd1_noc19_cs60/preview
- https://towardsdatascience.com/
- https://www.w3schools.com/datascience/
- https://github.com/jakevdp/PythonDataScienceHandbook
- https://www.kaggle.com

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 1 | 1 | 3 | | | | | | | | | | | |
| CO2 | 3 | 3 | 2 | 2 | 3 | | | | | | | | | | | |
| CO3 | 3 | 3 | 2 | 2 | 3 | | | | | | | | | | | |
| CO4 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | | |
| CO5 | | | | | | | | | 3 | 3 | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low

## III B. Tech. – II Semester

## (19BM60501) **DATA SCIENCE**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:** Concepts of data science, Extracting meaning from data, The dimensionality problem, Plotting with pandas and seaborn, Probability distributions, Time series analysis, Predictive modeling.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Demonstrate knowledge on the concepts of data science to perform data analysis.

CO2. Develop methods to extract meaning from data using feature selection techniques.

CO3. Create data visualization using charts, plots and histograms to identify trends, patterns and outliers in data using Matplotlib and Seaborn.

CO4. Develop distribution functions to analyze and interpret data to extract meaningful statistics.

CO5. Design and develop predictive models for a given problem to support prediction and forecasting.

**DETAILED SYLLABUS:**

**UNIT–I: INTRODUCTION (9 periods)**

Definition of data science, Skills for data science, Tools for data science, Data types, Data collections, Data preprocessing, Data analysis and data analytics, Descriptive analysis, Diagnostic analytics, Predictive analytics, Prescriptive analytics, Exploratory analysis, Mechanistic analysis.

**UNIT–II: DATA EXTRACTION (9 periods)**

Extracting meaning from data – Feature selection, User retention, Filters, Wrappers, Entropy, Decision tree algorithm; Random forests, The dimensionality problem, Single value decomposition, Principal component analysis.

**UNIT–III: DATA VISUALIZATION (8 periods)**

A Brief matplotlib API primer, Plotting with Pandas and Seaborn – Line plots, Bar plots, Histograms and density plots, Scatter plots, Facet grids and Categorical data; Other Python visualization tools.

**UNIT–IV: STATISTICAL THINKING (11 periods)**

Distributions – Representing and plotting histograms, Outliers, Summarizing distributions, Variance, Reporting results; Probability mass function – Plotting PMFs, Other visualizations, The class size paradox, Data frame indexing; Cumulative distribution functions - Limits of PMFs, Representing CDFs, Percentile based statistics, Random numbers, Comparing percentile ranks; Modeling distributions - Exponential distribution, Normal distribution, Lognormal distribution.

**UNIT–V: TIME SERIES ANALYSIS AND PREDICTIVE MODELING (8 periods)**

Time series analysis – Importing and cleaning, Plotting, Moving averages, Missing values, Serial correlation, Autocorrelation; Predictive modeling – Overview, Evaluating predictive models, Building predictive model solutions, Sentiment analysis.

***Total Periods: 45***

***Topics for self-study are provided in the lesson plan***

**TEXT BOOKS:**

1. Chirag Shah, *A Hands-on Introduction to Data Science*, Cambridge University Press, 2020.
2. Alen B. Downey, *Think Stats: Exploratory Data Analysis*, O'Reilly, 2nd Edition, 2014.

**REFERENCE BOOKS:**

1. Wes McKinney, *Python for Data Analysis*, O'Reilly, 2nd Edition, 2017.
2. Ofer Mendelevitch, Casey Stella, Douglas Eadline, *Practical Data science with Hadoop and Spark: Designing and Building Effective Analytics at Scale*, Addison Wesley, 2017.
3. Rachel Schutt, Cathy O'Neil, *Doing Data Science: Straight Talk from the Frontline*, O'Reilly, 2014.
4. Jake VanderPlas, *Python Data Science Handbook: Essential Tools for Working with Data*, O'Reilly, 2017.

**ADDITIONAL LEARNING RESOURCES:**

- https://swayam.gov.in/nd1_noc19_cs60/preview
- https://towardsdatascience.com/
- https://www.w3schools.com/datascience/
- https://github.com/jakevdp/PythonDataScienceHandbook
- https://www.kaggle.com

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 1 | 1 | | | | | | | | | | | | |
| CO2 | 3 | 3 | 2 | 2 | 1 | | | | | | | | | | | |
| CO3 | 3 | 3 | 2 | 2 | 2 | | | | | | | | | | | |
| CO4 | 3 | 3 | 2 | 2 | 2 | | | | | | | | | | | |
| CO5 | 3 | 3 | 2 | 2 | 2 | 1 | | | | | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low

## III B. Tech. – II Semester

## (19BM60502) **NATURE INSPIRED ALGORITHMS**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** A Course on "Differential Equations and Multivariable Calculus"

**COURSE DESCRIPTION:** Optimization, Classical optimization techniques, Nature inspired algorithms, Genetic algorithm, Particle swarm optimization, Ant colony optimization, Bee colony optimization, Cuckoo search algorithm, Firefly algorithm, Bat algorithm, Gray wolf optimization, Elephant herding optimization, Applications of nature inspired algorithms.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Demonstrate knowledge on optimization and classical optimization techniques to find optimal solutions for a given problem.

CO2. Analyze the key components and mathematical aspects of nature inspired algorithms.

CO3. Design efficient solutions for optimization problems using nature inspired algorithms.

CO4. Investigate the applications of nature inspired algorithms to solve wide range of optimization problems.

**DETAILED SYLLABUS:**

**UNIT–I: INTRODUCTION TO OPTIMIZATION (9 periods)**

**Introduction to Optimization:** Fundamentals of optimization, Types of optimization problems, Examples of optimization, Formulation of optimization problems, Classification of optimization algorithms, Traveling salesman problem, Knapsack problem.

**Classical Optimization Techniques:** Mathematical model of optimization, Linear programming – Simplex method, Revised simplex method, Kamarkar's method, Duality theorem, Decomposition principle, Transportation problem; Nonlinear Programming – Quadratic programming, Geometric programming; Dynamic programming, Integer programming, Stochastic programming, Lagrange multiplier method.

**UNIT–II: NATURE INSPIRED ALGORITHMS AND GENETIC ALGORITHM (8 periods)**

**Nature Inspired Algorithms:** Traditional vs nature inspired algorithms, Bioinspired algorithms, Swarm intelligence, Metaheuristics, Diversification and intensification, No free lunch theorem, Parameter tuning and control, Algorithm.

**Genetic Algorithm:** Basics, Genetic operators, Example of GA, Algorithm, Schema theory, Prisoner's dilemma problem, Variants and hybrids of GA.

**UNIT–III: PARTICLE SWARM, ANT COLONY, BEE COLONY AND CUCKOO SEARCH OPTIMIZATION ALGORITHMS (10 periods)**

**Particle Swarm Optimization:** Swarm behavior, Algorithm, Variants of algorithm.

**Ant Colony Optimization:** Ant colony characteristics, Ant colony optimization – Travelling salesman problem, algorithm; Variants of algorithm.

**Bee Colony Optimization:** Honey bee characteristics, Algorithm, Variants of algorithm.

**Cuckoo Search Algorithm:** Cuckoo bird behavior, Levy flights, Algorithm, Variants of algorithm.

**UNIT–IV: FIREFLY, BAT, GRAY WOLF AND ELEPHANT HERDING OPTIMIZATION ALGORITHMS (9 periods)**

**Firefly Algorithm:** Firefly behavior and characteristics, Algorithm, Variants and applications.

**Bat Algorithm:** Behavior of bats in nature, Algorithm, Variants and applications.

**Gray Wolf Optimization:** Gray wolf characteristics, Gray wolf optimization, Variants and applications.

**Elephant Herding Optimization:** Elephant herding behavior, Algorithm, Pseudocode, Variants of the algorithm.

**UNIT–V: APPLICATIONS OF NATURE INSPIRED ALGORITHMS (9 periods)**

Image processing, Classification, clustering and feature selection, Traveling salesman problem, Vehicle routing, Scheduling, Software testing, Deep belief networks, Swarm robots, Data mining and deep learning – Clustering, Support vector machines, Artificial neural networks, Optimizers for machine learning, Deep learning.

***Total Periods: 45***

***Topics for self-study are provided in lesson plan***

**TEXT BOOKS:**


1. A. Vasuki, *Nature-Inspired Optimization Algorithms,* CRC Press, 2020.
2. Xin-She Yang, *Nature-Inspired Optimization Algorithms,* Elsevier, 2nd Edition, 2020.


**REFERENCE BOOKS:**


1. Xin-She Yang, Xing-Shi He, *Mathematical Foundations of Nature-Inspired Algorithms*, Springer, 2019.
2. George Lindfield, John Penny, *Introduction to Nature-Inspired Optimization,* Elsevier, 2017.


**ADDITIONAL LEARNING RESOURCES:**


- Xin-She Yang, *Nature-Inspired Computation and Swarm Intelligence: Algorithms, Theory and Applications,* Elsevier, 2020.
- Hema Banati, Shikha Mehta, Parmeet Kaur, *Nature-Inspired Algorithms for Big Data Frameworks*, IGI Global, 2019.

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | | | | | | | | | | | | | | | |
| CO2 | 3 | 2 | | | | | | | | | | | | | | |
| CO3 | 2 | 3 | 3 | | | | | | | | | | | | | |
| CO4 | 3 | | | | | | | | | | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low

## III B. Tech. – II Semester

## (19BM60503) **MACHINE LEARNING**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** --

**COURSE DESCRIPTION:** Concept learning, General to specific ordering, Decision tree learning, Support vector machine, Artificial neural networks, Multilayer neural networks, Bayesian learning, Instance based learning, reinforcement learning.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Analyze the concept learning algorithms to automatically infer a general description for a given learning problem.

CO2. Analyze the underlying mathematical models within machine learning algorithms and learning tasks.

CO3. Evaluate and apply suitable machine learning algorithms for various types of learning tasks.

CO4. Design efficient neural architectures to model patterns for a given learning problem.

CO5. Select and apply machine learning algorithms to solve societal problems such as face recognition, text classification.

**DETAILED SYLLABUS:**

**UNIT–I: CONCEPT LEARNING AND GENERAL-TO-SPECIFIC ORDERING**

**(9 periods)**

Well-posed learning problems, Designing a learning system, Perspectives and issues in machine learning, Concept learning task, Concept learning as search, FIND-S, Version spaces and candidate elimination algorithm, Inductive bias.

**UNIT–II: DECISION TREE LEARNING AND KERNEL MACHINES (9 periods)**

**Decision Tree Learning:** Decision tree representation, Problems for decision tree learning, Decision tree learning algorithm, Hypothesis space search, Inductive bias in decision tree learning, Issues in decision tree learning.

**Kernel Machines**: Support vector machines – SVMs for regression, SVMs for classification, Choosing C, A probabilistic interpretation of SVMs.

**UNIT–III: ARTIFICIAL NEURAL NETWORKS (9 periods)**

Neural network representations, Appropriate problems for neural network learning, Perceptrons, Multilayer networks and Backpropagation algorithm, Convergence and local minima, Representational power of feedforward networks, Hypothesis space search and inductive bias, Hidden layer representations, Generalization, Overfitting, Stopping criterion, An Example - Face Recognition.

**UNIT–IV: BAYESIAN LEARNING** **(10 periods)**

Bayes theorem and concept learning, Maximum likelihood and least-squared error hypothesis, Maximum likelihood hypotheses for predicting probabilities, Minimum Description Length principle, Bayes optimal classifier, Gibbs algorithm, Naive Bayes classifier, An Example – Learning to classify text; Bayesian belief networks, EM Algorithm.

**UNIT–V: INSTANCE BASED LEARNING AND REINFORCEMENT LEARNING**

**(8 periods)**

**Instance Based Learning:** k-Nearest Neighbor learning, Locally weighted regression, Radial basis functions, Case-based reasoning.

**Reinforcement Learning:** The learning task, Q-learning, Nondeterministic rewards and actions, Temporal difference learning, Generalizing from examples, Relationship to dynamic programming.

***Total Periods: 45***

***Topics for self-study are provided in the lesson plan***

**TEXT BOOKS**:

1. Tom M. Mitchell, *Machine Learning*, McGraw Hill, 2013.
2. Kevin P. Murphy, *Machine Learning*: *A Probabilistic Perspective*, MIT Press, 2012.

**REFERENCE BOOKS**:

1. Ethem Alpaydin, *Introduction to Machine Learning*, MIT Press, 4th Edition, 2020.
2. Shai Shalev Shwartz, Shai Ben David, *Understanding Machine Learning: From Theory to Algorithms,* Cambridge University Press, 2014.

**ADDITIONAL LEARNING RESOURCES:**

- https://swayam.gov.in/nd1_noc19_cs52/preview
- https://www.udemy.com/course/machinelearning/

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 2 | | | | | | | | | | | | | | |
| CO2 | 2 | 3 | | | | | | | | | | | | | | |
| CO3 | 2 | 3 | 2 | 1 | | | | | | | | | | | | |
| CO4 | 3 | 3 | 3 | 1 | | | | | | | | | | | | |
| CO5 | 2 | 3 | 2 | | | 2 | | | | | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low

## III B. Tech. – II Semester

## (19BM60531) **MACHINE LEARNING LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:** Courses on "Programming for Problem Solving", "Machine Learning"

**COURSE DESCRIPTION:** Implementation of Back propagation algorithm, Decision tree learning, Neural networks, k-NN from scratch algorithm, Naïve Bayes classifier, Radial basis function neural network, SVM based classifier, Maximum likelihood estimation using statistical techniques.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Analyze the given problem and identify appropriate machine learning technique to provide an intelligent solution.

CO2. Design and implement machine learning solutions for classification, regression, and clustering problems.

CO3. Develop intelligent solutions to solve societal problems related to computer vision, information security, healthcare and other areas.

CO4. Work independently to solve problems with effective communication.

**LIST OF EXERCISES:**

1. Solve classification problem by constructing a feedforward neural network using Backpropagation algorithm. (Wheat Seed Data)
2. Implement ID3 (information gain) algorithm for decision tree learning for transforming continuous variables into discrete variables.
3. Explore the problem of overfitting in decision tree and develop solution using pruning technique.
4. Build a neural network that will read the image of a digit and correctly identify the number.
5. Implement k-NN algorithm to solve classification problem.
6. Use Naïve Bayes classifier to solve the credit card fraud detection problem over a skewed dataset.
7. Design and implement a radial basis function neural network to solve function approximation or regression problem.
8. Compare and analyze the performance of optimal Bayes classifier and Naïve Bayes using simulated Gaussian Data.
9. Train an SVM based classifier to predict whether the cancer is malignant or benign.
10. Solve the stock price forecasting problem using statistical techniques – Maximum Likelihood estimation after understanding the distribution of the data.

**REFERENCE BOOKS**:


1. Sebastian Raschka, Vahid Mirjalili, *Python Machine Learning*, Packt Publishing, 3rd Edition, 2019.
2. Aurelien Geron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, 2nd Edition, O'Reilly, 2019.


**SOFTWARE/TOOLS:**

- Python
- Scikit-learn/Keras/TensorFlow

**ADDITIONAL LEARNING RESOURCES:**

- https://www.coursera.org/learn/machine-learning
- https://nptel.ac.in/courses/106106202/

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 2 | 3 | 3 | 3 | 3 | | | | | | | | | | | |
| CO2 | 1 | 3 | 3 | 3 | 3 | | | | | | | | | | | |
| CO3 | 1 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | |
| CO4 | | | | | | | | | 3 | 3 | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low

## IV B. Tech. – I Semester

## (19BM70501) **DEEP LEARNING**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 40 | 60 | 100 | 3 | - | - | 3 |

**PRE-REQUISITES:** A Course on "Machine Learning"

**COURSE DESCRIPTION:** Overview of machine learning; Fundamentals of deep learning; Modern approaches in deep learning; Feedforward neural network architectures; Deep learning Models and Applications.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Analyze a neural network by applying the basics of mathematics and machine learning.

CO2. Analyze the data using multilayer perceptron and backpropagation algorithms.

CO3. Apply regularization and optimization techniques to improve the performance of Deep neural networks.

CO4. Identify appropriate deep learning model for text, multimedia, and biological data analysis.

CO5. Compare deep neural networks and deep learning models to infer the suitable learning algorithm on large scale data.

CO6. Develop a model for domain specific applications by applying various network models in deep learning.

**DETAILED SYLLABUS:**

**UNIT-I: INTRODUCTION (9 Periods)**

Historical Trends in Deep Learning – Machine Learning basics - Learning algorithms: Supervised and Unsupervised Training - Linear Algebra for Machine Learning - Testing - Cross Validation - Dimensionality Reduction - Over fitting /Under Fitting - Hyper parameters and validation sets - Estimators – Bias – Variance - Loss Function- Regularization.

**UNIT-II: NEURAL NETWORKS (9 Periods)**

Biological Neuron – Idea of Computational units - Linear Perceptron - Perceptron Learning Algorithm - Convergence theorem for Perceptron Learning Algorithm - Linear Separability - Multilayer perceptron – Backpropagation.

**UNIT-III: MODERN PRACTICES IN DEEP NETWORKS (10 Periods)**

Introductions to Simple DNN - Platform for Deep Learning - Deep Learning Software Libraries - Deep Feed forward networks – Gradient-Based Learning - Architecture Design –Various Activation Functions, ReLU, Sigmoid – Error Functions - Regularization methods for Deep Learning - Early Stopping - Drop Out - Optimization methods for Neural Networks- Adagrad, Adam.

**UNIT-IV: DEEP LEARNING MODELS** **(9 Periods)**

Convolutional Neural Networks (CNNs): CNN Fundamentals – Architectures – Pooling – Visualization – Sequence Modeling: Recurrent Neural Networks (RNN) - Long-Short Term Memory (LSTM) – Bidirectional LSTMs-Bidirectional RNNs -Deep Unsupervised Learning: Autoencoders – Auto Encoder Applications -Deep Boltzmann Machine (DBM).

**UNIT-V: CASE STUDY AND APPLICATIONS** **(8 Periods)**

Application Case Study - Handwritten digits recognition using deep learning - LSTM with Keras – Sentiment Analysis – Image Dimensionality Reduction using Encoders LSTM with Keras – Alexnet – VGGnet.

***Total Periods: 45***

***Topics for self-study are provided in the lesson plan***

**TEXT BOOK:**

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, 4th Edition, MIT Press, 2016.

**REFERENCE BOOKS:**

1. Kevin P. Murphy, "*Machine Learning: A Probabilistic Perspective*", MITPress,2012.
2. Michael A. Nielsen, *Neural Networks and Deep Learning, Determination* Press, 2015.
3. Deng & Yu, *Deep Learning: Methods and Applications*, Now Publishers, 2013.

**ADDITIONAL RESOURCES:**

1. https://www.youtube.com/watch?reload=9&v=aPfkYu_qiF4
2. http://www.deeplearning.net/tutorial/
3. https://www.guru99.com/deep-learning-tutorial.html
4. https://www.coursera.org/courses?query=deep%20learning

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 3 | 2 | 1 | | | | | | | | | | | |
| CO2 | 2 | 3 | 2 | 2 | 2 | | | | | | | | | | | |
| CO3 | 2 | 2 | 2 | 2 | 1 | | | | | | | | | | | |
| CO4 | 2 | 3 | 2 | 2 | 1 | | | | | | | | | | | |
| CO5 | 1 | 2 | 3 | 2 | 2 | | | | | | | | | | | |
| CO6 | 2 | 2 | 3 | 2 | 3 | 1 | 1 | | | | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low

# IV B. Tech. – I Semester

## (19BM70531) **DEEP LEARNING LAB**

| Int. Marks | Ext. Marks | Total Marks | L | T | P | C |
|---|---|---|---|---|---|---|
| 50 | 50 | 100 | - | - | 2 | 1 |

**PRE-REQUISITES:** A Course on "Deep Learning"

**COURSE DESCRIPTION:** Implementation of deep learning architectures, Modern approaches in deep learning, Feedforward neural network architectures, Deep learning models and applications.

**COURSE OUTCOMES:** *After successful completion of the course, students will be able to:*

CO1. Identify optimal hyperparameter values and appropriate architecture for a given problem and data using optimization techniques.

CO2. Analyze the characteristics of the given data and perform necessary pre-processing tasks to structure the data using Python libraries.

CO3. Utilize Python machine learning libraries and packages for building deep neural architectures to solve AI problems.

CO4. Work independently to solve problems with effective communication.

**LIST OF EXERCISES:**

1. Perform splitting of data for training, testing, and validation using k-fold cross validation.
2. Construct and implement multi-layer feed forward neural network for hand written digit classification problem.
3. Implement a binary and multi class image classification using Convolution Neural Network.
4. Perform hyper parameter tuning using Bayesian optimization technique for a Convolution Neural Network.
5. Analyze the effectiveness of various optimization algorithms with an image classification problem.
6. Solve the overfitting problem in a neural architecture using DropOut technique.
7. Study the efficiency of the transfer learning approach for a classification problem on the following architectures; VGG-16, Alexnet, and Inception-V3.
8. Solve a seq2seq problem (machine translation) using LSTM Recurrent Neural Architecture.
9. Solve a time series forecasting (stock prediction) using LSTM RNN.
10. Implement the image dimensionality reduction problem using a AutoEncoder architecture.

**REFERENCE BOOKS:**


1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning,* MIT Press, 2016.
2. S Lovelyn Rose, L Ashok Kumar, D Karthika Renuka, *Deep Learning Using Python*, Wiley, 2019.
3. François Chollet, *Deep Learning with Python*, Manning Publications, 2017.
4. Jojo Moolayil, *Learn Keras for Deep Neural Networks: A Fast-Track Approach to Modern Deep Learning with Python*, Apress, 2018.


**SOFTWARE/TOOLS:**

- Environment: Google CoLab
- Programming Language: Python 3.8
- Machine Learning Library: Tensor Flow 2.1 and Keras

**ADDITIONAL LEARNING RESOURCES:**

- Bharath Ramsundar, Reza Bosagh Zadeh, *TensorFlow for Deep Learning,* O'reilly, 2018.
- https://www.coursera.org/professional-certificates/tensorflow-in-practice
- https://www.coursera.org/learn/introduction-tensorflow

**CO-PO-PSO Mapping Table:**

| Course Outcome | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 2 | 3 | 3 | 3 | 3 | | | | | | | | | | | |
| CO2 | 2 | 3 | 3 | 3 | 3 | | | | | | | | | | | |
| CO3 | 2 | 3 | 3 | 3 | 3 | 3 | | | | | | | | | | |
| CO4 | | | | | | | | | 3 | 3 | | | | | | |

Correlation Level: 3-High; 2-Medium; 1-Low