## Honours*in Data Science

| Year & Semester | Course Code | Course | Teaching Scheme Hours/Week | | | Examination Scheme and Marks | | | | | | Credit Scheme | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | MSE-1 | MSE-II | CIE | TA | ESE/Oral | Total Marks | L/T | P | Total Credit |
| SY IV | ECE901 | Data Sciences and Visualization | 04 | -- | -- | 15 | 15 | 10 | 10 | 50 | 100 | 04 | -- | 04 |
| | ECE971 | Data Sciences and Visualization Laboratory | -- | -- | 02 | -- | -- | -- | 25 | -- | 25 | -- | 01 | 01 |
| | | **Total** | 04 | - | 02 | 125 | | | | | 125 | 04 | 01 | 05 |
| | | | | | | | | | | | | | | **Total Credits=05** |
| TY V | ECE902 | Statistical Foundations for Data Science | 04 | -- | -- | 15 | 15 | 10 | 10 | 50 | 100 | 04 | -- | 04 |
| | | **Total** | 04 | - | - | 100 | | | | | 100 | 04 | -- | 04 |
| | | | | | | | | | | | | | | **Total Credits =04** |
| TY VI | ECE903 | Machine Learning | 04 | -- | -- | 15 | 15 | 10 | 10 | 50 | 100 | 04 | -- | 04 |
| | ECE972 | Machine Learning Laboratory | -- | -- | 02 | -- | -- | -- | 25 | -- | 25 | -- | 01 | 01 |
| | | **Total** | 04 | -- | 02 | 125 | | | | | 125 | 04 | 01 | 05 |
| | | | | | | | | | | | | | | **Total Credits=05** |
| Final B.Tech VII | ECE904 | Artificial Intelligence for Data Analytics | 04 | -- | -- | 15 | 15 | 10 | 10 | 50 | 100 | 04 | -- | 04 |
| | | **Total** | 04 | -- | -- | 100 | | | | | 100 | 04 | -- | 04 |
| | | | | | | | | | | | | | | **Total Credits=04** |
| Final B.Tech. VIII | ECE973 | Mini Project | -- | -- | 04 | -- | -- | -- | 25 | 25 | 50 | -- | 02 | 02 |
| | | **Total** | -- | -- | 04 | -- | -- | -- | 25 | 25 | 50 | -- | 02 | 02 |
| | | | | | | | | | | | | | | **Total Credits=02** |

**Total Credit for Semester IV+V+VI+VII+VIII= 20**

L-Lecture, T-Tutorial, P- Practical, MSE- Mid Semester Exam, CIE-Continuous Internal Evaluation, TA-Teacher Assessment, ESE- End Semester Examination

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Syllabus of SY B. Tech. ( Honours* in Data Science) Semester-IV

| | |
|---|---|
| Course Code: ECE901<br>Course: Data Sciences and Visualization<br>**Teaching Scheme:**<br>Theory: 4 Hrs/week | Credits: 4-0-0<br>Mid Semester Examination-I: 15 Marks<br>Mid Semester Examination-II: 15 Marks<br>Continuous Internal Evaluation:10 Marks<br>Teacher Assessment: 10 Marks<br>End Semester Examination: 50 Marks<br>End Semester Examination (Duration): 2 Hrs |

| | | |
|---|---|---|
| **Prerequisite** | | Basic knowledge of mathematics and python programming. |
| **Objectives** | : | The course will introduce students to the fundamental data visualization concepts required for a program in data science. |
| **Unit-I** | : | **Introduction of Data**<br>Classification of Data, Data Literacy, sources of Data, Data acquisition, Data examination, Data transformation, Data exploration, Block Diagram of Data Science, Applications of Data science and requirement. (8 Hrs) |
| **Unit-II** | | **Data Analytics**<br>Definition and example.<br>Data Analysis Process: Data Requirement Specifications, Data Collection, Data Processing, Data Analysis, Infer and Interpret Results.<br>Data Analysis Methods: Qualitative Analysis, Quantitative Analysis, Text analysis, Statistical analysis, Diagnostic analysis, Predictive analysis.<br>(8 Hrs) |
| **Unit-III** | : | **Data Analysis Techniques and Tools**<br>Techniques based on Mathematics and Statistics, Techniques based on Artificial Intelligence and Machine Learning, Techniques based on Visualization and Graphs<br>Introduction to Data Analysis Tools: Excel, Tableau, Power BI, Fine Report, R & Python, SAS. (8 Hrs) |



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|---|---|---|
| **Unit-IV** | : | **Introduction to Data Visualization and Data Representation**<br>Basics of data visualization, Aesthetics in data visualization, Principles of good visualization design, Data visualization design workflow, Introduction to visual encoding, Chart types, Chart families, Categorical, Hierarchical, Relational, Temporal and Spatial. Methods of data visualization. Pi chart, Bubble diagram, Histogram and case studies. (8 Hrs) |
| **Unit-V** | : | **Interactivity**<br>Features of Interactivity, Data adjustments, View adjustments, Features of Annotation, Project Annotation, Chart Annotation, Features of colours, Data legibility, Features of Composition, Project Composition, Chart Composition. (8 Hrs) |
| **Unit-VI** | : | **Graphical analysis with gnuplot**<br>What is gnuplot and its limitation, Data analysis and visualization concepts, Simple plot, saving and exporting with gnuplot<br>Fundamental graphical methods, Relationships, Counting statistics, Ranked data, Multivariate data, Core principle of graphical analysis, A case study in iteration: car data. (8 Hrs) |
| **Reference books/ Text books** | : | 1. Andy Kirk, Data Visualization A Handbook for Data Driven Design, Sage Publications, 2016<br>2. Philipp K. Janert, Gnuplot in Action, Understanding Data with Graphs, Manning Publications, 2010 |



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Syllabus of SY B. Tech. ( Honours* in Data Science ) Semester-IV

| | |
|---|---|
| Course Code: ECE971 | Credits: 0-0-1 |
| Course: Laboratory Data Sciences and Visualization | Teacher Assessment: 25 Marks |
| **Teaching Scheme:** | |
| Practical: 2 Hrs/week | |

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|---|---|---|
| **Prerequisite** | | Basic knowledge of mathematics and Python/R programming/Tableau. |
| **Objectives** | : | The course will introduce students to the fundamental data visualization concepts required for a program in data science |
| **Laboratory Experiments** | : | 1. Introduction to programming language for data analytics: Python/R<br>2. Introduction to different libraries in Python/R<br>3. To Perform All Arithmetic and logical operations with Python/R<br>4. To perform basic data frame analysis using Python/R<br>5. Defining data visualization; Visualization workflow<br>6. Data Representation: chart types: categorical, hierarchical, relational, temporal & spatial<br>7. 2-D: bar charts, Clustered bar charts, dot plots, connected dot plots, pictograms, proportional shape charts, bubble charts, radar charts, polar<br>8. Charts, Range chart, Box-and-whisker plots, univariate scatter plots, histograms word cloud, pie chart, waffle chart, stacked bar chart, back-to-back bar chart, treemap and all relevant 2-D charts.<br>9. 3-D: surfaces, contours, hidden surfaces, pm3d coloring, 3D mapping;<br>10. Multi-dimensional data visualization; Graph data visualization; Annotation;<br>11. Case Study: Understanding basics of Recommendation Engines (with case study). |
| **Reference books/ Text books** | : | 1. Andy Kirk, Data Visualization A Handbook for Data Driven Design, Sage Publications, 2016<br>2. Philipp K. Janert, Gnuplot in Action, Understanding Data with Graphs, Manning Publications, 2010. |

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory



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- Oral examination conducted on the syllabus and term work mentioned above.



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Syllabus of TY B. Tech. (Honours* in Data Science) Semester-V

| | |
|---|---|
| Course Code: ECE902<br>Course: Statistical Foundations for Data Science<br>**Teaching Scheme:**<br>Theory: 4 Hrs/week | Credits: 4-0-0<br>Mid Semester Examination-I: 15 Marks<br>Mid Semester Examination-II: 15 Marks<br>Continuous Internal Evaluation:10 Marks<br>Teacher Assessment: 10 Marks<br>End Semester Examination: 50 Marks<br>End Semester Examination (Duration): 2 Hrs |

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|---|---|---|
| **Prerequisite** | | Basic knowledge of statistics and probability. |
| **Objectives** | : | The course will gives students to the fundamental mathematical concepts required for a program in data science. |
| **Unit-I** | : | **Introduction**<br>Measures of central tendency, mean median mode, measures of dispersion, means and standard deviation.<br>**Probability Review**<br>Sample Spaces, Conditional Probability and Independence, Density Functions, Expected Value, Variance, Joint, Marginal, and Conditional Distributions, Bayes' Rule, Bayesian Inference, Convergence and Sampling, Sampling and Estimation, Probably Approximately Correct (PAC), Concentration of Measure, Importance Sampling.<br>(8 Hrs) |
| **Unit-II** | : | **Linear Algebra Review**<br>Vectors and Matrices, Addition and Multiplication, Norms, Linear Independence, Rank,<br>Inverse, Orthogonality, Distances and Nearest Neighbors, Metrics, Lp Distances and their Relatives, Distances for Sets and Strings, Modeling Text with Distances, Similarities, Locality Sensitive Hashing.<br>(8 Hrs) |



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| **Unit-III** | : | **Linear Regression**<br>Simple Linear Regression, Linear Regression with Multiple Explanatory Variables, Polynomial Regression, Cross Validation, Regularized Regression, Functions, Gradients, Gradient Descent, Fitting a Model to Data, Least Mean Squares Updates for Regression, Decomposable Functions. (8 Hrs) |
| **Unit-IV** | : | **Principal Component Analysis**<br>Data Matrices, Singular Value Decomposition, Eigenvalues and Eigenvectors, The Power Method, Principal Component Analysis, Multidimensional Scaling, Clustering, Voronoi Diagrams, Delaunay Triangulation, Connection to Assignment-based Clustering, Hierarchical and k means Clustering. (8 Hrs) |
| **Unit-V** | : | **Classification**<br>Linear Classifiers, Perceptron Algorithm, Kernels, The Dual: Mistake Counter, Feature Expansion, Support Vector Machines, KNN Classifiers, Neural Networks. (8 Hrs) |
| **Unit-VI** | : | **Graphs**<br>Markov Chains, Ergodic Markov Chains, Metropolis Algorithm, PageRank, Spectral Clustering on Graphs, Laplacians and their Eigen-Structure, Communities in Graphs, Preferential Attachment, Betweenness, Modularity. (8 Hrs) |
| **Reference books/ Text books** | : | 1. B. L. S. Prakasa Rao, A First Course in Probability and Statistics, World Scientific/Cambridge University Press India, 2009.<br>2. R. V. Hogg, J. W. McKean and A. Craig, Introduction to Mathematical Statistics, 6th Ed., Pearson Education India, 2006.<br>3. G. Strang (2016). Introduction to Linear Algebra, Wellesley-Cambridge Press, Fifth edition, USA.<br>4. Bendat, J. S. and A. G. Piersol (2010). Random Data: Analysis and Measurement Procedures. 4th Edition. John Wiley & Sons, Inc., NY, USA: |



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Syllabus of TY B. Tech. (Honours* in Data Science) Semester-VI

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|---|---|
| Course Code: ECE903<br>Course: Machine Learning<br>Teaching Scheme:<br>Theory: 4 Hrs/week | Credits: 4-0-0<br>Mid Semester Examination-I: 15 Marks<br>Mid Semester Examination-II: 15 Marks<br>Continuous Internal Evaluation:10 Marks<br>Teacher Assessment: 10 Marks<br>End Semester Examination: 50 Marks<br>End Semester Examination (Duration): 2 Hrs |

| | | |
|---|---|---|
| **Prerequisite** | | Basic knowledge of mathematics, statistics and programming language (Python/R). |
| **Objectives** | : | To introduce students to the basic concepts and techniques of Machine Learning. |
| **Unit-I** | : | **Introduction**<br>Learning - Types of machine learning - Supervised learning - The brain and the neurons, Linear Discriminants -Perceptron - Linear Separability -Linear Regression - Multilayer perceptron – Examples of using MLP - Back propagation of error.<br>Suggested Activities: Design a Multilayer Perceptron for Rain Forecasting system.<br>(8 Hrs) |
| **Unit-II** | | **Classification Algorithms**<br>Decision trees - Constructing decision trees - Classification of regression trees - Regression example -<br>Probability and Learning: Turning data into probabilities - Some basic statistics - Gaussian mixture models - Nearest Neighbor methods.<br>Suggested Activities: Explore the Regression Examples in Machine Learning<br>(8 Hrs) |



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| **Unit-III** | : | **Analysis**<br>The k-Means algorithm - Vector Quantization's - Linear Discriminant Analysis - Principal component analysis - Factor Analysis - Independent component analysis - Locally Linear embedding – Iso map -Least squares optimization - Simulated annealing.<br>Suggested Activities: Simulated annealing / Modelling on any data science application.<br>(8 Hrs) |
| **Unit-IV** | : | **Optimization Techniques**<br>The Genetic algorithm - Genetic operators - Genetic programming - Combining sampling with genetic programming - Markov Decision Process - Markov Chain Monte Carlo methods: sampling – Monte carlo - Proposal distribution.<br>Suggested Activities: Design an Encryption algorithm using Genetic algorithm<br>(8 Hrs) |
| **Unit-V** | : | **Python for Machine Learning**<br>Baysean Networks - Markov Random moFields - Hidden Markov Models -Tracking methods.<br>(8 Hrs) |
| **Unit-VI** | : | **Python for MATLAB AND R users**<br>Python: Installation - Python for MATLAB AND R users - Code Basics - Using NumPy and MatPlotlib.<br>Suggested Activities: Design a simple application using NumPy and MatPlotlib.<br>(8 Hrs) |



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| **Reference books/ Text books** | : | 1. Kevin P. Murphy, "Machine Learning – A probabilistic Perspective", MIT Pres, 2016.<br>2. Randal S, "Python Machine Learning, PACKT Publishing, 2016.<br>3. Ethem Alpaydin, "Machine Learning: The New AI", MIT Press, 2016.<br>4. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.<br>5. Sebastian Raschka, "Python Machine Learning", Packt Publishing Ltd, 2015<br>6. E. Alpaydin, Introduction to Machine Learning, 3rd Edition, Prentice Hall (India) 2015.<br>7. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, 2nd Edn., Wiley India, 2007.<br>8. C. . Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), Springer, 2006.<br>9. S. O. Haykin, Neural Networks and Learning Machines, 3rd Edition, Pearson Education (India), 2016<br>10. J. Shawe-Taylor and Nello Christianini, Kernel Methods for Pattern Analysis, Cambridge University Press, 2004. |



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Syllabus of TY B. Tech. ( Honours* in Data science ) Semester-VI

| | |
|---|---|
| Course Code: ECE972<br>Course: Laboratory Machine Learning<br>**Teaching Scheme:**<br>Practical: 2 Hrs/week | Credits: 0-0-1<br>Teacher Assessment: 25 Marks |

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|---|---|---|
| **Prerequisite** | | Basic knowledge of mathematics, statistics and python programming. |
| **Objectives** | : | • To introduce students to the basic concepts and techniques of Machine Learning. |
| **Laboratory Experiments** | : | 1. Design of experiments in Machine Learning.<br>2. Introduction to popular Machine Learning Datasets and Toolkits.<br>3. Face Recognition using PCA.<br>4. Practical applications of clustering.<br>5. Experiments on supervised classification using MLP, RBF ANN, SVM and Decision Trees.<br>6. Application of Classifiers Ensembles.<br>7. Sequence classification using HMM.<br>8. Applications of CNN and RNN.<br>9. Path planning with Reinforcement Learning.<br>10. Introduction to advanced machine learning tools like, Azure ML studio, Spark. |



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| | | |
|---|---|---|
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| | | 9. S. O. Haykin, Neural Networks and Learning Machines, 3rd Edition, Pearson Education (India), 2016<br>10. J. Shawe-Taylor and Nello Cristianini, Kernel Methods for Pattern Analysis, Cambridge University Press, 2004.<br>11. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press, 2017<br>12. R. Sutton, Reinforcement Learning – An Introduction, MIT Press, 1998<br>13. Relevant Research Papers in the area of Machine Learning |

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.



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| Department of Electronics and Computer Engineering<br>Syllabus of Final Year B. Tech. ( Honours* in Data science ) Semester-VII | |
|---|---|
| Course Code: ECE904<br>Course: Artificial Intelligence for Data Analytics<br>Teaching Scheme:<br>Theory: 4 Hrs/week | Credits: 4-0-0<br>Mid Semester Examination-I: 15 Marks<br>Mid Semester Examination-II: 15 Marks<br>Continuous Internal Evaluation:10 Marks<br>Teacher Assessment: 10 Marks<br>End Semester Examination: 50 Marks<br>End Semester Examination (Duration): 2 Hrs |

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|---|---|---|
| **Prerequisite** | | Probability and Statistics, data analytics skills, knowledge of Computer science, Programming languages and coding. |
| **Objectives** | : | 1. Understanding Human learning aspects.<br>2. Understanding primitives and methods in learning process by computer.<br>3. To provide understanding of the techniques, mathematical concepts, and algorithm used in machines learning. |
| **Unit-I** | : | **Introduction to Intelligent Systems,**<br>History, Foundations and Mathematical treatments, Problem solving with AI, AI models, Learning aspects in AI, Intelligent Agents, types of Agents.<br>**Intelligent agents**: reactive, deliberative, goal-driven, utility-driven, and learning agents. (8 Hrs) |
| **Unit-II** | | **Problem-solving through Search**:<br>Forward and backward, state-space, blind, heuristic, problem-reduction, A, A*, AO*, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications. (8 Hrs) |



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| **Unit-III** | : | **Knowledge Representation and Reasoning:** ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications. **Planning**: planning as search, partial order planning, construction and use of planning graphs. (8 Hrs) |
| **Unit-IV** | : | **Representing and Reasoning with Uncertain Knowledge:** Probability, connection to logic, independence, Bayes rule, bayesian networks, probabilistic inference, sample applications. (8 Hrs) |
| **Unit-V** | : | **Decision-Making:** Basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications. (8 Hrs) |
| **Unit-VI** | : | **Machine Learning and Knowledge Acquisition:** Learning from memorization, examples, explanation, and exploration. learning nearest neighbor, naive Bayes, and decision tree classifiers, Q-learning for learning action policies, applications. Sample Applications of AI (8 Hrs) |
| **Reference books/ Text books** | : | **Text Books:** 1. Artificial Intelligence and Machine Learning By Vinod Chandra S.S. Anand Hareendran S 2. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach-Second Edition" Pearson Education 3. Tom M. Mitchell. "Machine Learning" McGraw-Hill, 1997. 4. Ethem Alpaydin "Introduction to machine learning" 2nd ed. The MIT Press, 2010 |



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Syllabus of Final Year B. Tech. ( Honours* in Data Science ) Semester-VIII

| | |
|---|---|
| Course Code: ECE973<br>Course: Mini Project<br>**Teaching Scheme:**<br>Practical: 4 Hrs/week | Credits: 0-0-2<br>Teacher Assessment: 25 Marks<br>Practical: 25 Marks |
| **Prerequisite** | Basic Programming Languages. |

To carry out a mini project and simple prototype in the area of interest based on the knowledge gained in Data Science from undergraduate and first semester.

Every individual student will be assigned a faculty to guide them. There will be three major reviews which will be carried out as listed below.

| Review # | Requirement | Mark Weightage | |
|---|---|---|---|
| | | Internal | External |
| 0 | Area / Title selection | - | - |
| 1 | Literature review / Proposal for the Project | 10% | - |
| 2 | Mathematical Modelling/Circuit Design | 20% | - |
| 3 | Final simulation / Hardware presentation | 20% | - |
| End Semester Exam | Final Viva-Voce and project demonstration | - | 50% |

The assessment of term work shall be done on the basis of the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.



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**Note:**

1. No additional fees will be charged for students opting for Honours/ Minor Degree
2. All the courses in the Honours/ Minor will be conducted in offline mode.
3. Re-examination is not applicable in Honours and Minor Scheme. Student failing in any of the Minor or Honours courses, at any stage will be discontinued from the Scheme.
4. Examination Scheme and Passing rules will be as per the academic rules and regulations of B. Tech.



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