GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA
Department of Information Technology
M.Tech. (Computer Science and Information Technology (Scheme-2020)

Subject Code: MCIT-101
Subject Name: Digital Image Processing

Programme: M. Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 100	**Duration of End Semester Exam(ESE):** 3 Hours
Total Marks: 150	**Course Type:** Programme Core

Course Outcomes:

After completing this course students will be able to:

1. Apply techniques and principles of image formation, sampling, quantization, spatial and frequency domain which will allow them to investigate specific image processing techniques.
2. Identify, formulate, and design algorithms in the area of digital image processing.
3. Use the techniques, skills, and modern engineering tools such as MATROX, MATLAB and OCTAVE for processing digital images.
4. Function on multi-disciplinary teams through experiments and projects related to imaging techniques.
5. Identify potential applications of image processing to advancement of knowledge in sciences and engineering with benefits in, e.g., policing, public safety, and social issues such as privacy.
6. Demonstrate a high level of self-directed learning ability, good oral and written communication skills on technical topics of digital image processing.

Prerequisites: Computer Fundamentals

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Introduction:
Fundamental steps in Digital Image Processing, Components of an image processing system, Image sampling and quantization. [3 hrs]

Digital Image Processing Operations:
Pixel relationships and distance metrics: Image coordinate system, Image topology, Connectivity, Relations, Distance measures. Classification of image processing Operations - Arithmetic, Logical Operations, Image interpolation Techniques (Down sampling and up sampling), Set operations, Statistical operations, Convolution and Correlation operations. [10 hrs]

Image Enhancement in Spatial Domain:
Image enhancement point operations: Linear and non-linear functions, Piecewise linear functions, Histogram processing. Spatial filtering - basics of filtering in the spatial domain, Smoothing linear and non-linear filters, sharpening filters. [5 hrs]

Part-B

Image Enhancement in Frequency Domain:
Basics of filtering in the frequency domain, Image smoothing and sharpening using frequency domain filters, Homomorphic filtering. [3 hrs]

Image Restoration:
A model of the image degradation/restoration process, Noise models, Noise filters, Degradation function. [2 hrs]

Multiresolution Analysis:
Wavelet analysis, Continuous wavelet transform, Discrete wavelet transform, Wavelet decomposition and reconstruction in two dimensions, Wavelet packet analysis, Wavelet based image denoising. [4 hrs]

Morphological Image Processing:
Structuring element, Erosion, Dilation, Opening, Closing, Hit-or-Miss transform, Boundary detection, Hole filling, Connected components, Convex hull, Thinning, Thickening, Skeletons, Pruning, Reconstruction by dilation and erosion. [3 hrs]

Image Segmentation: Classification of image segmentation algorithms, Point, Line and Edge detection, Hough transforms, Corner detection, Global thresholding, Otsu's method, Multivariable thresholding, Region-based segmentation, Watershed segmentation. [6 hrs]

Text Books

1. R. C. Gonzalez and R. E. Woods, "Digital Image Processing", Pearson Education, 2018.
2. S. Sridhar, "Digital Image Processing", Oxford University Press, 2016.
3. M. Sonka, V. Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", CL Engineering, 2007

Reference Books:

1. K. R. Castleman, "Digital Signal Processing", Pearson Education, 2007.
2. R. Gonzalez and R. Woods, "Digital Image Processing Using MATLAB", McGraw Hill Education, 2017.

Subject Code: LMCIT-101
Subject Name: Digital Image Processing Laboratory

Programme: M. Tech.	**L:** 0 **T:** 0 **P:** 4
Semester: 1	**Teaching Hours:** 48
Theory/Practical: Practical	**Credits:** 2
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 100%
External Marks: 50	**Duration of End Semester Exam(ESE):** 1.5 Hours
Total Marks: 100	**Course Type:** Programme Core

Prerequisite: Basic understanding of programming concepts.

Resource requirement: Any source software like Octave, Scilab, MATROX imaging Library MATLAB with Image

Course Outcomes:
After completing this course students will be able to:

1. Apply knowledge of software tools and techniques with hands-on experience for processing digital images.
2. Design solutions for the understanding of the image enhancement, image compression, image segmentation.
3. To conduct investigation and develop programming skills in digital image processing related problems.
4. Use the modern engineering tools such as Scilab, MATLAB Octave etc. for solving problems related to image processing.
5. Function on multi-disciplinary teams through mini projects based on image processing problems.
6. Predict knowledge and skill base necessary to further explore advanced topics of Digital Image Processing

Detailed Contents

1. Familiarity with MATLAB/Octave basic image processing commands.
2. Understanding the basic data types and their conversion from one to another.
3. Learning to build functions and scripts.
4. Implementation of various flow control and decision statements.
5. Implementation of various image enhancement techniques in the spatial domain.
6. Implementation of various image enhancement techniques in the frequency domain.
7. Implementation of various image segmentation techniques.
8. Demonstration of Image Acquisition through Matrix Frame Grabber Card and CCD camera.
9. Implementation of basic image processing operations through MATROX MIL 9.0

Mini- Project: By using various concepts of image processing, students are required to prepare a project by a single student. He has to submit a project report of 8 to 10 pages (approximately) and the will have to demonstrate the project as well as have to give a presentation of the same.
Note: It is recommended that mini project allocation to students be done within two-three weeks of the start of the semester. This is only the suggested list of Practical's. Instructor may also frame additional Practical's relevant to the course contents (if required).

Subject Code: MCIT-102
Subject Name: Soft Computing

Programme: M. Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 100	**Duration of End Semester Exam(ESE):** 3 Hours
Total Marks: 150	**Course Type:** Programme Core

Course Outcomes:
After studying this course the student will be able to:

1. Identify and describe soft computing techniques and their roles in building intelligent machines
2. Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering
3. Implement the appropriate Neural Network Model for an optimization problem under consideration.
4. Apply genetic algorithms to combinatorial optimization problems.
5. Evaluate and compare solutions by various soft computing approaches for a given problem.

Prerequisites: Basic knowledge of mathematics

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Introduction:
Introduction to Soft Computing and Neural Network, Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence, Machine Learning Basics.[8 hrs]

Fuzzy Logic:
Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Features of Membership Functions, Methods of Membership Value Assignments, Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making. [10 hrs]

Part-B

Neural Networks:
Evolution of Neural Networks, Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: theory, architecture, training algorithm; Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks. [10 hrs]

Genetic Algorithms: Introduction to Genetic Algorithms (GA), Biological Background, Traditional Optimization and Search Techniques, Genetic Algorithm vs. Traditional Algorithms, Operators in Genetic Algorithms, Stopping Condition for Genetic Algorithm Flow [8 hrs]

Text Books:

1. S.N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", 3rd edition, Wiley India Pvt. Ltd., 2019.
2. S. Rajasekaran, G. A. VijayalakshmiPai, "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning Pvt. Ltd, 2013.

Reference Books:

1. Jyh-Shing Roger Jang, "Neuro-Fuzzy And Soft Computing A Computational Approach To Learning And Machine Intelligence", Prentice Hall of India, 2008.
2. B. K. Tripathy, J. Anuradha, **"**Soft Computing: Advances and Applications", 1st Edition, Cengage India, 1st edition, 2018.

Subject Code: MCIT-103
Subject Name: Introduction to Bioinformatics

Programme: M. Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 100	**Duration of End Semester Exam(ESE):** 3 Hours
Total Marks: 150	**Course Type:** Programme Elective-I

Course Outcomes:
After studying this course the student will be able to:

1. To get introduced the basic concepts of bioinformatics and its significance in biological data analysis
2. Describe the history, scope and importance of bioinformatics and role of Internet in bioinformatics
3. Explain about the methods to characterize and manage the different types of biological data
4. Classify the different types of biological databases and understanding the sequence alignments
5. Introduction to methods and problems occurring in phylogenetic tree construction
6. Overview about the next-generation sequencing and medical applications

Prerequisites: Probability and Statistics basics, Data Structures and Algorithms

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Introduction:
Historical Overview and Definition of Bioinformatics, Applications of Bioinformatics, Molecular Biology and Bioinformatics, Central Dogma of Molecular Biology: Concept of DNA, RNA, Transcription and Translation, Proteins and Amino Acids. [8hrs]

Biological databases:
Role of bioinformatics in biological sciences, Goal, Scope, Biological Databases, Pitfalls of biological databases, tools for Web Search, Data Retrieval Tools, Information Retrieval from NCBI Genbank, Data Mining of Biological Databases. [8hrs]

Part-B

Sequence Alignment:
Introduction, Concept of Alignment, Scoring Matrices, PAM (Percent Accepted Mutations), BLOSUM (BLOcksSUbstitution Matrix), Pair-wise Alignment, Global Alignment, Local Alignment, Needleman-Wunsch Algorithm, Smith-Waterman Algorithm. [8 hrs]

Phylogenetic Analysis:
Overview, Methods of Phylogenetic Analysis: Distance based methods, character based methods, Tree evaluation, problems in phylogenetic analysis, Automated tools for phylogenetic analysis.[6hrs]

Next-generation Sequencing:

Introduction, Accessing GenBank and moving around NCBI databases, performing basic sequence analysis, working with modern sequence formats, working with alignment data, medical applications. [6hrs]

Text Books:

1. Tiago Antao, "Bioinformatics with Python Cookbook", PACKT Publishing, Birmingham, UK, 2015.
2. Z. Ghosh and B. Mallick "Bioinformatics: Principles and Applications", Oxford University Press, UK, 2013.
3. S.C., Rastogi, N. Mendiratta, P. Rastogi, "Bioinformatics: Methods and Applications (Genomics, Proteomics And Drug Discovery)" PHI Learning, 4th edition, 2013.

Reference Books:

1. JinXiong "Essential Bioinformatics", Cambridge University Press, 2012
2. B. Bergeron "Bioinformatics Computing", Prentice Hall Inc., 2015.
3. 3. S. Ignacimuthu, s.j. "Basic Bioinformatics", Narosa Publishing House Pvt. Ltd, New Delhi, 2013.

Subject Code: LMCIT-103
Subject Name: Introduction to Bioinformatics Laboratory

Programme: M. Tech.	**L:** 0 **T:** 0 **P:** 2
Semester: 1	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits: 1**
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 100%
External Marks: 50	**Duration of End Semester Exam(ESE):** 1.5 Hours
Total Marks: 100	**Course Type:** Programme Elective-I

Pre-requisites: Knowledge of Database Management System

Course Outcomes:
After studying this course the student will be able to:

1. Knowledge of different biological database Protein and gene sequence data bases
2. Information Retrieval from NCBI Genbank
3. To learn and implement the different R Packages
4. Implementing sliding window analysis of GC content using R
5. To perform Sequence analysis of FASTA files using python
6. Working with modern sequence formats using python

Detailed Contents:

1. Knowledge of different biological database Protein and gene sequence data bases (NCBI, DDBJ, EMBL, SWISS PROT, PIR)
2. Information Retrieval from NCBI Genbank.
3. To install R and a brief introduction to R
4. R packages for bioinformatics: Bioconductor and SeqinR
5. Retrieving and reading genome sequence data using SeqinR
6. A sliding window analysis of GC content using R
7. To perform Sequence analysis of FASTA files using python.
8. Working with modern sequence formats using python.

Mini Project: By using various concepts of syllabus students required to prepare a project in a group of two to three students.. The group of students must submit a project report of 8 to 10 pages (approximately) and the team will have to demonstrate the project as well as have to give a presentation of the same

Note: It is recommended that mini project allocation to students be done within two-three weeks of the start of the semester. This is only the suggested list of Practical's. Instructor may also frame additional Practical's relevant to the course contents (if required).

GURU NANAK DEV ENGINEERING COLLEGE, LUDHIANA
Department of Information Technology
M.Tech. (Computer Science and Information Technology (Scheme-2020)

Subject Code: MCIT-104
Subject Name: Data Warehousing and Data Mining

Programme: M. Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 100	**Duration of End Semester Exam(ESE):** 3 Hours
Total Marks: 150	**Course Type:** Programme Elective-I

Course Outcomes:
After studying this course the student will be able to:

1. Understand Data Warehouse fundamentals, Data Mining Principles
2. Design data warehouse with dimensional modeling and apply OLAP operations.
3. Identify appropriate data mining algorithms to solve real world problems.
4. Compare and evaluate different data mining techniques like classification, prediction, Clustering and association rule mining.
5. Describe complex data types with respect to text and web mining.
6. Benefit the user experiences towards research and innovation.

Prerequisites: Knowledge of Database Management System

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Data Warehousing:
Data Warehouse Concepts, Benefits, comparison OLTP and Data warehouse, Problems in DWH, Architectures of DWH, Data Mart, and Reasons for creating Data Mart. Data warehouse design: Dimension Modeling, Fact Table, Schemas for data warehouse, Steps to create data warehouse, Data Warehouse Design Practices and Methodologies, Data Integration Concepts, Details of Data Integration Tools. OLAP: Online Analytical Processing, OLAP cube, OLAP operations types of OLAP: ROLAP, MOLAP, Hybrid OLAP, Advantages & Disadvantages, OLTP vs. OLAP. [12 hrs]

Part-B

Data Mining:
Introduction to Data mining and knowledge discovery, Know your Data, Data Pre-processing, Mining frequent patterns, associations and correlations: Basic concepts and methods, Classification: Basic concepts, Classification algorithms, Clustering: Basic Concepts, Clustering algorithms, Cluster analysis: Basic Concepts and methods, outlier detection. [18 hrs]

Web and Text Mining:
Introduction, web mining, web content mining, web structure mining, we usage mining, Text mining unstructured text, episode rule discovery for texts, hierarchy of categories, text clustering. [6hrs]

Text Books:

1. Jiaweihan, Micheline K amber and Jian pei , "Data mining: concepts and techniques" , 3rd ed. the morgankaufmann series in data management , systems morgankaufmann publishers, july 2011.
2. Arun K. Pujari, "Data Mining Techniques", Universities press, 2001

3. MichaleMannino, Data warehouse Essentials, 2nd Edition, Chicago Business Press, 2018

Reference Books:

1. Introduction to Data Mining – Pang-Ning Tan, Vipinkumar, Michael Steinbach, Pearson.

2. Data Mining Principles & Applications – T.V Sveresh Kumar, B.Esware Reddy, Jagadish S Kalimani, Elsevier.

Subject Code: LMCIT-104
Subject Name: Data Warehousing and Data Mining Laboratory

Programme: M. Tech.	**L:** 0 **T:** 0 **P:** 2
Semester: 1	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits: 1**
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 100%
External Marks: 50	**Duration of End Semester Exam(ESE):** 1.5 Hours
Total Marks: 100	**Course Type:** Programme Elective-I

Pre-requisites: Knowledge of Database Management Systems

Course Outcomes:
After studying this course the student will be able to:

1. Create and customize a data warehouse
2. Apply data integration
3. Study different Data integration and data mining tools
4. Evaluate and analyses data using different data mining techniques
5. Apply classification or clustering to the dataset
6. Implement association algorithms on large datasets

Detailed Contents:

1. Design a Data ware House using any tool.
2. Create customize and extend pivot table using Pivot4j software.
3. Perform data integration using any data integration tool.
4. Explore and install the different data mining tools.
5. Perform data Cleaning and Data Preprocessing tasks on data sets using data mining tool.
6. Implement different classification/Regression algorithms on large dataset using data mining tools to predict results.
7. Implement data mining Association algorithms in Large Databases.
8. Apply the concept of Clustering techniques on any large dataset to analysis data clusters.

Mini Project: - Student has to do a project assigned from course contents in a group of two or three students. The group of students must submit a project report of 8 to 10 pages (approximately) and the team will have to demonstrate as well as have to give a presentation of the same.

Note: It is recommended that mini project allocation to students be done within two-three weeks of the start of the semester. This is only the suggested list of Practical's. Instructor may also frame additional Practical's relevant to the course contents (if required).

Subject Code: MCIT-105
Subject Name: Recommender System

Programme: M. Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 100	**Duration of End Semester Exam(ESE):** 3 Hours
Total Marks: 150	**Course Type:** Programme Elective-I

Course Outcomes:

After studying this course students will be able to:

1. Understand information retrieval concepts , Models and techniques
2. Identify different methods for content based filtering
3. describe approaches for user or item based recommendations
4. use hybrid approaches for recommender system
5. Evaluate recommender system
6. Benefit the user experiences towards research and innovation

Prerequisites: Basic knowledge of mathematics

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Introduction:
Overview of Information Retrieval, Retrieval Models, Search and Filtering Techniques: Relevance Feedback, User Profiles, Recommender system functions, Matrix operations, covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with Recommender system.[7hrs]

Content-based Filtering:
High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.[6hrs]

Part-B

Collaborative Filtering:
User-based recommendation, Item-based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems. [8hrs]

Hybrid approaches:
Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies [8hrs]

Evaluating Recommender System:

Introduction, General properties of evaluation research, Evaluation designs: Accuracy, Coverage, confidence, novelty, diversity, scalability, serendipity, Evaluation on historical datasets, Offline evaluations.[6hrs]

Text Books:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1st ed.
2. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer (2016), 1st ed.

Reference Books:

1. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer (2013), 1st ed.
2. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st ed.

Subject Code: LMCIT-105
Subject Name: Recommender System Laboratory

Programme: M. Tech.	**L:** 0 **T:** 0 **P:** 2
Semester: 1	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits: 1**
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 100%
External Marks: 50	**Duration of End Semester Exam(ESE):** 1.5 Hours
Total Marks: 100	**Course Type:** Programme Elective-I

Prerequisites: Basic programming skills.

Course Outcomes:
After studying the course students will be able to do

1. Explore data visualization methods and preprocessing tools.
2. Evaluate the developed models based on performance parameters
3. Implement the user based data filtering techniques
4. Apply item based collaborative filtering algorithms
5. Explore feature extraction methods
6. Apply and generate covariance matrices

Detailed Contents:

1. Explore data Visualization methods to understand the statistics of the dataset.
2. Working on data Preprocessing tools to clean the required data.
3. Find the correlation between various attributes of data by generating covariance matrices.
4. Extract the features and convert the features into vector-space representation.
5. Implement Nearest Neighbor Classification algorithm for Content-based learning model of user profiles.
6. Implement Bayes Classification algorithm for Content-based learning model of user profiles.
7. Implement Rule based Classification algorithm for Content-based learning model of user profiles.
8. Implement the user-based collaborative filtering algorithm.
9. Implement the item-based collaborative filtering algorithm.
10. Implement the naive Bayes model for collaborative filtering
11. Implement the decision tree model for collaborative filtering.
12. Implement the unconstrained matrix factorization method with stochastic gradient descent and batch updates.
13. Implement an entry-wise bagging model by using a weighted latent factor model as the base model.
14. Implement an algorithm for constructing the ROC and the precision-recall curves.
15. Compute the RMSE, MSE and MAE of the predictive models on some open source dataset.

Minor Project: Students are required to develop and evaluate recommender system based on any dataset in a group of two students. The usage of concepts like content based and collaborative filtering as well as the evaluation metrics such as RMSE, MSE and MAE must be used for the development of the project is recommended. The group of students must submit a project report of 8 to 10 pages (approximately) and the team will have to demonstrate the project as well as have to give a presentation of the same.

Note: It is recommended that mini project allocation to students be done within two-three weeks of the start of the semester. This is only the suggested list of Practical's. Instructor may also frame additional Practical's relevant to the course contents (if required).

Subject Code: MCIT-106
Subject Name: Machine Learning

Programme: M. Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 100	**Duration of End Semester Exam(ESE):** 3 Hours
Total Marks: 150	**Course Type:** Programme Elective-II

Course Outcomes:
After studying this course the student will be able to:
1. Apply Supervised Learning, Unsupervised learning, Deep Learning, Visualization techniques
2. Recognize and formalize a task as a machine learning problem
3. Interpret and present the predicted model
4. Identify suitable algorithms to tackle different machine learning problems
5. Apply machine learning algorithms to real datasets
6. Make powerful and accurate predictions.

Prerequisites: Basics of Mathematics, Algorithms

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Introduction to Probability and Statistics:
Population and sample, Gaussian/ normal distribution and their PDF's and CDF's, Co-variance, Pearson Correlation Coefficient, Spearman Rank Correlation Coefficient, Correlation vs Causation, Confidence interval (C.I) Introduction, Computing confidence interval given the underlying distribution, C.I for mean of a random variable, Confidence interval using bootstrapping, Hypothesis testing methodology, Null-hypothesis, p-value, Hypothesis Testing Intuition with coin toss example, Resampling and permutation test, Kolmogorov–Smirnov (KS)Test for similarity of two distributions, Proportional Sampling**.** [6 hrs]

Introduction to Machine Learning:
Difference between Machine Learning and traditional programming, Applications of Machine Learning, Why Machine Learning is the Future [3hrs]

Regression:
Simple Linear Regression, Multiple Linear Regression, Polynomial Regression, Support Vector Regression, Decision Tree Regression, Random Forest Regression. [8 hrs]

Part-B

Classification:
Linear, Non-linear, Multi-class and Multi-label classification, Neural Networks: Introduction, Perceptron, Multilayer Perceptron,Logistic Regression, K-Nearest Neighbors (K-NN), Support Vector Machine (SVM),Naive Bayes, Decision Tree Classification, Random Forest Classification. [6 hrs]

Clustering:

Introduction to clustering, Hierarchical: AGNES, DIANA, Partitional: K-means clustering, K- Mode Clustering, Self-Organizing Map, Expectation Maximization, Gaussian Mixture Models [7 hrs]

Performance Measurement:
Confusion matrix, log loss, Accuracy, R-Squared, Median Absolute deviation, Area Under the Curve (AUC), Receiver Operating Characteristics (ROC) curve, Outliers, Class imbalance. [4 hrs]

Text Books:

1. Jason Brownlee "Master Machine Learning Algorithms" Edition, v1.13, 2018
2. Alpaydin E., Introduction to Machine Learning, MIT Press (2010).
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach " Deep Learning (Adaptive Computation and Machine Learning series)" MIT Press (2017)
4. AurelienGeron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", Shroff/O'Reilly; First edition (2017)

Reference Books:

1. Michie D., Spiegelhalter D. J., Taylor C. C., Machine Learning, Neural and Statistical Classification. Overseas Press (2009).
2. N. J. Nilson, Introduction to Machine Learning, Stanford Online Link http://robotics.stanford.edu/people/nilsson/mlbook.html (Accessed on 30 July 2020)

Online learning material:

1. Machine Learning A-Z™: Hands-On Python & R In Data Science Created by Kirill Eremenko, Hadelin de Ponteves, Super Data Science Team, Super Data Science Support https://www.udemy.com/machinelearning/ (Accessed on 30 July 2020)
2. https://towardsdatascience.com The 5 Clustering Algorithms Data Scientists Need to Know (Accessed on 30 July 2020)
3. Crash Course on Machine Learning by Google https://developers.google.com/machine-learning/crash-course/ (Accessed on 30July 2020)

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Subject Code: LMCIT-106
Subject Name: Machine Learning Laboratory

Programme: M. Tech.	**L:** 0 **T:** 0 **P:** 2
Semester: 1	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits: 1**
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 100%
External Marks: 50	**Duration of End Semester Exam(ESE):** 1.5 Hours
Total Marks: 100	**Course Type:** Programme Elective-II

Pre-requisites: Basic programming skills, working of various Gates and computer fundamentals

Course Outcomes:
After studying this course, the student will be able to:

1. Collect data and apply pre-processing techniques
2. Implement and compare the relevant algorithms
3. Make robust Machine Learning models
4. Use Machine Learning for personal purpose
5. Formulate business problems as Machine Learning problems
6. Make powerful analysis

Detailed Contents:

1. Implement Simple Linear Regression.
2. Implement Random Forest Regression.
3. Implement Logistic Regression.
4. Implement Decision Tree classification algorithms.
5. Implement k-nearest neighbors classification algorithms.
6. Implement Support Vector Machine (SVM) classification algorithms.
7. Implement Naive Bayes classification algorithms.
8. Implement K-means Clustering to Find Natural Patterns in Data.
9. Implement K- Mode Clustering.
10. Evaluating Machine Learning algorithm with balanced and unbalanced datasets.
11. Compare various Machine Learning algorithms based on various performance metrices.**Mini Mini Project:** By using various concepts of syllabus students are required to prepare a project in a group of two to three students. The group of students must submit a project report of 8 to 10 pages (approximately) and the team will have to demonstrate the project as well as must give a presentation of the same. Some if the projects can be:

- Implement the classification Machine Learning models on the dataset (Amazon food reviews dataset) using hyperparameter tunning.
- Implement the clustering algorithm on the dataset using hyper parameter tuning.
- Try to solve the titanic dataset problem which is publically available on Kaggle with the use of the performance metrics (confusion matrix, classification report, AUC Roc curve) along with the visualizations.
- Explainable AI (Take a dataset from kaggle.com and implement the Explainable AI using SHapley Additive exPlanation(SHAP) or (LIME).
- Try to implement the some Kaggle problem

Note:

- Any Programming languages can also be used for implementation

- It is recommended that mini project allocation to students be done within two-three weeks of the start of the semester.
- This is only the suggested list of Practical's; Projects Instructor may also frame additional Practical's relevant to the course contents (if required)

Online learning Material:

1. http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php , Virtual machine learning labs [Accessed 31 July 2020]
2. https://playground.tensorflow.org/ , Tinker with a Neural Network Right Here in Your Browser [Accessed 31 July 2020]
3. https://ml-playground.com/ , Machine Learning Playground [Accessed 31 July 2020]

Subject Code: MCIT-107
Subject Name: Applied Data Science with Python

Programme: M. Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 100	**Duration of End Semester Exam(ESE):** 3 Hours
Total Marks: 150	**Course Type:** Programme Elective-II

Course Outcomes:
After studying this course, the student will be able to:

1. Conduct an inferential statistical analysis
2. Understand fundamental python programming techniques
3. Discern whether a data visualization is good or bad
4. Enhance a data analysis with applied machine learning
5. Analyze the connectivity of a social network
6. Do text mining and text manipulation

Prerequisites: Basic Mathematics

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Introduction to Data Science in Python:
Data Science, Jupyter Notebook, Python Functions, Python Types and Sequences, Python More on Strings, Python Demonstration: Reading and Writing CSV files, Python Dates and Times, Advanced Python Objects, map(), The Series Data Structure, Querying a Series, The DataFrame Data Structure, DataFrame Indexing and Loading, Querying a DataFrame, Indexing DataFrame, Missing values distributions, sampling and t-tests. [8 hrs]

Principles of Information Visualization: Matplotlib Architecture, Basic Plotting with Matplotlib, Scatterplots, Line Plots, Bar Charts, Dejunkifying a Plot. Subplots, Histograms, BoxPlots, Heatmaps, Animation, Interactivity, Plotting with Pandas, Seaborn [5 hrs]

Fundamentals of Machine Learning:
Introduction to Machine Learning, Linear Regression, Cross Validation and Bias -Variance Trade-off, Logistic Regression, K Nearest Neighbors, Decision Trees and Random Forests, Support Vector Machines Means Clustering, Principal Component Analysis [6 hrs]

Part-B

Applied Text Mining in Python:
Working with Text in Python: Handling Text in Python, Regular Expressions. Basic of Natural Language Processing, Basic NLP tasks with NLTK, Text Classification, Identifying Features from Text, Naive Bayes Classifiers, Naive Bayes Variations, Support Vector Machines [6 hrs]

Applied Social Network Analysis in Python:
Networks: Definition and Why We Study Them, Network Definition and Vocabulary, Node and Edge Attributes, Bipartite Graphs. Connected Components, Network Robustness, Degree and

Closeness Centrality, Betweenness Centrality, Basic Page Rank, Scaled Page Rank, Hubs and Authorities [8 hrs]

Text Books:

1. Jason Brownlee "Machine Learning Mastery with Python"Edition, v1.13, 2018
2. Joel Grus "Data Science from Scratch: First Principles with Python", 2nd Edition Shroff/O'Reilly 2019
3. Jake VanderPlas "Python Data Science Handbook: Essential Tools for Working with Data" Shroff/O'Reilly 2016
4. Ian Goodfellow, YoshuaBengio, Aaron Courville, Francis Bach "Deep Learning (Adaptive Computation and Machine Learning series)" MIT Press (2017)
5. AurelienGeron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems", Shroff/O'Reilly; First edition (2017)

Reference Books:

1 Michie D., Spiegelhalter D. J., Taylor C. C., Machine Learning, Neural and Statistical Classification. Overseas Press (2009).
2 N. J. Nilson, Introduction to Machine Learning, Stanford, Online Link http://robotics.stanford.edu/people/nilsson/mlbook.html (Accessed on 21 July 2019)

Subject Code: LMCIT-107
Subject Name: Applied Data Science with Python Laboratory

Programme: M. Tech.	**L:** 0 **T:** 0 **P:** 2
Semester: 1	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits: 1**
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 100%
External Marks: 50	**Duration of End Semester Exam(ESE):** 1.5 Hours
Total Marks: 100	**Course Type:** Programme Elective-II

Prerequisites: Basic programming skills.

Course Outcomes:
After studying this course, the student will be able to:

1. Use Python for Data Science and Machine Learning
2. Implement Machine Learning Algorithms
3. Learn to use NumPy for Numerical Data
4. Learn to use Pandas for Data Analysis
5. Learn to use Matplotlib for Python Plotting
6. Text mining using python

Detailed Contents:

1. Introduction to Jupyter Notebook System.
2. Write a python program to implement Strings in python.
3. Write a python program for working with Reading and Writing CSV files
4. Write a python program to demonstrate Python Dates and Times functions.
5. Write a python program to implement Series Data Structure
6. Write a python program for Querying a Series
7. Write a python program to implement Data Frame.
8. Write a python program to implement Hypothesis Testing.
9. Write a python program to demonstrate Plotting with Matplotlib
10. Write a python program to demonstrate Scatterplots
11. Write a python program to demonstrate Line Plots
12. Write a python program to create Bar Charts
13. Write a python program to create Box Plots
14. Write a python program to create Heatmap
15. Write a python program to implement K Nearest Neighbors
16. Write a python program to implement Decision Trees
17. Write a python program to implement Random Forests
18. Write a python program to implement Support Vector Machines
19. Write a python program to implement K Means Clustering
20. Write a python program to implement basic Natural Language Processing tasks with NLTK.
21. Write a python program to implement Text Classification
22. Write a python program for Network Visualizations in NetworkX

Mini Project: Real World use of Text mining, Natural Language processing, Sentimental Analysis Machine learning in recommendation system, financial analytics, disease prediction, Digital Image processing etc. Using the listed topics student has to do a project assigned from course contents in a group of two or three students. The group of students must submit a project report of 8 to 10 pages

(approximately) and the team will have to demonstrate as well as have to give a presentation of the same.

Note: It is recommended that mini project allocation to students be done within two-three weeks of the start of the semester. This is only the suggested list of Practical's. Instructor may also frame additional Practical's relevant to the course contents (if required).

Subject Code: MCIT-108
Subject Name: Introduction to Internet of Things

Programme: M. Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 100	**Duration of End Semester Exam(ESE):** 3 Hours
Total Marks: 150	**Course Type:** Programme Elective-II

Course Outcomes:

After studying this course the student will be able to:

1. Understand the vision of IoT from a global context
2. Interpret the impact and challenges posed by IoT networks leading to new architectural models
3. Appraise the role of IoT protocols for efficient network communication
4. Use of devices, gateways and data management in IoT
5. Elaborate the need of data analytics and security in IoT
6. Illustrate different sensor technologies for sensing real world entities and identify the applications of IoT in industry

Prerequisites: Fundamentals of Computer Networks, Wireless Sensor Network, Communication and Internet Technology, Web Technology, Information Security

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Introduction to Internet of Things:
Definition and Characteristics of IoT, IoT strategic research and innovation directions, Future Internet technologies, Infrastructure, Network and Communication, Processes, Data Management, Security, Privacy & Trust, Device level energy issues, IoT related standardization, recommendations on research topics [8 hrs]

IoT models and protocols Physical design of IoT – IoT protocols, IoT communication models, IoT communication APIs, communication protocols, embedded systems, Domain specific IoTs – home, city, environment, energy, retails, logistics, agriculture, industry, health and lifestyle [5 hrs]

M2M to IoT:
Basic perspective, M2M value chains, an IoT architecture outline, IoT value chains, software defined networks, virtualization, difference between SDN and NFV for IoT, basics of IoT system management with NETCOZF, YANG-NETCONF, YANG, SNMP NETOPEER [8 hrs]

Part-B

Introduction to Python:
Language features of python, data types, data structures, control of flow, functions, modules, packaging, file handling, date/time operations, classes, exception handling, python packages – JSON, XML, HTTP Lib, URL Lib, SMTP Lib [8 hrs]

IoT physical devices and end points :
Introduction to raspberry PI – interfaces (serial, SPI, I2C), programming – python program with raspberry PI with focus of interfacing external gadgets, controlling output, reading input from pins [7 hrs]

Text Books:

1. ArshdeepBahga and Vijay Madisetti, "Internet of Things – A Hands-on approach", University press, 2015.
2. Matt Richardson and Shawn Wallace, "Getting started with Raspberry Pi", O'Reilly (SPD), 2014.
3. Francis da Costa, "Rethinking the Internet of Things: A Scalable approach of connecting everything", Apress Publications, 2013.

Reference Books:

1. CunoPfister, "Getting started with the Internet of Things", O'Reilly Media, 2011.
2. Ronald L. Krutz and Russell Dean Vines, "cloud security: a comprehensive guide to secure cloud computing", Wiley-India, 2010.

Subject Code: LMCIT-108
Subject Name: Introduction to Internet of Things Laboratory

Programme: M. Tech.	**L:** 0 **T:** 0 **P:** 2
Semester: 1	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits: 1**
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 100%
External Marks: 50	**Duration of End Semester Exam(ESE):** 1.5 Hours
Total Marks: 100	**Course Type:** Programme Elective-II

Prerequisites: Basic programming skills.

Course Outcomes:
After studying this course the student will be able to:

1. Implementation of Linux commands through raspberry Pi
2. Familiarity with environment, data types and operators used in python
3. Learn to use the various control structures and numerous native data types with their methods
4. Design user defined functions, modules and packages
5. Create and handle files in python
6. Utilization of network and sensors for IoT applications

Detailed Contents

1. Start raspberry Pi and try various Linux commands in command terminal window:
a) ls, cd, touch, mv, rm, man, mkdir, rmdir, tar, gzip, cat, more, less, ps, sudo, cron, chown, chgrp, ping etc.

2. Run some python programs on Pi like:
   a) Read your name and print hello message with name
   b) Read two numbers and print their sum, difference, product and division
   c) Word and character count of a given string
   d) Area of a given shape (rectangle, triangle, and circle) reading shape and appropriate values from standard input
   e) Print a name 'n' times where name and n are read from standard input, suing for and while loops
   f) Handle divided by zero exception
   g) Print current time for 10 times with an interval of 10 seconds
   h) Read a file line by line and print the word count of each line

3. Light an LED through python program
4. Get input from two switches and switch on corresponding LEDs
5. Flash an LED at a given on time and off time cycle, where the two times are taken from a file
6. Flash an LED based on cron input (acts as an alarm)
7. Switch on a relay at a given time using cron, where the relay's contact terminals are connected to a load
8. Get the status of a bulb at a remote place (on the LAN) through web

Mini Project: - Student should have hands on experience in using various sensors like temperature, humidity, smoke, light etc. and should be able to use control web camera, network and relays connected to the Pi. Student has to do a project assigned from course contents in a group of two or

three students. The group of students must submit a project report of 8 to 10 pages (approximately) and the team will have to demonstrate as well as have to give a presentation of the same.

Note: It is recommended that mini project allocation to students be done within two-three weeks of the start of the semester. This is only the suggested list of Practical's. Instructor may also frame additional Practical's relevant to the course contents (if required).

Subject Code: MRM-101
Subject Name: Research Methodology and IPR

Programme: M. Tech.	**L:** 3 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 100	**Duration of End Semester Exam(ESE):** 3 Hours
Total Marks: 150	**Course Type:** Programme Elective-II

Course Outcomes:
After studying this course the student will be able to:

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Prerequisites: Basic Mathematics

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Introduction:
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations [8 hrs]

Literature Survey:
Effective literature studies approaches, analysis Plagiarism, Research ethics [4 hrs]

Writing:
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee [4 hrs]

Part-B

IPR:
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents [6 hrs]

Patents:

Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications. [4 hrs]

Recent Trends:
New Developments in IPR: Administration of Patent System, New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies [6 hrs]

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: An introduction for science & engineering students"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

Reference Books:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
2. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Subject Code: MAC-101
Subject Name: English for Research Paper Writing

Programme: M. Tech.	**L:** 2 **T:** 0 **P:** 0
Semester: 1	**Teaching Hours:** 24
Theory/Practical: Theory	**Credits:** 0
Internal Marks: 50	**Percentage of Numerical/Design Problems:** 20%
External Marks: 0	**Duration of End Semester Exam(ESE): NA**
Total Marks: 50	**Course Type:** Programme Elective-II

Course Outcomes:
After studying this course the student will be able to:
1. Understand the process for the improvement of writing skills
2. Understand the process for the improvement the level of readability
3. Learning about the categorization of different sections
4. Elaborate the correlation between title and contents
5. Attainment of key skills for writing title, abstract, introduction, literature, methods, results, discussion and conclusion
6. Design the useful phrases for good quality of paper

Prerequisites: Knowledge of Technologies, English Reading and Writing Skills

Additional Material Allowed in ESE: NIL (Mention anything like graph, calculator etc, if required in exam)

Detailed Contents:

Part-A

Module 1:
Planning and preparation, word order, breaking up long sentences, structuring paragraphs and sentences, being concise and removing redundancy, avoiding ambiguity and vagueness [4 hrs]

Module 2:
Clarifying who did what, highlighting your findings, hedging and criticizing, paraphrasing and plagiarism, sections of a paper, abstracts, and introduction [4 hrs]

Module 3:
Review of the literature, methods, result, discussion, conclusions, and the final check [4 hrs]

Part-B

Module 4:
Key skills are needed when writing a title, key skills are needed when writing an abstract, key skills are needed when writing an introduction, key skills are needed when writing a review of the literature[4 hrs]

Module 5:
Skills are needed when writing the methods, skills needed when writing the results, skills are needed when writing the discussion, and skills are needed when writing the conclusions [4 hrs]

Module 6:
Useful phrases, how to ensure paper is as good as it could possibly be the first – time submission [4 hrs]

Text Books:

1. R. Goldbort, "Writing for science", Yale university press, 2006. (available on Google books)
2. R. Day, "How to write and publish a scientific paper", Cambridge university press, 2006.
3. N. Highman, "Handbook of writing for the mathematical sciences", SIAM Highman's book, 1998.

Reference Books:

1. Adrian Wallwork, "English for writing research papers", Springer Newyork Dordrecht Heidelberg London, 2011.