Data Analytics

Title: Statistical Methods and Data Analysis **Code: 18B11CI916**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: None

Objective:

The objective of course is to equip the students with the mathematical & statistical techniques & their application to business problems. The emphasis will be on the concepts & application rather than derivations. The intention of the course is to make students able to use statistics as a helpful tool for solving complex business research problems under uncertainty and understand methods that quantify issues and give business managers a better basis for making decisions.

Learning Outcomes:

Course Outcome	Description
CO1	To familiarize the concept of data and data categorization and introduce the field of statistics & data analysis.
CO2	To understand and compute various measures of descriptive statistics such as mean, median, standard deviation, skewness, and kurtosis.
CO3	To describe basic concepts of probability and probability distributions and its applications in solving various business problems.
CO4	To learn and apply various statistical techniques such as sampling distribution, interval estimation and hypothesis testing for inferential data analysis using real world examples.
CO5	To develop the understanding to analyze a set of data / real world situations using correlation, regression analysis and ANOVA.
CO6	To build up decision making skills pertinent to the practice of statistics, including the students' abilities to formulate problems, to think creatively, and to synthesize information.

Course Content:

Unit-1: Introduction to Statistics, Types, Scope; Data sources, Data presentation, tabulation, charting, graphs; Measures of central tendency – Mean, Median, Mode; Measures of variations – range, interquartile range, standard deviation; Skewness, moments & kurtosis; Covariance and correlation.

Unit-2: Introduction to probability, basic laws & concepts, conditional probability; Probability distributions, random variable, probability function, expected value and variance, Discrete probability distribution, Binomial Distribution, Poisson Distribution, Continuous Probability Distribution, Normal Distribution, Exponential Distribution.

Unit-3: Sampling – introduction, purpose, random sampling methods, non-random sampling methods; Sampling distributions, Sampling Distribution of the Mean, Central Limit Theorem, Sampling Distribution of the Proportion.
Unit-4: Statistical estimation – Introduction, Properties of a good estimator, Point Estimation, Interval Estimation for sample mean, Interval Estimation for sample proportion, Sample size determination, Hypothesis testing – basic concepts, Null and the Alternative Hypothesis, Tests of Hypotheses about Population Means, Tests of Hypotheses about Population Proportions.
Unit-5: Regression analysis, linear regression, regression lines, regression coefficients, coefficient of determination, Analysis of Variance – introduction, assumptions, computation; One-way classification – variance between samples, variance within samples, F-ratio calculation, Two-way classification.

Teaching Methodology:

The course is a mix of classroom teaching (power point slides) which includes case studies, quiz, problem solving, and numerical questions.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lectures, tutorials and e-books on Statistical Methods and Data Analysis (are added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Anderson, Statistics for Business & Economics, Thomson Learning, Bombay.

Reference Books/Material:

[1] Gupta S.P. & Gupta M.P., Business Statistics, Sultan Chand & Sons, Delhi.
[2] Levin & Rubin, Statistics for Management, Prentice Hall of India, New Delhi.
[3] Mann P., Introductory Statistics, Wiley.
[4] Schumuller J., Statistical Analysis with Excel for Dummies, John Wiley & Sons, NJ.
[5] Berk & Karey, Data Analysis with Microsoft Excel, Cengage Learning, Boston.

Title: Statistical Methods and Data Analysis Lab **Code: 18B17CI976**

L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: None

Objective:

The objective of course is to equip the students with the mathematical & statistical techniques & their application to business problems. The intention of the course is to make students able to apply statistics using Microsoft Excel as a tool for solving complex business research problems under uncertainty and understand methods that quantify issues and give business managers a better basis for making decisions.

Learning Outcomes:

Course Outcome	**Description**
CO1	To familiarize the concept of data and data categorization and introduce the field of statistics & data analysis.
CO2	To understand and compute various measures of descriptive statistics such as mean, median, standard deviation, skewness, and kurtosis.
CO3	To apply basic concepts of probability and probability distributions and its applications in solving various business problems.
CO4	To learn and apply various statistical techniques such as sampling distribution, interval estimation and hypothesis testing for inferential data analysis using real world examples.
CO5	To develop the understanding to analyze a set of data / real world situations using correlation, regression analysis and ANOVA.
CO6	To build up decision making skills pertinent to the practice of statistics, including the students' abilities to formulate problems, to think creatively, and to synthesize information.

Course Content:

Unit-1: Introduction to Statistics, Types, Scope; Data sources, Data presentation, tabulation, charting, graphs; Measures of central tendency – Mean, Median, Mode; Measures of variations – range, interquartile range, standard deviation; Skewness, moments & kurtosis; Covariance and correlation.

Unit-2: Introduction to probability, basic laws & concepts, conditional probability; Probability distributions, random variable, probability function, expected value and variance, Discrete probability distribution, Binomial Distribution, Poisson Distribution, Continuous Probability Distribution, Normal Distribution, Exponential Distribution.

Unit-3: Sampling – introduction, purpose, random sampling methods, non-random sampling methods; Sampling distributions, Sampling Distribution of the Mean, Central Limit Theorem, Sampling Distribution of the Proportion.

Unit-4: Statistical estimation – Introduction, Properties of a good estimator, Point Estimation, Interval Estimation for sample mean, Interval Estimation for sample proportion, Sample size determination, Hypothesis testing – basic concepts, Null and the Alternative Hypothesis, Tests of Hypotheses about Population Means, Tests of Hypotheses about Population Proportions.

Unit-5: Regression analysis, linear regression, regression lines, regression coefficients, coefficient of determination, Analysis of Variance – introduction, assumptions, computation; One-way classification – variance between samples, variance within samples.

Teaching Methodology:

The course is taught through 2-hour lab exercises conducted using Microsoft Excel. The main emphasis is on problem solving and application of statistical concepts for business problems.

Evaluation Scheme:

Exams	**Marks**
Lab work	40 Marks
Lab record	15 Marks
Mid sem P1 Test	15 Marks
End sem P2 Test	15 Marks
Attendance and discipline	15 Marks
Total	**100 Marks**

Text Book:

1. Anderson, Essentials of Modern Business Statistics with Microsoft Excel, Cengage.

Title of Course: Machine Learning **Course Code: 18B11CI918**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: The mathematical tools needed for the course will be covered in some classes in the first week of the course.

Objective:
1. To learn and be able to implement the basic statistical techniques in the areas of interests.
2. To develop the abilities to apply the basic Machine Learning algorithms and interpret their results.

Learning Outcomes:

At the end of the course, students:

1. Get familiar with the fundamental methods at the core of modern machine learning.
2. Have a good grounding of the essential algorithms for supervised and unsupervised learning
3. Possess demonstrative skills in using and applying Machine Learning.
4. Work as a team on a project.

Course Outcome	**Description**
CO1	List various approaches of Machine Learning.
CO2	Describe machine learning algorithms to solve the real world problems
CO3	Develop Hypothesis and machine learning models
CO4	Identify appropriate models for solving machine learning problems.
CO5	Apply learning techniques to solve real world machine learning problems
CO6	Evaluate and interpret the results of the algorithms.

Course Content:

Unit-I: Introduction to machine learning, supervised and unsupervised machine learning, Applications of AI and machine learning , Linear Algebra, Matrices, Multi-Variable Calculus and Vectors, Mean, Median, mode, Dispersion.

Unit-II: Probability, Probability Distributions, and Central Limit Theorem.
Hypothesis Testing: The what, why and how of Hypothesis Testing are covered in this module. P-Value, different types of tests and implementation in Python.
Exploratory Data Analysis: EDA brings out the information from the Data. This module covers Data Cleaning, Univariate/ Bivariate analysis.

Unit-III: Linear Regression: Simple and Multiple, Issues in Regression like Collinearity. Project on Linear Regression. Logistic Regression Univariate and Multivariate Logistic Regression for

classification in ML, Implementation in R/Python, Naive Bayes Classification. Bias-Variance Tradeoff, Evaluation metrics: Confusion Matrix, F1 Score, Root Mean Squared Error.

Unit-IV: Decision Tree, Random Forest, SVM, Validation Techniques: Leave one out cross-validation, K-fold cross-validation, Stratified k-fold cross-validation.

Unit-V: K-Means clustering, Introduction to Neural Networks, Convolutional Neural Network.

Teaching Methodology:

This course is introduced to help students understand the discipline of Machine Learning. The programming tool used to teach this course are R and Python. Starting from the basic mathematical tools, the student will slowly be exposed to inferential statistics, and later to Machine Learning Algorithms. This theory course is well complemented by a laboratory course under the name Machine Learning Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 20-30% from coverage till Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage till Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Machine Learning (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

- Hastie, Tibshirani and Friedman. Elements of statistical learning.

Reference Material:

- L. Rosasco. Introductory Machine Learning Notes.
- Larry Wasserman. Clustering chapter

Title of Course: Machine Learning Lab **Course Code: 18B17CI996**
L-T-P scheme: 0-0-1 **Credit: 1**

Prerequisite: The mathematical tools needed for the course will be covered in some classes in the first week of the course.

Objective:

1. To learn and be able to implement the basic statistical techniques in the areas of interests.
2. To develop the abilities to apply the basic Machine Learning algorithms and interpret their results.

Learning Outcomes:
At the end of the course, students:

Course Outcome	**Description**
CO1	Get familiar with the fundamental methods at the core of modern machine learning.
CO2	Have a good grounding of the essential algorithms for supervised and unsupervised learning
CO3	Possess demonstrative skills in using and applying Machine Learning.
CO4	Work as a team on a project.

Course Content:

Unit-I: Introduction to machine learning, supervised and unsupervised machine learning, Applications of AI and machine learning , Linear Algebra, Matrices, Multi-Variable Calculus and Vectors, Mean, Median, mode, Dispersion.

Unit-II: Probability, Probability Distributions, and Central Limit Theorem.
Hypothesis Testing: The what, why and how of Hypothesis Testing are covered in this module. P-Value, different types of tests and implementation in Python.
Exploratory Data Analysis: EDA brings out the information from the Data. This module covers Data Cleaning, Univariate/ Bivariate analysis.

Unit-III: Linear Regression: Simple and Multiple, Issues in Regression like Collinearity. Project on Linear Regression. Logistic Regression Univariate and Multivariate Logistic Regression for classification in ML, Implementation in R/Python, Naive Bayes Classification. Bias-Variance Tradeoff, Evaluation metrics: Confusion Matrix, F1 Score, Root Mean Squared Error.

Unit-IV: Decision Tree, Random Forest, SVM, Validation Techniques: Leave one out cross-validation, K-fold cross-validation, Stratified k-fold cross-validation.

Unit-V: K-Means clustering, Introduction to Neural Networks, Convolutional Neural Network.

Teaching Methodology:

This course is introduced to help students understand the discipline of Machine Learning. The programming tool used to teach this course are R and Python. Starting from the basic mathematical tools, the student will slowly be exposed to inferential statistics, and later to Machine Learning Algorithms. This theory course is well complemented by a laboratory course under the name Machine Learning Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Evaluations		**Marks**	**Remarks**
P-1		15 Marks	
P-2		15 Marks	
Continuous Evaluations	Viva	20 Marks	
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Discipline and Punctuality and Attendance	15 Marks	
Total		**100 Marks**	

Learning Resources:

Lab exercises and lecture slides on Machine Learning (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

- Hastie, Tibshirani and Friedman. Elements of statistical learning.

Reference Material:

- L. Rosasco. Introductory Machine Learning Notes.
- Larry Wasserman. Clustering chapter

Title of Course: Data Analytics Systems and Algorithms **Course Code: 18B11CI917**
L-T-P Scheme: 3-0-0 **Credits: 3**

Pre-requisite:

- Students must have the minimal concept of Data Base Management Systems
- They must also have the concept of different types of algorithms used for searching data
- Students must have already studied the course "Business Analysis Techniques"

COURSE OVERVIEW:

This course will introduce students to this rapidly growing field of data analytics and equip them with some of its basic principles and tools as well as its general mindset. Students will learn concepts, techniques and tools they need to deal with various facets of data analytics practice, including data collection and integration, exploratory data analysis, predictive modelling, descriptive modelling, data product creation, evaluation, and effective communication.

Objective: The primary aim of this course is to further expand your understanding of data analytics and algorithms. To understand Data Analytics Life Cycle and Business Challenges. To understand Analytical Techniques and Statically Models

Learning Outcomes

Course Outcome	Description
CO1	**Demonstrate** proficiency with statistical analysis of data.
CO2	**Understand** the ability to build and assess data-based models.
CO3	**Demonstrate** skill in data management
CO4	**Illustrate** statistical analyses with professional statistical software.
CO5	**Implement** clustering algorithms like hierarchical Agglomerative clustering and k-means algorithm.
CO6	**Apply** data analytics concepts and methods to solve problems in real-world contexts and will communicate these solutions effectively

Course Outline:

Unit I: Introduction and Data Pre-processing: Data Science Introduction, Big Data and Data Science, Current landscape of perspectives

Unit II: Data Analysis and Correlations: Basic Concepts and Methods Populations and samples, Statistical modelling, probability distributions, Regression, fitting a model, Dimensionality Reduction: PCA & DWT, Correlation and regression analysis. Chi-square t and F distributions (definitions only) Confidence interval Single mean and difference known and unknown variances.

Unit III: Introduction to machine learning and Cluster Analysis: Basic Concept and Methods Supervised and unsupervised learning, Training and testing data, over fitting and under fitting. Distance measures: - Manhattan, Chebbychev, Mahalanobis Distance Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Evaluation of Clustering, Clustering High-Dimensional Data Clustering Graph and Network Data

Unit IV: Classification Algorithms: Basic Concepts, Decision Tree Induction, Bayes Classification Methods, Rule-Based Classification, Model Evaluation and Selection, Techniques to Improve Classification Accuracy, Support Vector Machines, Lazy Learners (or Learning from Your Neighbors)

Unit V: Introduction to Web Search and Social Media Analytics: Data Wrangling: APIs and other tools for scrapping the Web Mining Complex Data Types, Other Methodologies of Data, Mining, Data Mining Applications, Data Mining and Society, Data Mining Trends Social Media Analytics is the science of analyzing data to convert information to useful knowledge. This knowledge could help us understand our world better and, in many contexts, enable us to make better decisions.

Text Book

1. Data Mining, Concepts and Techniques: Jiawei Han and Micheline Kamber, Elsevier 2nd edition.
2. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from the Frontline, O'Reilly. 2014.
3. Avrim Blum, John Hopcroft and Ravindran Kannan. Foundations of Data Science.

Refernce Books:

1. Data Mining: Introductory and Advanced Topics: Margaret H. Dunham, Prentice Hall.
2. Data Warehousing, Data Mining and OLAP: Alex, Berson, Stephen J. Smith, Tata McGraw-Hill, 2004.
3. Mining the Web : Discovering knowledge from hypertext data: Soumen Chakrabarty, Morgan Kaufmann
4. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press. 2014.
5. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Elements of Statistical Learning, Second Edition. ISBN 0387952845. 2009.

Evaluation Scheme:

Evaluations	Marks	Remarks
T-1	15 Marks (1-Hours)	1^{st} - 4^{th} Week
T-2	25 Marks (1:30 Hours)	5^{th} - 10^{th} Week
T-3	35 Marks (2-Hours)	11^{th} - 16^{th} Week
Assignments	10 Marks	
Tutorials / Subject Seminar	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Course Title: Data Analytics Lab **Course Code: 18B17CI977**
L-T-P Scheme: 0-0-2 **Credit: 1**

Prerequisite: Basic Programming Knowledge

Course Objectives:

The objective of this course is to provide comprehensive knowledge of python programming paradigms required for Data Analytics.

Learning Outcomes: At the end of the course students should be able to:

- Identify the need for data science and solve basic problems using Python built-in data types and their methods.
- Design an application with user-defined modules and packages using OOPs concept
- Employ efficient storage and data operations using NumPy arrays.
- Apply powerful data manipulations using Pandas.
- Do data preprocessing and visualization using Pandas

Course Content:

Unit-1: INTRODUCTION TO DATA ANALYTICS AND PYTHON PROGRAMMING

Introduction to Data Analytics, Essential Python libraries-Python, Introduction-Features, Identifiers, Reserved words, Indentation, Comments, Built-in Data types and their Methods: Strings, List, Tuples, Dictionary, Set-Type Conversion-Operators. Decision Making- Looping- Loop Control statement- Math and Random number functions. User defined functions- function arguments & its types.

Practical Component:

1. Implement basic Python programs for reading input from console.
2. Perform Creation, indexing, slicing, concatenation and repetition operations on Python built-in data types: Strings, List, Tuples, Dictionary, and Set.
3. Solve problems using decision and looping statements.
4. Apply Python built-in data types: Strings, List, Tuples, Dictionary, Set and their methods to solve any given problem.
5. Handle numerical operations using math and random number functions.
6. Create user-defined functions with different types of function arguments.

Unit-2: FILE, EXCEPTION HANDLING AND OOPs

User defined Modules and Packages in Python- Files: File manipulations, File and Directory related methods. Python Exception Handling. OOPs Concepts -Class and Objects, Constructors - Data hiding- Data Abstraction- Inheritance.

Practical Component:

1. Create packages and import modules from packages.
2. Perform File manipulations- open, close, read, write, append and copy from one file to another.
3. Handle Exceptions using Python Built-in Exceptions
4. Solve problems using Class declaration and Object creation.
5. Implement OOP concepts like Data hiding and Data Abstraction.
6. Solve any real-time problem using inheritance concept.

Unit-3: INTRODUCTION TO NUMPY

NumPy Basics: Arrays and Vectorized Computation- the NumPy ndarray-Creating ndarrays- Data Types for ndarrays- Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing-Transposing Arrays and Swapping Axes.

Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods-Sorting- Unique and Other Set Logic.

Practical Component:

1. Create NumPy arrays from Python Data Structures, Intrinsic NumPy objects and Random Functions.
2. Manipulation of NumPy arrays- Indexing, Slicing, Reshaping, Joining and Splitting.
3. Computation on NumPy arrays using Universal Functions and Mathematical methods.
4. Import a CSV file and perform various Statistical and Comparison operations on rows/columns.
5. Load an image file and do crop and flip operation using NumPy Indexing.

Unit-4: DATA MANIPULATION WITH PANDAS

Introduction to pandas Data Structures: Series, Data Frame, and Essential Functionality: Dropping Entries- Indexing, Selection, and Filtering- Function Application and Mapping- Sorting and Ranking. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format.

Practical Component:

1. Create Pandas Series and Data Frame from various inputs.
2. Import any CSV file to Pandas Data Frame and perform the following:
    a. Visualize the first and last 10 records
    b. Get the shape, index and column details
    c. Select/Delete the records (rows)/columns based on conditions.
    d. Perform ranking and sorting operations.
    e. Do required statistical operations on the given columns.
    f. Find the count and uniqueness of the given categorical values.

Unit-5: DATA CLEANING, PREPARATION AND VISUALIZATION

Data Cleaning and Preparation: Handling Missing Data - Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers- String Manipulation: Vectorized String Functions in pandas. Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots.

Practical Component:

1. Import any CSV file to Pandas Data Frame and perform the following:
    a. Handle missing data by detecting and dropping/ filling missing values.
    b. Transform data using apply () and map () method.
    c. Detect and filter outliers.
    d. Perform Vectorized String operations on Pandas Series.
    e. Visualize data using Line Plots, Bar Plots, Histograms, Density Plots and Scatter Plots.

TEXT BOOKS

1. Y. Daniel Liang, "Introduction to Programming using Python", Pearson, 2012.
2. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly, 2nd Edition, 2018.
3. Jake Vander Plas, "Python Data Science Handbook: Essential Tools for Working with Data", O'Reilly, 2017.

REFERENCE BOOKS

1. Wesley J. Chun, "Core Python Programming", Prentice Hall, 2006.
2. Mark Lutz, "Learning Python", O'Reilly, 4th Edition, 2009.

E-BOOKS

1. https://www.programmer-books.com/introducing-data-science-pdf
2. https://www.cs.uky.edu/~keen/115/Haltermanpythonbook.pdf
3. http://math.ecnu.edu.cn/~lfzhou/seminar/[Joel_Grus]_Data_Science_from_Scratch_First_Princ.pdf

MOOC

1. https://www.edx.org/course/python-basics-for-data-science
2. https://www.edx.org/course/analyzing-data-with-python
3. https://www.coursera.org/learn/python-plotting?specialization=data-science-python

Evaluation Scheme:

Exams	**Marks**
P1-Test	15 Marks
P2-Test	15 Marks
Day to day work	40 Marks
Assignment	10 Marks
Lab Record	15 Marks
Attendance	5 Marks
Total	**100 Marks**

Title: Information Retrieval **Code: 18B11CI919**
L-T-P scheme: 3-0-0 **Credit: 3**

COURSE OVERVIEW:
The main objective of this course is to present the scientific support in the field of information search and retrieval. This course explores the fundamental relationship between information retrieval, hypermedia architectures, and semantic models, thus deploying and testing several important retrieval models such as vector space, Boolean and query expansion. It discusses implementation and evaluation issues of new algorithms like clustering, pattern searching, and stemming with advanced data/file structures, indirectly facilitating a platform to implement comprehensive catalogue of information search tools while designing an e-commerce web site.

PRE-REQUISITES:
1. Students must have the minimal concept of Data Base Management Systems.
2. They must also have the concept of different types of algorithms used for searching data.
3. They must also have the minimal knowledge of Natural language such as thesaurus, synonyms etc. to understand the concept of retrieving the textual information because text is the main data type used in Information Retrieval Systems.

COURSE OBJECTIVES:

- Demonstrate genesis and diversity of information retrieval situations for text and hyper media.
- Describe hands-on experience store, and retrieve information from www using semantic approaches.
- Demonstrate the usage of different data/file structures in building computational search engines.
- Analyze the performance of information retrieval using advanced techniques such as classification, clustering, and filtering over multimedia.
- Analyze ranked retrieval of a very large number of documents with hyperlinks between them.
- Demonstrate Information visualization technologies like Cognition and perception in the Internet or Web search engine.

Learning Outcomes:

Course Outcome	Description
CO1	Understanding the basics of Information retrieval like what is a corpus, what is precision and recall of an IR system.
CO2	Understanding the data structures like Inverted Indices used in Information retrieval systems.
CO3	Understanding the basics of web search.
CO4	Understanding the different techniques for compression of an index including the dictionary and its posting list.

CO5	Understanding the different components of an Information retrieval system.
CO6	Developing the ability of develop a complete IR system from scratch.

Course Content:

Unit-1: Introduction – Information versus Data Retrieval. Modeling of Information retrieval, Boolean Model, Vector Model, Probabilistic Model, Set Theoretical Models, Structured Text Retrieval Models

Unit-2: Classification, Measures of Association, Cluster Hypothesis, Single Link Clusters, File Structures, Inverted Files, Index Sequential Files, Ring Structures, Doubly Chained Trees, and Hash Addressing.

Unit-3: Evaluation, Relevance, Precision and Recall, Interpolation, Averaging techniques, The Swets Model.

Unit-4: Search Engines, Boolean Search, Matching Functions, Serial Search, Cluster Representatives, Cluster based retrieval.

Unit-5: Web search basics – Web characteristics - crawling and indexes – Features of a crawler – Crawler architecture – DNS resolution – The URL frontier – Distributing indexes – Connectivity servers.

Unit-6: Link Analysis – The Web as a graph – Anchor text and the web graph, Page Rank – Markov chains, Page Rank computation, Topic-specific Page Rank, Hubs and authorities

Teaching Methodology:

- Blackboard teaching
- PowerPoint presentations

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 and Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	100 Marks	

Learning Resources:

Tutorials and lecture slides on Information Retrieval (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

1. An Introduction to Information Retrieval: Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Cambridge University Press, Cambridge, England, 2009
2. Information Retrieval: Implementing and evaluating search engines: Stefan Büttcher, Charles L. A. Clarke, Gordon V. Cormack, MIT Press, 2010 "Web Engineering: A Practitioner's Approach"; Roger Pressman and David Lowe, McGraw-Hil Publication, 3e, 2009.

Reference Books/Material:

1. Information Retrieval: Algorithms and Heuristics: David A. Grossman, Ophir Frieder, Springer.
2. Information Retrieval: Data Structures and Algorithms by Frakes, Pearson

Journals References:

[1] ACM Transactions on Information Systems
[2] ACM Transactions on the Web
[3] Information Processing and Management (formerly Information Storage and Retrieval)
[4] Information Processing and Management, Elsevier
[5] Journal of the American Society for Information Science, JASIST
[6] Information Retrieval, Kluwer
[7] Journal of Intelligent Information Systems, Kluwer

Title: Information Retrieval Lab **Code: 18B17CI979**
L-T-P scheme: 0-0-2 **Credit: 1**

COURSE OVERVIEW:
The goal of this lab course is to provide students with an understanding of all aspects of the design and implementation of Web search engines. Students will master the fundamental concepts of Information Retrieval, i.e., text representation, indexing, querying, and ranking by relevance.

PRE-REQUISITES:
1. Good programming skills (Python and Java language)
2. Critical analysis skills
3. They must also have the minimal knowledge of Natural language such as thesaurus, synonyms etc. to understand the concept of retrieving the textual information because text is the main data type used in Information Retrieval Systems.

COURSE OBJECTIVES:
- Demonstrate Text pre-processing: tokenization, stop words, stemming, n-grams.
- Describe Indexing fields and document ranking by relevance.
- Demonstrate Retrieval models.
- Analyze the Rank fusion and learning to rank.
- Analyze Ranking by document authority (PageRank).
- Demonstrate Search engine evaluation methods

Learning Outcomes:

Course Outcome	**Description**
CO1	Learn the concept of information relevance.
CO2	Analyze Web and multimedia data.
CO3	Learn how to rank information by relevance, Understand evaluation protocols.
CO4	Implement information retrieval models, Ability to adapt and improve components of a search engine.
CO5	Deploy search engines with large-scale datasets, Design evaluation protocols and evaluate search engines.
CO6	Select the right IR techniques for particular problems, Design information retrieval systems.

Organization:
During the course lectures, we will discuss key concepts and introduce well-established information retrieval techniques and algorithms: the vector space model, the BM25 retrieval model, information relevance, PageRank, indexing, language-models and learning to rank.
Students are further exposed to these key information retrieval concepts on the laboratory lectures. The weekly laboratories, aim to provide students with a hands-on experience to allow

the consolidation of the concepts discussed in the lectures. Students are guided through the full set of laboratories, requiring a careful analysis of experimental results at specific checkpoints throughout the semester.

Lab Exercises:

00 - Getting started
01 - Introduction to Python
02 - Introduction to Jupyter
03 - Text Analysis
04 - Indexing
05 - Basic Retrieval
06 - Advanced Retrieval
07 - Evaluation

Teaching Methodology:

- Live coding
- PowerPoint presentations

Evaluation Scheme:

Exams	**Marks**	**Coverage**
P -1	15 Marks	Based on Unit-1, Unit-2
P -2	15 Marks	Based on Unit-3 and Unit-4 and around 30% from coverage of Test-1
Continuous Evaluation	70 Marks	Viva : 20 marks Discipline and Punctuality : 15 marks Demonstration : 20 marks Attendance : 05 marks
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Information Retrieval (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

1. An Introduction to Information Retrieval: Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Cambridge University Press, Cambridge, England, 2009
2. Information Retrieval: Implementing and evaluating search engines: Stefan Büttcher, Charles L. A. Clarke, Gordon V. Cormack, MIT Press, 2010 “Web Engineering: A Practitioner's Approach”; Roger Pressman and David Lowe, McGraw-Hil Publication, 3e, 2009.

Reference Books/Material:

1. Information Retrieval: Algorithms and Heuristics: David A. Grossman, Ophir Frieder, Springer.

2. Information Retrieval: Data Structures and Algorithms by Frakes, Pearson

Journals References:

1. ACM Transactions on Information Systems
2. ACM Transactions on the Web
3. Information Processing and Management (formerly Information Storage and Retrieval)
4. Information Processing and Management, Elsevier
5. Journal of the American Society for Information Science, JASIST
6. Information Retrieval, Kluwer
7. Journal of Intelligent Information Systems, Kluwer

Title of Course: Big Data Processing Lab **Course Code: 18B17CI980**
L-T-P Scheme: 0-0-2 **Course Credits: 1**

Big Data Processing Lab: 18B17CI980	
Course Outcome	**Description**
CO1	Identify challenges of Big data and its existing technologies
CO2	Use UNIX and HDFS commands
CO3	Analyze data using Map-Reduce framework
CO4	Students are able to work with NoSQL databases such as MongoDB and Cassandra
CO5	Students are able to design Big data queries using Hive and Pig.

COURSE OBJECTIVES

- Demonstrate the HDFS commands
- Implement HADOOP with Map-Reduce
- Use Apache Pig for analytics framework
- Demonstrate HIVE QL
- Compute the Page-Rank using Pig
- Implement Map-Reduce programs for data analysis

Course Contents:

List of Experiments

1. Set up a pseudo-distributed, single-node Hadoop cluster backed by the Hadoop Distributed File System, running on Ubuntu Linux. After successful installation on one node, configuration of a multi-node Hadoop cluster (one master and multiple slaves). Hadoop file management: Adding files and directories ,Retrieving files , Deleting files
2. Move files between your regular Linux file-system and HDFS you can use the put and get commands.
3. Run the word-count job with the command below, where "/user/biadmin/input/" is where the input files are, and "output" is the directory where the output of the job will be stored.
4. Write a script to implement the following:
   - ❖ Exploring Data with Apache Pig
   - ❖ Splitting a Dataset
   - ❖ Joining Datasets with Apache Pig
5. Write a script to implement the following on the given dataset:
   - ❖ Sorting
   - ❖ Grouping the Data with Apache Pig
6. Write a script to Demonstration: Computing Page Rank using Pig
7. Database manipulation using Hive: To create, alter, drop databases and views
8. Define an external Hive table and review the results, Implement Partition and Skew in Hive
9. Functions and indexes in Hive, Use Hive to Drop Functions and indexes
10. Produce the histogram by summing the word counts grouped by word length.

Reading Material(s):

1. Data Science and Big Data Analytics, EMC2 Education Dept. of CSE VR14 VRSEC 162 Services
2. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, 2ned, Elseiver publishers
3. Vignesh Prajapati, Big Data Analytics with R and Hadoop, packt publishing, 2013
4. Bill Franks, Taming the Big Data Tidal Wave, 1st Edition, Wiley, 2012. [3] Frank J. Ohlhorst, Big Data Analytics, 1st Edition, Wiley, 2012.

Evaluation Scheme:

Exams	**Marks**
P1-Test	15 Marks
P2-Test	15 Marks
Day to day work	40 Marks
Assignment	10 Marks
Lab Record	15 Marks
Attendance	5 Marks
Total	**100 Marks**

Artificial Intelligence and Machine Learning

Title: Statistical Methods and Data Analysis **Code: 18B11CI916**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: None

Objective:

The objective of course is to equip the students with the mathematical & statistical techniques & their application to business problems. The emphasis will be on the concepts & application rather than derivations. The intention of the course is to make students able to use statistics as a helpful tool for solving complex business research problems under uncertainty and understand methods that quantify issues and give business managers a better basis for making decisions.

Learning Outcomes:

Course Outcome	Description
CO1	To familiarize the concept of data and data categorization and introduce the field of statistics & data analysis.
CO2	To understand and compute various measures of descriptive statistics such as mean, median, standard deviation, skewness, and kurtosis.
CO3	To describe basic concepts of probability and probability distributions and its applications in solving various business problems.
CO4	To learn and apply various statistical techniques such as sampling distribution, interval estimation and hypothesis testing for inferential data analysis using real world examples.
CO5	To develop the understanding to analyze a set of data / real world situations using correlation, regression analysis and ANOVA.
CO6	To build up decision making skills pertinent to the practice of statistics, including the students' abilities to formulate problems, to think creatively, and to synthesize information.

Course Content:

Unit-1: Introduction to Statistics, Types, Scope; Data sources, Data presentation, tabulation, charting, graphs; Measures of central tendency – Mean, Median, Mode; Measures of variations – range, interquartile range, standard deviation; Skewness, moments & kurtosis; Covariance and correlation.

Unit-2: Introduction to probability, basic laws & concepts, conditional probability; Probability distributions, random variable, probability function, expected value and variance, Discrete probability distribution, Binomial Distribution, Poisson Distribution, Continuous Probability Distribution, Normal Distribution, Exponential Distribution.

Unit-3: Sampling – introduction, purpose, random sampling methods, non-random sampling methods; Sampling distributions, Sampling Distribution of the Mean, Central Limit Theorem, Sampling Distribution of the Proportion.
Unit-4: Statistical estimation – Introduction, Properties of a good estimator, Point Estimation, Interval Estimation for sample mean, Interval Estimation for sample proportion, Sample size determination, Hypothesis testing – basic concepts, Null and the Alternative Hypothesis, Tests of Hypotheses about Population Means, Tests of Hypotheses about Population Proportions.
Unit-5: Regression analysis, linear regression, regression lines, regression coefficients, coefficient of determination, Analysis of Variance – introduction, assumptions, computation; One-way classification – variance between samples, variance within samples, F-ratio calculation, Two-way classification.

Teaching Methodology:

The course is a mix of classroom teaching (power point slides) which includes case studies, quiz, problem solving, and numerical questions.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lectures, tutorials and e-books on Statistical Methods and Data Analysis (are added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Anderson, Statistics for Business & Economics, Thomson Learning, Bombay.

Reference Books/Material:

[1] Gupta S.P. & Gupta M.P., Business Statistics, Sultan Chand & Sons, Delhi.
[2] Levin & Rubin, Statistics for Management, Prentice Hall of India, New Delhi.
[3] Mann P., Introductory Statistics, Wiley.
[4] Schumuller J., Statistical Analysis with Excel for Dummies, John Wiley & Sons, NJ.
[5] Berk & Karey, Data Analysis with Microsoft Excel, Cengage Learning, Boston.

Title: Statistical Methods and Data Analysis Lab **Code: 18B17CI976**

L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: None

Objective:

The objective of course is to equip the students with the mathematical & statistical techniques & their application to business problems. The intention of the course is to make students able to apply statistics using Microsoft Excel as a tool for solving complex business research problems under uncertainty and understand methods that quantify issues and give business managers a better basis for making decisions.

Learning Outcomes:

Course Outcome	**Description**
CO1	To familiarize the concept of data and data categorization and introduce the field of statistics & data analysis.
CO2	To understand and compute various measures of descriptive statistics such as mean, median, standard deviation, skewness, and kurtosis.
CO3	To apply basic concepts of probability and probability distributions and its applications in solving various business problems.
CO4	To learn and apply various statistical techniques such as sampling distribution, interval estimation and hypothesis testing for inferential data analysis using real world examples.
CO5	To develop the understanding to analyze a set of data / real world situations using correlation, regression analysis and ANOVA.
CO6	To build up decision making skills pertinent to the practice of statistics, including the students' abilities to formulate problems, to think creatively, and to synthesize information.

Course Content:

Unit-1: Introduction to Statistics, Types, Scope; Data sources, Data presentation, tabulation, charting, graphs; Measures of central tendency – Mean, Median, Mode; Measures of variations – range, interquartile range, standard deviation; Skewness, moments & kurtosis; Covariance and correlation.

Unit-2: Introduction to probability, basic laws & concepts, conditional probability; Probability distributions, random variable, probability function, expected value and variance, Discrete probability distribution, Binomial Distribution, Poisson Distribution, Continuous Probability Distribution, Normal Distribution, Exponential Distribution.

Unit-3: Sampling – introduction, purpose, random sampling methods, non-random sampling methods; Sampling distributions, Sampling Distribution of the Mean, Central Limit Theorem, Sampling Distribution of the Proportion.

Unit-4: Statistical estimation – Introduction, Properties of a good estimator, Point Estimation, Interval Estimation for sample mean, Interval Estimation for sample proportion, Sample size determination, Hypothesis testing – basic concepts, Null and the Alternative Hypothesis, Tests of Hypotheses about Population Means, Tests of Hypotheses about Population Proportions.

Unit-5: Regression analysis, linear regression, regression lines, regression coefficients, coefficient of determination, Analysis of Variance – introduction, assumptions, computation; One-way classification – variance between samples, variance within samples.

Teaching Methodology:

The course is taught through 2-hour lab exercises conducted using Microsoft Excel. The main emphasis is on problem solving and application of statistical concepts for business problems.

Evaluation Scheme:

Exams	**Marks**
Lab work	40 Marks
Lab record	15 Marks
Mid sem P1 Test	15 Marks
End sem P2 Test	15 Marks
Attendance and discipline	15 Marks
Total	**100 Marks**

Text Book:

1. Anderson, Essentials of Modern Business Statistics with Microsoft Excel, Cengage.

Title of Course: Machine Learning **Course Code: 18B11CI918**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: The mathematical tools needed for the course will be covered in some classes in the first week of the course.

Objective:
1. To learn and be able to implement the basic statistical techniques in the areas of interests.
2. To develop the abilities to apply the basic Machine Learning algorithms and interpret their results.

Learning Outcomes:

At the end of the course, students:

1. Get familiar with the fundamental methods at the core of modern machine learning.
2. Have a good grounding of the essential algorithms for supervised and unsupervised learning
3. Possess demonstrative skills in using and applying Machine Learning.
4. Work as a team on a project.

Course Outcome	**Description**
CO1	List various approaches of Machine Learning.
CO2	Describe machine learning algorithms to solve the real world problems
CO3	Develop Hypothesis and machine learning models
CO4	Identify appropriate models for solving machine learning problems.
CO5	Apply learning techniques to solve real world machine learning problems
CO6	Evaluate and interpret the results of the algorithms.

Course Content:

Unit-I: Introduction to machine learning, supervised and unsupervised machine learning, Applications of AI and machine learning , Linear Algebra, Matrices, Multi-Variable Calculus and Vectors, Mean, Median, mode, Dispersion.

Unit-II: Probability, Probability Distributions, and Central Limit Theorem.
Hypothesis Testing: The what, why and how of Hypothesis Testing are covered in this module. P-Value, different types of tests and implementation in Python.
Exploratory Data Analysis: EDA brings out the information from the Data. This module covers Data Cleaning, Univariate/ Bivariate analysis.

Unit-III: Linear Regression: Simple and Multiple, Issues in Regression like Collinearity. Project on Linear Regression. Logistic Regression Univariate and Multivariate Logistic Regression for

classification in ML, Implementation in R/Python, Naive Bayes Classification. Bias-Variance Tradeoff, Evaluation metrics: Confusion Matrix, F1 Score, Root Mean Squared Error.

Unit-IV: Decision Tree, Random Forest, SVM, Validation Techniques: Leave one out cross-validation, K-fold cross-validation, Stratified k-fold cross-validation.

Unit-V: K-Means clustering, Introduction to Neural Networks, Convolutional Neural Network.

Teaching Methodology:

This course is introduced to help students understand the discipline of Machine Learning. The programming tool used to teach this course are R and Python. Starting from the basic mathematical tools, the student will slowly be exposed to inferential statistics, and later to Machine Learning Algorithms. This theory course is well complemented by a laboratory course under the name Machine Learning Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 20-30% from coverage till Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage till Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Machine Learning (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

- Hastie, Tibshirani and Friedman. Elements of statistical learning.

Reference Material:

- L. Rosasco. Introductory Machine Learning Notes.
- Larry Wasserman. Clustering chapter

Title of Course: Machine Learning Lab **Course Code: 18B17CI996**
L-T-P scheme: 0-0-1 **Credit: 1**

Prerequisite: The mathematical tools needed for the course will be covered in some classes in the first week of the course.

Objective:

1. To learn and be able to implement the basic statistical techniques in the areas of interests.
2. To develop the abilities to apply the basic Machine Learning algorithms and interpret their results.

Learning Outcomes:
At the end of the course, students:

Course Outcome	**Description**
CO1	Get familiar with the fundamental methods at the core of modern machine learning.
CO2	Have a good grounding of the essential algorithms for supervised and unsupervised learning
CO3	Possess demonstrative skills in using and applying Machine Learning.
CO4	Work as a team on a project.

Course Content:

Unit-I: Introduction to machine learning, supervised and unsupervised machine learning, Applications of AI and machine learning , Linear Algebra, Matrices, Multi-Variable Calculus and Vectors, Mean, Median, mode, Dispersion.

Unit-II: Probability, Probability Distributions, and Central Limit Theorem.
Hypothesis Testing: The what, why and how of Hypothesis Testing are covered in this module. P-Value, different types of tests and implementation in Python.
Exploratory Data Analysis: EDA brings out the information from the Data. This module covers Data Cleaning, Univariate/ Bivariate analysis.

Unit-III: Linear Regression: Simple and Multiple, Issues in Regression like Collinearity. Project on Linear Regression. Logistic Regression Univariate and Multivariate Logistic Regression for classification in ML, Implementation in R/Python, Naive Bayes Classification. Bias-Variance Tradeoff, Evaluation metrics: Confusion Matrix, F1 Score, Root Mean Squared Error.

Unit-IV: Decision Tree, Random Forest, SVM, Validation Techniques: Leave one out cross-validation, K-fold cross-validation, Stratified k-fold cross-validation.

Unit-V: K-Means clustering, Introduction to Neural Networks, Convolutional Neural Network.

Teaching Methodology:

This course is introduced to help students understand the discipline of Machine Learning. The programming tool used to teach this course are R and Python. Starting from the basic mathematical tools, the student will slowly be exposed to inferential statistics, and later to Machine Learning Algorithms. This theory course is well complemented by a laboratory course under the name Machine Learning Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Evaluations		**Marks**	**Remarks**
P-1		15 Marks	
P-2		15 Marks	
Continuous Evaluations	Viva	20 Marks	
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Discipline and Punctuality and Attendance	15 Marks	
Total		**100 Marks**	

Learning Resources:

Lab exercises and lecture slides on Machine Learning (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

- Hastie, Tibshirani and Friedman. Elements of statistical learning.

Reference Material:

- L. Rosasco. Introductory Machine Learning Notes.
- Larry Wasserman. Clustering chapter

Title of Course: Artificial Neural Network **Course Code: 18B11CI932**
L-T Scheme: 3-0-0 **Course Credits: 3**

Objectives: To introduce some of the fundamental techniques and principles of neural computation. To investigate some common models and their applications.

Prerequisites:

Basic knowledge of computer architecture, basics of algorithms.

Learning Outcomes:

Course Outcome	**Description**
CO1	Understand the learning and generalization issue in neural computation.
CO2	Understand the basic ideas behind most common learning algorithms for multilayer perceptrons, radial-basis function networks, and Kohonen self-organizing maps.
CO3	Implement common learning algorithms using an existing package.
CO4	Apply neural networks to classification and recognition problems.

Course Content:

1. **What Are Neural Networks:**
   History, Artificial and biological neural networks, Artificial intelligence and neural networks.
2. **Neurons and Neural Networks**
   Biological neurons, Models of single neurons, Different neural network models.
3. **Single Layer Perceptrons**
   Least mean square algorithm, Learning curves, Learning rates, Perceptron
4. **Multilayer Perceptrons**
   The XOR problem, Back-propagation algorithm, Heuristic for improving the back-propagation algorithm, Some examples
5. **Radial-Basis Function Networks**
   Interpolation, Regularization, Learning strategies
6. **Kohonen Self-Organizing Maps**
   Self-organizing map, The SOM algorithm, Learning vector quantization

References

- **Books**
  - Introduction to Artificial Neural Systems, by Jacek Zurada
  - An Introduction to Neural Networks K. Gurney, UCL Press, London.

- Introduction to Neural Networks, R. Beale and T. Jackson, IOP Press.
- The Essence of Neural Networks, R. Callan, Prentice Hall Europe.
- Neural Networks: A Comprehensive Foundation, Simon Haykin, Prentice Hall.
- Book by Haykins
- Book by Hassoul
- Book by Yagnanarayana
- Perceptrons, by Minsky and Papert
- Parallel and Distributed Processing, by McClelland and Rumelhart
- Neuro Computing - Volume 1 and Volume 2, edited by Anderson
-

- **Journals**
  - IEEE transactions on Neural Networks
  - IEEE transactions on Systems, Man and Cybernetics (SMC)
  - IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI)
  - Neural Networks
  - Neuro Computing
  - Machine Learning

Title of Course: Deep Learning **Course Code: 18B11CI933**

L-T-P scheme: 3-0-0 **Course Credits: 03**

Prerequisite: Students must have a good understanding of Machine Learning, Neural Networks and familiarity with vector and matrices.

Objective:

Deep Learning is one of the most exciting and promising segments of Artificial Intelligence and machine learning technologies. This course is designed to help students develop expertise in deep learning techniques and build open-source software. Students will be able learn topics such as Convolutional Neural Networks, recurrent neural networks, training deep networks and high-level interfaces Build deep learning models and interpret the results

Learning Outcomes:

Course Outcome	Description
CO1	Understand complexity of deep learning algorithms and their limitations
CO2	Capable of confidently applying common Deep Learning algorithms in practice, and implementing their own.
CO3	Performing distributed computations
CO4	Performing experiments in deep learning using real-world data

Course Contents:

Unit 1: Deep Neural Network

Hidden layers, Construction of Deep neural network, Forward propagation method, Backward propagation algorithm, Setting number of hidden nodes per layer, Training Deep Neural Network with TensorFlow's High-Level API,

Unit 2: Optimization and Regularization methods for Deep Neural Network

Vanishing/Exploding Gradients Problems: Xavier and He Initialization, Nonsaturating Activation Functions, Batch Normalization, Gradient Clipping, Faster Optimizers: Momentum optimization, Nesterov Accelerated Gradient, AdaGrad, RMSProp, Adam Optimization, Learning Rate Scheduling, Regularization methods: Dropout , Data Augmentation, Max-Norm Regularization, Early Stopping, $\ell 1$ and $\ell 2$ Regularization

Unit 3: Convolutional Neural Networks

Computer Vision Application perspective: Human Visual Cortex, Convolutional Layer, Pooling layers, Filters, Feature maps, Implementing CNN using Tensorflow, Memory requirement, Various CNN architectures: LeNet-5, AlexNet, GoogLeNet, and ResNet

Unit 4: Reccurent Neural Networks

Recurrent Neurons, Memory Cells, Input and Output Sequences, Handling Variable Length Input Sequences, Handling Variable-Length Output Sequences, Basic RNNs in TensorFlow, Training RNNs, Training a Sequence Classifier, Training to Predict Time Series, GRU Cell, LSTM Cell

Unit 5: Applications of Deep neural Network
Computer vision and Natural language processing related projects using Keras and Tensorflow

Text Books

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Aurelien Geron, Hands-on Machine Learning 2nd Ed, Publisher(s): O'Reilly Media, Inc 2019

References

1. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
4. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004

Title: Soft Intelligence Course Code: **18B11CI934**

L-T-P scheme: 3-0-0 Credit: **3**

Introduction:

Soft Intelligence is an emerging approach to computing which parallel the remarkable ability of the human mind to reason and learn in an environment of uncertainty and imprecision. Soft Intelligence is based on some biological inspired methodologies such as genetics, evolution, ant's behaviors, particles swarming, human nervous systems, etc. Now, Soft Intelligence is the only solution when we don't have any mathematical modeling of problem solving (i.e., algorithm), need a solution to a complex problem in real time, easy to adapt with changed scenario and can be implemented with parallel computing. It has enormous applications in many application areas such as medical diagnosis, computer vision, hand written character recondition, pattern recognition, machine intelligence, weather forecasting, network optimization, VLSI design, etc.

Course Objectives:

This course will cover fundamental concepts used in Soft Intelligence. The concepts of Fuzzy logic (FL) will be covered first, followed by Artificial Neural Networks (ANNs) and optimization techniques using Genetic Algorithm (GA). Applications of Soft Intelligence techniques to solve a number of real life problems will be covered to have hands on practices. In summary, this course will provide exposure to theory as well as practical systems and software used in soft Intelligence. It will enable students to:
(a) Appreciate the advantages and limitations of fuzzy systems and their potential impacts and applications in intelligent control and automation;
(b) Appreciate the advantages and limitations of neural networks and their potential impacts and applications in intelligent automation; and
(c) Develop an understanding of generic algorithms and their potential applications.

Learning Outcomes:

After completing this course, you will be able to learn:

- Fuzzy logic and its applications.
- Artificial neural networks and its applications.
- Solving single-objective optimization problems using GAs.
- Solving multi-objective optimization problems using Evolutionary algorithms (MOEAs).
- Applications of Soft intelligence to solve problems in varieties of application domains.
-

Course Outcome	Description
CO1	Introduce the concepts of Fuzzy sets and fuzzy logic.
CO2	Introduce types of Fuzzy Inference System and difference among them, review of gradient-based optimization techniques steepest descent method and Newton's method.
CO3	To make students familiar with derivative-free optimization and supervised

	learning neural networks.
CO4	To make students familiar with Unsupervised Learning Neural Networks.
CO5	To make students familiar with Adaptive Neuro-Fuzzy Inference system, GAs and Coactive Neuro Fuzzy modeling.
CO6	To make students familiar with Genetic modeling and its application.

Topics Outline:

Unit – I Soft Intelligence: Introduction of Soft Intelligence, Soft Intelligence vs. hard computing, various types of Soft Intelligence techniques, applications of Soft Intelligence. Artificial Intelligence : Introduction, Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies. Knowledge representation issues, Prepositional and predicate logic, monotonic and non monotonic reasoning, forward Reasoning, backward reasoning, Weak & Strong Slot & filler structures, NLP.

Unit – II Neural Network : Structure and Function of a single neuron: Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural net, Difference between ANN and human brain, characteristics and applications of ANN, single layer network, Perceptron training algorithm, Linear separability, Widrow & Hebb;s learning rule/Delta rule, ADALINE, MADALINE, AI v/s ANN. Introduction of MLP, different activation functions, Error back propagation algorithm, derivation of BBPA, momentum, limitation, characteristics and application of EBPA,

Unit – III Counter propagation network, architecture, functioning & characteristics of counter Propagation network, Hopfield/ Recurrent network, configuration, stability constraints, associative memory, and characteristics, limitations and applications. Hopfield v/s Boltzman machine. Adaptive Resonance Theory: Architecture, classifications, Implementation and training. Associative Memory.

Unit – IV Fuzzy Logic: Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, Fuzzy systems: crisp logic, fuzzy logic, introduction & features of membership functions, Fuzzy rule base system : fuzzy propositions, formation, decomposition & aggregation of fuzzy rules, fuzzy reasoning, fuzzy inference systems, fuzzy decision making & Applications of fuzzy logic.

Unit – V Genetic algorithm : Fundamentals, basic concepts, working principle, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator, Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional methods.

Evaluation scheme:

T1	– 15marks
T2	– 25 marks
T3	- 35 marks
Assignments/ Quizzes/attendance	– 25 marks
Total	**100 marks**

Readings

1. S, Rajasekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications, PHI Publication, 1st Edition, 2009

Other References:

1. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, 1997.
2. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
3. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003.
4. R.Eberhart, P.Simpson and R.Dobbins, "Computational Intelligence - PC Tools", AP Professional, Boston, 1996.
5. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004.
6. S.N.Sivanandam & S.N.Deepa "Principles of Soft Computing" Wiley India Pvt. Ltd., 2007

Resources

Lecture presentations, assignments will be posted on the student resource from time to time. In addition following additional online/downloadable resources will be useful.

Internet of Robotic Things

Title: Statistical Methods and Data Analysis **Code: 18B11CI916**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: None

Objective:

The objective of course is to equip the students with the mathematical & statistical techniques & their application to business problems. The emphasis will be on the concepts & application rather than derivations. The intention of the course is to make students able to use statistics as a helpful tool for solving complex business research problems under uncertainty and understand methods that quantify issues and give business managers a better basis for making decisions.

Learning Outcomes:

Course Outcome	Description
CO1	To familiarize the concept of data and data categorization and introduce the field of statistics & data analysis.
CO2	To understand and compute various measures of descriptive statistics such as mean, median, standard deviation, skewness, and kurtosis.
CO3	To describe basic concepts of probability and probability distributions and its applications in solving various business problems.
CO4	To learn and apply various statistical techniques such as sampling distribution, interval estimation and hypothesis testing for inferential data analysis using real world examples.
CO5	To develop the understanding to analyze a set of data / real world situations using correlation, regression analysis and ANOVA.
CO6	To build up decision making skills pertinent to the practice of statistics, including the students' abilities to formulate problems, to think creatively, and to synthesize information.

Course Content:

Unit-1: Introduction to Statistics, Types, Scope; Data sources, Data presentation, tabulation, charting, graphs; Measures of central tendency – Mean, Median, Mode; Measures of variations – range, interquartile range, standard deviation; Skewness, moments & kurtosis; Covariance and correlation.

Unit-2: Introduction to probability, basic laws & concepts, conditional probability; Probability distributions, random variable, probability function, expected value and variance, Discrete probability distribution, Binomial Distribution, Poisson Distribution, Continuous Probability Distribution, Normal Distribution, Exponential Distribution.

Unit-3: Sampling – introduction, purpose, random sampling methods, non-random sampling methods; Sampling distributions, Sampling Distribution of the Mean, Central Limit Theorem, Sampling Distribution of the Proportion.
Unit-4: Statistical estimation – Introduction, Properties of a good estimator, Point Estimation, Interval Estimation for sample mean, Interval Estimation for sample proportion, Sample size determination, Hypothesis testing – basic concepts, Null and the Alternative Hypothesis, Tests of Hypotheses about Population Means, Tests of Hypotheses about Population Proportions.
Unit-5: Regression analysis, linear regression, regression lines, regression coefficients, coefficient of determination, Analysis of Variance – introduction, assumptions, computation; One-way classification – variance between samples, variance within samples, F-ratio calculation, Two-way classification.

Teaching Methodology:

The course is a mix of classroom teaching (power point slides) which includes case studies, quiz, problem solving, and numerical questions.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lectures, tutorials and e-books on Statistical Methods and Data Analysis (are added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Anderson, Statistics for Business & Economics, Thomson Learning, Bombay.

Reference Books/Material:

[1] Gupta S.P. & Gupta M.P., Business Statistics, Sultan Chand & Sons, Delhi.
[2] Levin & Rubin, Statistics for Management, Prentice Hall of India, New Delhi.
[3] Mann P., Introductory Statistics, Wiley.
[4] Schumuller J., Statistical Analysis with Excel for Dummies, John Wiley & Sons, NJ.
[5] Berk & Karey, Data Analysis with Microsoft Excel, Cengage Learning, Boston.

Title: Statistical Methods and Data Analysis Lab **Code: 18B17CI976**

L-T-P scheme: 0-0-2 **Credit: 1**

Prerequisite: None

Objective:

The objective of course is to equip the students with the mathematical & statistical techniques & their application to business problems. The intention of the course is to make students able to apply statistics using Microsoft Excel as a tool for solving complex business research problems under uncertainty and understand methods that quantify issues and give business managers a better basis for making decisions.

Learning Outcomes:

Course Outcome	**Description**
CO1	To familiarize the concept of data and data categorization and introduce the field of statistics & data analysis.
CO2	To understand and compute various measures of descriptive statistics such as mean, median, standard deviation, skewness, and kurtosis.
CO3	To apply basic concepts of probability and probability distributions and its applications in solving various business problems.
CO4	To learn and apply various statistical techniques such as sampling distribution, interval estimation and hypothesis testing for inferential data analysis using real world examples.
CO5	To develop the understanding to analyze a set of data / real world situations using correlation, regression analysis and ANOVA.
CO6	To build up decision making skills pertinent to the practice of statistics, including the students' abilities to formulate problems, to think creatively, and to synthesize information.

Course Content:

Unit-1: Introduction to Statistics, Types, Scope; Data sources, Data presentation, tabulation, charting, graphs; Measures of central tendency – Mean, Median, Mode; Measures of variations – range, interquartile range, standard deviation; Skewness, moments & kurtosis; Covariance and correlation.

Unit-2: Introduction to probability, basic laws & concepts, conditional probability; Probability distributions, random variable, probability function, expected value and variance, Discrete probability distribution, Binomial Distribution, Poisson Distribution, Continuous Probability Distribution, Normal Distribution, Exponential Distribution.

Unit-3: Sampling – introduction, purpose, random sampling methods, non-random sampling methods; Sampling distributions, Sampling Distribution of the Mean, Central Limit Theorem, Sampling Distribution of the Proportion.

Unit-4: Statistical estimation – Introduction, Properties of a good estimator, Point Estimation, Interval Estimation for sample mean, Interval Estimation for sample proportion, Sample size determination, Hypothesis testing – basic concepts, Null and the Alternative Hypothesis, Tests of Hypotheses about Population Means, Tests of Hypotheses about Population Proportions.

Unit-5: Regression analysis, linear regression, regression lines, regression coefficients, coefficient of determination, Analysis of Variance – introduction, assumptions, computation; One-way classification – variance between samples, variance within samples.

Teaching Methodology:

The course is taught through 2-hour lab exercises conducted using Microsoft Excel. The main emphasis is on problem solving and application of statistical concepts for business problems.

Evaluation Scheme:

Exams	**Marks**
Lab work	40 Marks
Lab record	15 Marks
Mid sem P1 Test	15 Marks
End sem P2 Test	15 Marks
Attendance and discipline	15 Marks
Total	**100 Marks**

Text Book:

1. Anderson, Essentials of Modern Business Statistics with Microsoft Excel, Cengage.

Title: Sensors, Actuators & Signal Processing **Code: 18B11EC911**

L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied course, "*Instrumentation and control*".

Objective:
The aim is to provide knowledge of sensor technology, features and characteristics of sensors, measuring devices and sensor and actuators applications in industry.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the basics of sensors, Principles, Classification, Parameters, Basic requirements of sensors.
CO2	Describe the types of electrical and electronic sensors.
CO3	Develop the appropriate technology to implement digital sensors.
CO4	Identify Concepts of Actuators, Types of actuators, Actuator performance criteria and selection.
CO5	Applications of naming, addressing, time synchronization and routing protocols.
CO6	Demonstrate deployment and basic maintenance skills.

Course Content:
Unit-1: Fundamentals of sensors :Introduction to sensors , Principles, Classification, Parameters, Basic requirements of a sensors- Classification of sensors- Static and dynamic characteristics of sensors..

Unit-2: Electrical and Electronic sensors: Overview of analog mechanical, pneumatic and hydraulic, optical and opto-electronic sensors, electric and electronic sensors, Capacitive and Inductive type displacement sensor- position sensors, Resistive sensors, strain sensors, photoelectric sensors, fiber optic sensors and piezoelectric sensors.

Unit-3: Digital Sensors: Digital sensors, incremental sensors, position converters. Sensors to detect the position - Hall sensors, Sensors for measuring humidity and analyze the gases and the environment. Reflective optical and ultrasonic rangefinders. Sensors to measure speed and acceleration.

Unit-4: Actuators: Basic Concepts of Actuators, Types of actuators, Actuator performance criteria and selection, Fluidic actuators, Solenoids and voice coil motors, Stepper motors, DC motors, Piezo-electric actuators, Shape memory alloy actuators.

Unit-5: Signal Processing :Introduction, Fourier series and Fourier Transform representation of continuous and discrete time signals, Amplification, Filters, Converters, Compensation.

Teaching Methodology:

This course is introduced to help students to learns about various sensors, actuators and their functions. At the end of the course the student will be able to analyze, design, and evaluate digital circuits, of medium complexity, that are based on SSIs, MSIs, and programmable logic devices.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 & Unit-2.
Test-2	25 Marks	Based on Unit-2 & Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 to Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Sensors, Actuators and Signal Processing (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

[1] D. Patranabis, “Sensors and Transducers”, PHI Learning Private Limited.
[2] Patranabis, “Sensors and Actuators”, 2nd Edition, PHI, 2013.

Reference Books:

[1] Julian W.Gardner and Vijay K Varadhan, “Microsensors, MEMS and Smart Devices”, John Wiley & sons, 2001.

Web References:

[1] Tiny Battery May Power Next-Gen Gadgets. Arthur Tham. News Digest. 24-Feb-2003.http://www.extremetech.com/article2/0,3973,901021,00.asp

[2] “Carbon-MEMS Architectures for 3D Micro-batteries” PowerPoint Presentation. Marc Madou. Department of Mechanical and Aerospace Engineering. UCI, October 14, 2003.
[3] “MEMS for Environmental and Bioterrorism Applications”. Southwestern Center for Microsystem Education and BioLink, 2009.

Journal References:
[1] IEEE Journal on Sensors
[2] IEEE Transactions on Vehicular Technology

Title: Measurement & Instrumentation **Code: 18B11EC314**

L-T Scheme: 3-0-0 **Credits: 3**

Prerequisite: Nil

Objectives:

1. To introduce students to the automatic measurement process.
2. To understand students how different types of meters work and their construction.
3. To provide a student knowledge of the various types of sensors and their signal conditioning circuits.
4. To develop the ability to use modern tools necessary for hardware projects.

Learning Outcomes:

Course Outcome	Description
CO1	Outline the measurement process and instrument characteristics concerning their needs in the industry.
CO2	Describe the working principle and operation of various types of measuring instruments.
CO3	Develop a measurement setup to meet industry expectations.
CO4	Identify and use various electrical instruments used in the measurement process.
CO5	Apply error analysis on a given measurement setup.
CO6	Demonstrate the application of various measurement devices.

Course Contents

Unit 1: Fundamentals of Measurement: Measurement Methods, Generalized measurement System, Classification of Instruments, Static & Dynamic Characteristics, Errors & Uncertainty measurement of system, Linear & Non-linear Systems.

Unit 2: Transducers: Transducers – Classification of transducers, Temperature transducer, Pressure transducer, Displacement transducer, Strain gauge, LVDT, RTD, Thermistor, Thermocouple, Piezo-electric transducer.

Unit 3: Signal Conditioning Circuits: D.C. bridges and their application in measurement of resistance, Kelvin's double bridge, A.C. Bridges- general equation, Potentiometer- DC potentiometer, multi-range potentiometer, Q-meter and its applications. Amplifiers, Attenuators, Filters, Instrumentation Amplifier, Analog to digital converts.

Unit 4: Electrical Instruments: Moving coil, Moving iron, PMMC, Dynamometer and Induction type instruments, Measurement of Voltage, Current, Power, Power Factor, Energy, Instrument Transformer - current and potential transformer, Measurement of Phase & Frequency.

Unit 5: Signal Generators and Display Devices: Multivibrators: a stable, monostable and bistable types. Generation of square and triangular waveforms. IC 555 timer and its

application in multivibrators. Construction & working of Basic CRO, its Components (Deflection plates, Screen, Aquadag, Time Base Generator, Oscilloscope Amplifiers), Measurements of phase and frequency (Lissajous Patterns), Types of CRO, Special types of CRO, Types of CRO Probes. Digital Voltmeter.

Teaching Methodology:
This course is introduced to familiarize the student with the devices and processes utilized in the automation industry. Starting from the basic concepts, the student will gradually develop an understanding of practical setups used in the industry. The entire course is broken down into five units, such that each unit covers a particular aspect of the measurement process. This theory course is well complemented by a laboratory course under the name Measurement and Instrumentation Lab in the same semester that helps a student learn with hands-on experience.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1, Unit-2 (Selected topic)
Test-2	25 Marks	Based on Unit-2 & Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 to Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:
Tutorials and lecture slides on Measurement & Instrumentation (will be added from time to time): Digital copy will be available on the JUET server.

Text Books:

[1] A.K.Sawhney & Puneet Sawhney, A Course in Mechanical Measurements and Instrumentation, 12/e, Dhanpat Rai & Co. (P) Ltd.,2004
[2] Albert D.Helfrick & William D.Cooper, "Modern Electronic Instrumentation and Measurement Technique",Low Price Edition, Pearson Education, 2005
[3] Ernest O.Doebelin, "Measurement Systems Application and Design", 5/e, Tata McGraw –Hill Publishing Company Ltd., 2004

Reference Books/Materials:

[1] H.S.Kalsi, "Electronic Instrumentaion", Technical Education Series, Tata McGraw – Hill Publishing Company Ltd.,2001

[2] D.C. Kulshreshtha, “Principles of Electrical Engineering”, Tata McGraw Hill Publishing Co

Web References:

[1] https://nptel.ac.in/courses/108105153/
[2] https://nptel.ac.in/courses/108/105/108105064/

Journals References:

[1] International Journal of Instrumentation Technology (Inderscience)
[2] IEEE Transactions on Instrumentation and Measurement

Title: Digital Control System **Code: 18B11EC919**
L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: Students must have already studied courses, "*Control Systems*".

Objective:

1. To familiarize the student with the working of automation systems.
2. To develop an ability to design a computer-aided control system with given requirements.

Learning Outcomes:

Course Outcome	Description
CO1	Outline various digital control systems and their application.
CO2	Describe the element and operation of a digital control system.
CO3	Develop the architecture of an automation system based on the specified requirements.
CO4	Identify the hardware and software components of a computer-aided control system.
CO5	Application of digital control systems on a given assignment/ project.
CO6	Demonstration and deployment of basic software modules of a digital control system.

Course Content:

Unit 1: Introduction to Digital Control: Review of conventional control system. Manual and automatic control schemes. Model-based and model-less control. Need of automatic control, Advantages, Limitations, Applications.

Unit 2: Programmable Logic Controller: History of programmable logic controller (PLC). Architecture of PLC. Elements of PLC, CPU, IO Modules, Power supply and Communication Modules, Input Output Devices, Interfacing of Field Devices.

Unit 3: Distributed Control Systems: Basics of Distributed Control Systems (DCS). Architecture and Working. Components of DCS, Field Instruments and Interfacing Circuits, Communication Protocols. Control of Field Instruments using Relay Devices.

Unit 4: Supervisory Control and Data Acquisition (SCADA): Introduction to SCADA. Fundamental Principle of Modern SCADA Systems. SCADA Hardware and Software. Remote Terminal Units (RTU). Master Station. Interfacing between SCADA and PLC.

Unit 5: Design of Industrial Automation Setup: Requirement gathering, System layout, Identification of Modules, Hardware Implementation, Software design. Case Study of Industrial Automation in Food Processing and Manufacturing Industry.

Teaching Methodology:

This course is introduced to help students transition from a simple electrical and electronics engineering concepts to applications of digital control system. Starting with the understanding ofcontinuous systems, the student will be able to understand computer-aided control and other aspects of system analysis. The entire course is broken down into five separate units to develop an

understanding of various aspects of automation. Each section includes multiple technologies to help a student gain more experience as an electronic control system designer.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lecture notes/slides on Digital Control System (will be added from time to time):
Digital copywill be available on the JUET server.

Text Books:

[1] K.S. Manoj, Industrial Automation with SCADA: Concepts, Communications and Security,Notion Press, 1/e, Indian Edition, 2019.

[2] T.R. Kurfess, Robotics and Automation Handbook, CRC Press, 2/e, Indian Edition, 2004.

Reference Books/Material:

[1] G. F. Franklin, J. D.Powell and M. L. Workman, Digital Control of Dynamic Systems, Addison Wesley, 1998,Pearson Education,Asia, 3/e, 2000.

[2] K. J.Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design,Prentice Hall, 3/e, 1997.

Web References:

[1] https://nptel.ac.in/courses/108/105/108105088/
[2] https://www.eolss.net/

Journals References:

[1] Science direct journal of digital control system
[2] IRE Transactions on Industrial Electronics

Title of Course: Machine Learning **Course Code: 18B11CI918**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: The mathematical tools needed for the course will be covered in some classes in the first week of the course.

Objective:
1. To learn and be able to implement the basic statistical techniques in the areas of interests.
2. To develop the abilities to apply the basic Machine Learning algorithms and interpret their results.

Learning Outcomes:

At the end of the course, students:

1. Get familiar with the fundamental methods at the core of modern machine learning.
2. Have a good grounding of the essential algorithms for supervised and unsupervised learning
3. Possess demonstrative skills in using and applying Machine Learning.
4. Work as a team on a project.

Course Outcome	**Description**
CO1	List various approaches of Machine Learning.
CO2	Describe machine learning algorithms to solve the real world problems
CO3	Develop Hypothesis and machine learning models
CO4	Identify appropriate models for solving machine learning problems.
CO5	Apply learning techniques to solve real world machine learning problems
CO6	Evaluate and interpret the results of the algorithms.

Course Content:

Unit-I: Introduction to machine learning, supervised and unsupervised machine learning, Applications of AI and machine learning , Linear Algebra, Matrices, Multi-Variable Calculus and Vectors, Mean, Median, mode, Dispersion.

Unit-II: Probability, Probability Distributions, and Central Limit Theorem.
Hypothesis Testing: The what, why and how of Hypothesis Testing are covered in this module. P-Value, different types of tests and implementation in Python.
Exploratory Data Analysis: EDA brings out the information from the Data. This module covers Data Cleaning, Univariate/ Bivariate analysis.

Unit-III: Linear Regression: Simple and Multiple, Issues in Regression like Collinearity. Project on Linear Regression. Logistic Regression Univariate and Multivariate Logistic Regression for classification in ML, Implementation in R/Python, Naive Bayes Classification. Bias-Variance Tradeoff, Evaluation metrics: Confusion Matrix, F1 Score, Root Mean Squared Error.

Unit-IV: Decision Tree, Random Forest, SVM, Validation Techniques: Leave one out cross-validation, K-fold cross-validation, Stratified k-fold cross-validation.

Unit-V: K-Means clustering, Introduction to Neural Networks, Convolutional Neural Network.

Teaching Methodology:

This course is introduced to help students understand the discipline of Machine Learning. The programming tool used to teach this course are R and Python. Starting from the basic mathematical tools, the student will slowly be exposed to inferential statistics, and later to Machine Learning Algorithms. This theory course is well complemented by a laboratory course under the name Machine Learning Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 & Unit-4 and around 20-30% from coverage till Test-1
Test-3	35 Marks	Based on Unit-5 to Unit-6 and around 30% from coverage till Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Machine Learning (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

- Hastie, Tibshirani and Friedman. Elements of statistical learning.

Reference Material:

- L. Rosasco. Introductory Machine Learning Notes.
- Larry Wasserman. Clustering chapter

Title of Course: Machine Learning Lab **Course Code: 18B17CI996**
L-T-P scheme: 0-0-1 **Credit: 1**

Prerequisite: The mathematical tools needed for the course will be covered in some classes in the first week of the course.

Objective:

1. To learn and be able to implement the basic statistical techniques in the areas of interests.
2. To develop the abilities to apply the basic Machine Learning algorithms and interpret their results.

Learning Outcomes:
At the end of the course, students:

Course Outcome	**Description**
CO1	Get familiar with the fundamental methods at the core of modern machine learning.
CO2	Have a good grounding of the essential algorithms for supervised and unsupervised learning
CO3	Possess demonstrative skills in using and applying Machine Learning.
CO4	Work as a team on a project.

Course Content:

Unit-I: Introduction to machine learning, supervised and unsupervised machine learning, Applications of AI and machine learning , Linear Algebra, Matrices, Multi-Variable Calculus and Vectors, Mean, Median, mode, Dispersion.

Unit-II: Probability, Probability Distributions, and Central Limit Theorem.
Hypothesis Testing: The what, why and how of Hypothesis Testing are covered in this module. P-Value, different types of tests and implementation in Python.
Exploratory Data Analysis: EDA brings out the information from the Data. This module covers Data Cleaning, Univariate/ Bivariate analysis.

Unit-III: Linear Regression: Simple and Multiple, Issues in Regression like Collinearity. Project on Linear Regression. Logistic Regression Univariate and Multivariate Logistic Regression for classification in ML, Implementation in R/Python, Naive Bayes Classification. Bias-Variance Tradeoff, Evaluation metrics: Confusion Matrix, F1 Score, Root Mean Squared Error.

Unit-IV: Decision Tree, Random Forest, SVM, Validation Techniques: Leave one out cross-validation, K-fold cross-validation, Stratified k-fold cross-validation.

Unit-V: K-Means clustering, Introduction to Neural Networks, Convolutional Neural Network.

Teaching Methodology:

This course is introduced to help students understand the discipline of Machine Learning. The programming tool used to teach this course are R and Python. Starting from the basic mathematical tools, the student will slowly be exposed to inferential statistics, and later to Machine Learning Algorithms. This theory course is well complemented by a laboratory course under the name Machine Learning Lab in the same semester that helps a student learn with hand-on experience.

Evaluation Scheme:

Evaluations		**Marks**	**Remarks**
P-1		15 Marks	
P-2		15 Marks	
Continuous Evaluations	Viva	20 Marks	
	Demonstration	20 Marks	
	Lab Record	15 Marks	
	Discipline and Punctuality and Attendance	15 Marks	
Total		**100 Marks**	

Learning Resources:

Lab exercises and lecture slides on Machine Learning (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

- Hastie, Tibshirani and Friedman. Elements of statistical learning.

Reference Material:

- L. Rosasco. Introductory Machine Learning Notes.
- Larry Wasserman. Clustering chapter

Title of Course: Robotics & Machine Vision **Course Code: 18B11EC913**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite

Students must have the concept of Microprocessors and Python Programming.

Objective:

To familiarize students with the concepts and techniques of robot manipulator, its kinematics, programming and build confidence to evaluate, choose and incorporate robots in engineering systems.

Learning Outcomes:

Robotics & Machine Vision	
Course Outcome	**Description**
CO1	Understanding the fundamental principles of robotics and machine vision, including topics such as kinematics, control, perception, and cognition.
CO2	Ability to design, develop, and implement robotic systems using various hardware and software tools.
CO3	Analysis of machine vision techniques and algorithms, including image processing, object recognition, and tracking.
CO4	Evaluate the methods to apply machine vision techniques in robotic systems for various applications
CO5	Ability to create various types of robot programming and its applications. To Demonstrate the image processing and image analysis techniques by machine vision system

Course Content:

Unit I: Fundamentals of Robot

Robotics – Introduction – Basic structure – Classification of robot and Robotic systems – laws of robotics – work space, precision movement. Drives and Controls systems: Hydraulic systems, power supply – servo valve – hydraulic motor – DC servo motors – stepper motors – operation – selection of system – control system – servo control.

Unit II: Robot Motion Analysis

Kinematics of Robot: Introduction, Matrix Representation, homogeneous transformation, forward and inverse kinematics, Inverse kinematics Programming, Degeneracy, dexterity, velocity and static forces, Basics of trajectory planning.

Unit III: Grippers and Sensors

Robot end effectors: Types of end effectors – Mechanical grippers – Types of Gripper mechanisms – Grippers force analysis – Other types of grippers – Vacuum cups – Magnetic grippers – Adhesive grippers – Robot end effectors interface. Sensors: Position sensors – Potentiometers, encoders, - LVDT, Velocity sensors, Acceleration Sensors, Force, Pressure and Torque sensors, Touch and Tactile sensors, Proximity, Range and sniff sensors.

Unit IV: Programming and Application
Types of programming – programming languages sample program for different types of robots – Industrial Applications: Application of robots in processing operations – Assembly and inspections – Material handling – Loading and unloading – AI and Robotics.

Unit V: Machine Vision
Introduction – image processing vs image analysis, image acquisition, digital images – sampling and quantization – image definition, levels of computation. Image processing Techniques: Data reduction – Windowing, digital conversion. Segmentation – Thresholding, Connectivity, Noise reduction, Edge detection, Segmentation, Region growing and Region splitting, Binary morphology and grey morphology operation – feature extraction.

Teaching Methodology:
The students will be able to explain the basic concepts like various configurations, classification and parts of robots. He would also be able to explain the concept of kinematics, degeneracy, dexterity and trajectory planning, compare various end effectors (grippers and tools) and sensors used in robots, analyze the concept of Artificial Intelligence in robots, various types of robot programming and its applications, demonstrate the image processing and image analysis techniques by machine vision system. Lectures would be interactive and it would cover the core concepts that are explained in the text and reference materials with adequate examples.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1, Unit-2(30%)
Test-2	25 Marks	Based on Unit-2(70%) & Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 to Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on Web Development (will be added from time to time):
Digital copy will be available on the JUET server.

TEXT BOOKS

1. Saeed B.Niku, Introduction to Robotics: Analysis, Systems, Applications, 2nd edition, Pearson Education India, PHI 2003 (ISBN 81-7808-677-8)
2. M.P.Groover, Industrial Robotics – Technology, Programming and Applications, McGraw- Hill, USA, 1986

REFERENCE BOOKS

1. Janakiraman P.A., Robotics and image processing, Tata McGraw Hill, 1995.
2. YoremKoren, Robotics for Engineers, McGraw-Hill, USA, 1992.
3. Richard D.Klafter, Thomas A.Chmielewski and Michael Negin, Robotic Engineering – An Integrated Approach, Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.
4. Ramesh Jam, Rangachari Kasturi, Brain G.Schunck, Machine Vision, Tata McGraw Hill.

Web References:

[1] https://www.robotshop.com/community/blog/show/10-tips-for-getting-started-with-robotics
[2] https://nptel.ac.in/courses/112105236
[3] https://nptel.ac.in/courses/112/101/112101099/

Journals References:

[1] IEEE Journal on Robotics and Automation
[2] The International Journal of Robotics Research
[3] Robotics & artificial intelligence by springer
[4] Journal of Intelligent & Robotic Systems by springer

Title of Course: Robotics Programming Lab. **Course Code: 18B11EC973**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite

Students must have the concept of Microprocessors and Microcontrollers.

Objective:

The objective of a robotics programming laboratory is to provide students with hands-on experience in designing, building, and programming robots. The primary goal of the laboratory is to enable students to apply theoretical concepts learned in the classroom to practical projects. Students are typically provided with a range of hardware and software tools to design and build their own robots for different applications. The laboratory aims to develop skills in programming languages commonly used in robotics. In addition, the laboratory provides an opportunity for students to develop their critical thinking and problem-solving skills, as they work on projects that require creativity and innovation.

Overall, the objective of a robotics programming laboratory is to provide students with the practical skills and knowledge needed to develop and program robots for a range of real-world applications.

Learning Outcomes:

Robotics Programming Lab.	
Course Outcome	**Description**
CO1	Understand the basics of robotics, including robot components, sensors, actuators and coding platforms.
CO2	Explore and investigate algorithms for robot control using simulation software such as TinkerCad and programming language such as Python.
CO3	Analyze and evaluate the performance of robot systems and algorithms, including accuracy, speed, and reliability.
CO4	Validate knowledge of robotics and programming to solve real-world problems and challenges.
CO5	Collaborate with team members to develop and incorporate robotics projects, and effectively communicate ideas and results.

Course Content:

List of Experiments

1. (i) To Install Arduino IDE and interfacing with the computer.
   (ii) To know about basic components and the opensource online software Tinkercad for simulations.
2. (i) To blink LED using Tinkercad software and implement using Arduino.
   (ii) To blink 2 LEDs using Tinkercad software and implement using Arduino.
3. Finding the distance of the object using Tinkercad and implement it using Arduino.
4. To design Traffic lights using LED blinking process in Tinkercad and implement using Arduin
5. To light up the LED when there is no sensing light (Dark) environment.
6. (i) To blink 4 LEDs group (2 LED) one by one with delay of 3 seconds using Tinkercad software and implement using Arduino.
   (ii) Blinking of 4 LEDs with delay of 2 seconds in right to left and vice versa direction using

Tinkercad and Arduino.

7 (i) Display the name horizontally on LCD display by transferring the data serially using Tinkercad and Arduino.

(ii) Display the name Vertically on LCD display by transferring the data serially using Tinkercad and Arduino.

8. (i) Blinking of 8 LEDs in sequence with delay of 2 seconds using Tinkercad and Implement using Arduino.

(ii) To implement the traffic light system using Tinkercad and implement using Arduino.

9. (i) To derive the motor in clockwise direction using Tinkercad and implement using Arduino.

(i) Driving two motors separately in forward and reverse direction alternately with delay of 2 seconds.

10. To design a Line follower Robot using Arduino.
11. To implement Light Sensor with Simple Home Automation
12. To design Home Automation System
13. To implement controlling of car using Remote control.
14. To Interfacing Seven Segment Display on TinkerCad and implement using Arduino.
15. To Use an Ultrasonic Sensor to Control Neopixels using Tinkercad and implement with Arduino.
16. To Design obstacle avoidance Robot using Arduino.
17. To design a Maze Solving Robot using Arduino.
18. To design Self Balancing Robot using Arduino.

Teaching Methodology:

The students will be able to learn and get a clear overview by providing an overview of the robotics programming laboratory and the learning objectives. This helps students understand what they will be learning and the practical applications of the course material. Robotics programming is best learned through hands-on experience which will be provided to students with opportunities to build and program robots using a variety of tools and technologies. This can help them develop problem-solving skills and become more confident in their abilities. The students will be given idea to incorporate new developments into the course material to keep it relevant and engaging for students. The students will be encouraged to work together on projects and incorporate examples of different robotics' applications.

Evaluation Scheme:

Exams		**Marks**	**Coverage**
P-1		**15 Marks**	**Based on Lab Exercises: 1-5**
P-2		**15 Marks**	**Based on Lab Exercises: 5-10**
Day-to-Day Work	**Viva**	**20 Marks**	**70 Marks**
	Demonstration	**20 Marks**	
	Lab Record	**15 Marks**	
	Attendance & Discipline	**15 Marks**	
Total		**100 Marks**	

Learning Resources:

Study material of Robotics Programming Lab (will be added time to time): Digital copy will be available on the JUET server.

TEXT BOOKS

1. Saeed B.Niku, Introduction to Robotics: Analysis, Systems, Applications, 2nd edition, Pearson Education India, PHI 2003 (ISBN 81-7808-677-8)
2. M.P.Groover, Industrial Robotics – Technology, Programming and Applications, McGraw- Hill, USA, 1986

REFERENCE BOOKS

3. Janakiraman P.A., Robotics and image processing, Tata McGraw Hill, 1995.
4. YoremKoren, Robotics for Engineers, McGraw-Hill, USA, 1992.
5. Richard D.Klafter, Thomas A.Chmielewski and Michael Negin, Robotic Engineering – An Integrated Approach, Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.
6. Ramesh Jam, Rangachari Kasturi, Brain G.Schunck, Machine Vision, Tata McGraw Hill.

Web References:

[1] https://www.robotshop.com/community/blog/show/10-tips-for-getting-started-with-robotics
[2] https://nptel.ac.in/courses/112105236
[3] https://nptel.ac.in/courses/112/101/112101099/

Journals References:

[1] IEEE Journal on Robotics and Automation
[2] The International Journal of Robotics Research
[3] Robotics & artificial intelligence by springer
[4] Journal of Intelligent & Robotic Systems by springer

Title: Internet of Things Technology & Applications **Code: 18B11CI937**

L-T-P Scheme: 2-0-0 **Credit: 2**

Prerequisite:

Students are expected to have a good understanding of computer networks, familiarity with network programming, and object oriented programming.

Objective:

The course is designed to give the students a solid grounding of the key technologies involved and how they are integrated to form complete Internet of Things(IoT) systems.

Learning Outcomes

1. Understand how Arduino and raspberry work as IoT devices
2. Review the various network protocols & communication technology used in IoT.
3. Be familiar with data analytic with IoT

Course Outcomes:

Course Outcome	Description
CO1	Familiarization with different physical Device related to IoT
CO2	Understand the IoT Architectures with devices
CO3	Demonstrate the various tools required in IoT
CO4	Review of various IoT protocols
CO5	Data analytic with IoT
CO6	Python programming for IoT

Course Content:

Unit 1-IoT Physical Device & Endpoints: Arduino UNO, Raspberry Pi,Operating system, interfaces, Intel edison & Intel Galileo board, pcDuino,Beagle Black and Cubieboard

Unit 2- IoT Architectures: Elements of an IoT Architecture, Design considerations.

Unit 3- IoT Application & Tools: Smart Perishable Tracking, lavatory Maintenance, Smart Warehouse,IoT possibility in retail sector,Smart driver assistance system etc., Chef,Setting up Chef, Puupet, Key concepts of Chef and Puppet.

Unit 4-IoT Protocols :Message Queuing Telemetry Transport (MQTT), Constrained Application Protocol (CoAP), Bluetooth Low Energy(BLE), Light Fidelity (Li-Fi)

Unit 5-Data analytic for IoT: Apache Hadoop,Map Reduce model, Hadoop YARN.Apache Oozie,Apache Spark.

Unit-6:IoT System using Python: Package,Amazon EC2, Autoscaling, S3, RDS, DynamoDB and MapReduce.

Teaching Methodology:

The students will be able to learn basic concepts ofIot, its working principle & operation of single layer and multilayer neural networks.

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1, Unit-2
Test-2	25 Marks	Based on Unit- 3 & Unit-4 and around 20% from coverage of Test-1
Test-3	35 Marks	Based on Unit-5 and Unit-5 and around 20% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Tutorials and lecture slides on IoT(will be added from time to time): Digital copy will be available on the JUET server

Text Books

1 Srinivasa K G ,Siddesh G. M. & Hanumantha Raju R., “Internet of Things”, 2nd Edition,Cenegae Education, 2019.

2 Shriram K Vasudevan, Abhishek S Nagarajan & RMD Sundram, “Internet of Things”, 1st Edition,John Wiley & Sons,2019.

Arshdeep Bahga & Vijay Madisetti, “Internet of Things-A Hands-on-Approach”, 1st Edition, VPT, 2014.

Title: Internet of Things Lab **Code: 18B17CI997**

L-T-P Scheme: 0-0-2 **Credit: 1**

Prerequisite:

Students are expected to have a good understanding of computer networks, familiarity with network programming, and object oriented programming.

Objective:

The course is designed to give the students a solid grounding of the key technologies involved and how they are integrated to form complete Internet of Things(IoT) systems.

Learning Outcomes

1. Understand how Arduino and raspberry work as IoT devices
2. Review the various network protocols & communication technology used in IoT.
3. Be familiar with data analytic with IoT

Course Outcomes:

Course Outcome	Description
CO1	Familiarization with different physical Device related to IoT
CO2	Understand the Arduino Programming
CO3	Work on LED and LCD
CO4	Understand various motor behavior
CO5	Illustrate the work function of various sensors

Course Content:

Lab Exercise: Arduino UNO, LED , LCD , Motion Sensor, Pressure sensor, Moisture sensor etc., Motors like as steeper, DC etc. Wifi, Bluetooth, Camera.

Teaching Methodology:

The students will be able to learn basic concepts of IoT programming.

Evaluation Scheme:

Internal Evaluation/ Exams	Marks	Coverage
P-1	15	Based on Lab Experiments: 1-6
P-2	15	Based on Lab Experiments: 7-12
Attendance & Discipline	15	Attendance (5) & Discipline (10)

Lab Record	15	Writing work
Day-to-Day Work	40	Viva-voce
Total	100	

Learning Resources:

Program on IoT will be added on the JUET server.

Text Books

3 Srinivasa K G, Siddesh G. M. & Hanumantha Raju R., "Internet of Things", 2nd Edition,Cenegae Education, 2019.

4 Shriram K Vasudevan, Abhishek S Nagarajan & RMD Sundram, "Internet of Things", 1st Edition,John Wiley & Sons,2019.

Data Marketing

Title: Consumer Behaviour **Code: 18B11HS925**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: None

Objective:

Consumer Behavior course enables a student to gain a comprehensive understanding of consumer behavior & market research and their relevance in gaining consumer insight. This course explores various aspects of consumer decision making process keeping the individual, social and cultural dimensions of consumer behavior as a backdrop. During the course students will frequently be asked to consider two perspectives when thinking about the concepts they cover. One is the perspective of a marketing manager, who needs to understand consumer behavior to develop, implement and evaluate effective marketing strategies. Second is the perspective of the customer and understand influences of marketing on your own behavior. The course also introduces the concept of marketing research and the tools and techniques for which are further enhanced through a separate course on research methodology.

Learning Outcomes:

Course Outcome	Description
CO1	Demonstrate how knowledge of consumer behaviour can be applied to marketing.
CO2	Identify and explain factors which influence consumer behaviour.
CO3	Distinguish between different consumer behaviour influences and their relationships
CO4	Establish the relevance of consumer behaviour theories and concepts to marketing decisions.
CO5	In a team, work effectively to prepare a research report on consumer behaviour issues within a specific context.
CO6	Use most appropriate techniques to apply market solutions

Course Content:

Unit I: Consumer behavior: Concept and Implications; Integration of consumer behavior in the marketing concept; Consumer Decision Making Process; Levels of consumer decision making; Types of Consumer Decision Making.

Unit II: Key Determinants of Consumer Behaviour and Marketing Strategy; Providing Customer Value and Retention; Market segmentation: Concept, Bases and Significance; How market

segmentation operates; Criteria for effective targeting of market segments; Target Marketing strategies.

Unit III: Consumer Motivation; Dynamics of Motivation, type and systems of needs; Personality and theories of personality (relevant to marketing); Consumer diversity; Self and self-image; Consumer Perception; Dynamics of perception and consumer imagery; Consumer Learning; Behavioral and cognitive learning theories; Consumer Attitude; Attitude formation and behavior; Communication and consumer behavior.

Unit IV: Family: Concept, Roles and influences; Reference groups and their influence; Social class and consumer behavior; Influence of culture on consumer behavior; Culture and core values; Influence of sub culture & cross culture on consumer behavior.

Unit V: Consumer Influence and the Diffusion of Innovations; Opinion Leadership, WOM, e-WOM. New times, new consumers; Managing Consumer Dynamics; Consumer decision making and beyond; Consumer Satisfaction and Dissatisfaction: Mechanism; Managing Post-purchase behavior.

Teaching Methodology:

The course is a mix of classroom teaching (power point slides) which includes case studies, quiz, and assignments.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 and around 30% from coverage of Test-2
Assignment	10 Marks	
Case Studies	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lectures, case-studies and e-books on ‘Introduction to E-commerce’ (are added from time to time): Digital copy will be available on the JUET server.

Text Book:

1. Schiffman, L.G. and Kanuk, L.L. (2011) Consumer Behavior, 9th Ed., Prentice Hall.
2. Batra, S.K. and Kazmi, S.H.H. (2009) Consumer Behavior Text and Cases 2nd Eds Excel Books.

Reference Books/Material:

1. Loudon, D.L. and Bitta, A.J.D. (2005) Consumer Behavior Concepts and Applications, TMH.
2. Solomon, Michael R. (2013) Consumer Behavior 10th Ed., Prentice Hall.
3. Blackwell, R.D, Miniard, P.W, and Engel, J.F. (2006) Consumer Behaviour, Cengage.

Course Title: Ethics, IPR and Cyber laws **Course Code :**18B11HS926

L-T-P scheme: 3-0-0 **Credit: 3**

Scope and Objectives:

Advancement in technology often comes with unexpected issues and unintended consequences. The central idea is that the society and information technology revolution are shaping each other. Information technology embodies social values and in turn produces change in values. Thus, the main objective of this course is to help students grapple with the ethical issues, intellectual property rights and cyber laws. The course shall eventually navigate students through ethical,IPR and cyber law issues related to social life and technology on their own.

CourseOutcome

CO1: Understand the ethical, cultural & social issues related to human life and technology.

CO2: Practice responsible use of technology systems, information & software

CO3: To develop positive attitude towards the human conduct and technology uses that support lifelong learning & productivity.

CO4: Identify and explore the IPR related policies.

CO5: To be able to apply the relevant cyber laws to factual situations.

CO6: To develop a holistic personality of the students with good culture, values, ethics and attitudes.

Course Contents

Chapter	Topics
1	Public policy for Technology
2	Social Impact on Information system & Technology
3	Corporate Social responsibility
4	Ethics 2 - Business Ethics and Values - Code of conduct and Professional practices - Environmental Ethics
5	Contract Act - Sale and Agreement to sell - Formalities of the Contract - Condition and Warranty - Transfer of Title - Rights of Unpaid Seller
6	Consumer Protection Act 3 - Background and Objectives - Relief under the Consumer Protection Act - General relief of compensation - Meaning and scope of consumer and C.P.A - Consumer rights

7	Intellectual Property Act and Patent 2 - Patents - Copyrights - Trademarks - Registered (industrial) design - Protection of IC layout design, - Geographical indications, and - Protection of undisclosed information
8	IT ACT 2000 3 - Cyber Crime and Laws - Computer crimes: Fraud and Embezzlement, Sabotage and - Information Theft, intruders, Hacking and cracking - Digital Forgery - Cyber Terrorism - Wire Tapping - Cyber Space: copyright and cyberspace, offensive speech in cyberspace and liability of service provider - ICE Bill
8	Right to Information Act
9	Environment Protection Act
10	Corporate Governance

Evaluation scheme

Test-I	15 Marks
Test-II	25 Marks
Test-III	35 Marks
Tutorial evaluation	5 Marks
Assignment	10 Marks
Quiz	5 Marks
Attendance	5 Marks
Total	**100 Marks**

Text Books:

1. Business Law by PC Tulsian and Bharat Tulsian
2. Business Law by D Chandra Bose

Reference Books:

1. Social Inequality in India by K.L. Sharma, Yogendra Sing
2. Information Technology – Law and Practice by Vakul Sharma
3. Indian ethics by Purusottama Bilimoria, Joseph Prabhu, Renuka M. Sharma

Course Title: Digital Marketing Research **Course Code :**18B11HS927

L-T-P scheme: 3-0-0 **Credit: 3**

Scope

Students gain an understanding of marketing research and its value in analyzing consumers, markets, and the environment. Topics include an overview of market research and research design, exploratory research; descriptive research; scaling; sampling; and data analysis and reporting.

Objectives

Upon completion of this course, students will be able to:

- Write a management decision problem and a marketing research problem, and discuss the differences between them.
- Clearly articulate the value in conducting exploratory research to define the research problem.
- Collect secondary data to refine a marketing research problem.
- Plan, conduct, and interpret a focus group.
- Create a strategy for increasing survey response rates.
- Differentiate between situations that call for surveys and situations that call for observational research.
- Recommend the best sampling technique for different situations and defend that recommendation.
- Create a frequency distribution and a cross-tabulation, conduct basic statistical analysis on the data, and summarize the results in clear language.
- Write a marketing research report in APA style.

Learning Outcomes:

CO1	Develop awareness about the basic concepts of digital marketing research. Discuss the key elements of a digital marketing research.
CO2	Develop a clear understanding of the Digital marketing research Landscape, Digital Analytics Concepts.
CO3	Develop a clear understanding of the tools for Digital marketing research
CO4	Devise a plan based on a sound conceptual framework to implement the digital marketing research.
CO5	Develop understanding of various types of digital marketing research and Developing understanding of digital data research analysis and reporting

Course outline

Unit 1: Introduction to Marketing Research and Research Design

- Topic 1: The Introduction of Digital Marketing Research
- Topic 2: The Digital Marketing Research Process
- Topic 3: Marketing Research and Digital Marketing Decision Making
- Topic 4: The Importance of Defining the Problem
- Topic 5: The Management-Decision Problem and the Marketing Research Problem
- Topic 6: Search and Research.
- Topic 7: Basic Research Design and the Types of Research: Qualitative VS Quantitative

Unit 2: Exploratory Research

- Topic 1: Secondary vs. Primary Data
- Topic 2: How to Use Secondary Data
- Topic 3: Sources of Secondary Data
- Topic 4: Introduction to Qualitative Research
- Topic 5: Focus Groups

Unit 3: Descriptive Research

- Topic 1: Survey Methods
- Topic 2: How to Choose a Survey Method
- Topic 3: Observational Methods
- Topic 4: How to Choose Between Surveys and Observation

Unit 4: Scaling

- Topic 1: Primary Scales of Measurement
- Topic 2: Comparative Scales
- Topic 3: Noncomparative Scales
- Topic 4: Noncomparative Scale Decisions
- Topic 5: Scale Evaluation
- Topic 6: Questionnaire Design

Unit 5: Sampling

- Topic 1: The Concept of Sampling
- Topic 2: The Sampling Design Process
- Topic 3: Nonprobability Sampling
- Topic 4: Probability Sampling
- Topic 5: Internet Sampling

Unit 6: Data Analysis and Reporting

- Topic 1: Data Collection
- Topic 2: Data Preparation
- Topic 3: Data Analysis
- Topic 4: Communicating the Research Results

Evaluation scheme

Test-I	15 Marks
Test-II	25 Marks
Test-III	35 Marks
Tutorial evaluation	5 Marks
Assignment	10 Marks
Quiz	5 Marks
Attendance	5 Marks
Total	**100 Marks**

Required Text and Materials

Malhotra, N. Basic Marketing Research: Integration of Social Media. 4th ed. Toronto, ON. Pearson Education Ltd, 2012.Type: Textbook, ISBN-13: 978-0-13-254448-1 / ISBN-10: 0-13-254448-2

Course Title: Introduction to Social Media Marketing **Course Code :**18B11HS928
L-T-P scheme: 3-0-0 **Credit: 3**

Scope

Social media has given marketers a way to connect with consumers in an unprecedented and revolutionary way, but the very newness of this medium is as challenging as it is exciting, particularly to those who aren't 'digital natives'. This course is designed for students that offer a step by step guide to this newly dominant marketing discipline.

Objectives

Businesses and non-profit organizations of all types and sizes have recognized the value of social media marketing for its power to reach customers in order to meet diverse strategic objectives that range from building brands to developing customer loyalty. The need for professionals who are attuned to the new and emerging processes for engaging the marketing function in digital spaces is creating a demand for savvy social media marketing professionals.

The dramatic upheaval in the ways businesses as well as non-profits view and engage customers, as represented by social media marketing, demands that students entering the workforce are comfortable with the use of social media for strategic marketing. There is a strong need for marketing professionals who are attuned to the digital world and the myriad options that interactive social media represents for engaging customers. The Introduction to Social Media Marketing examines the ways in which interactive technologies are changing the rules and processes for customer engagement. The course will survey the landscape of social media tools with an eye towards critically analyzing their role as effective means for delivering and receiving marketing messages and communications. Special emphasis will be placed upon cornerstone digital marketing techniques that feature utilization of technologies that depend upon customer participation. Students will be exposed to case studies and actual examples of successful, as well as less than optimal, marketing efforts that use such tools. The course will introduce students to the above commonly used social media tools in the marketing and business context by critically examining the functionality and technological underpinnings that enhance their utility as marketing devices as well as the risks that might be associated with their use

CourseOutcome

CO1	Understand the ways in which businesses and non-profits use social media marketing to engage customers.
CO2	Discuss the various strategies of social media marketing with reference to market intelligence, digital transformation etc.
CO3	Acquire and execute the Operational social media marketing
CO4	Compare the various tools of operational social media marketing.
CO5	Critiques about thesocial media's usefulness for businesses as a vehicle for facilitating customer communication and interactions
CO6	Develop successful written, visual, and digital communication skills essential for a career in digital marketing including social media marketing. Apply the key elements of a digital marketing strategy.

Learning Outcome

- Understand the foundational vocabulary and terminology of social media marketing and social media analytics as well as the technologies involved in order to effectively communicate tactics, strategies and decisions related to social media marketing;
- Comprehend the changes to marketing processes in a new economy that features interactive technology that allows for engaging customers in dramatically different ways from the past;
- Appreciate the strategic implications, including risks and ethical implications, of social media marketing highlighting its "real time" aspect along with the speed and highly reproducible nature of such communication;
- Critically evaluate a wide variety of commonly used social media and digital marketing tools in order to assess their effectiveness as well as potential risks, limitations and short-comings;
- Analyze social media's usefulness for businesses as a vehicle for facilitating customer communication and interactions;
- Capably analyze new social media sites or tools that develop in the future and apply them to marketing and business needs or objectives related to developing new markets and sources of revenue.

Course Outline

Unit1 Introduction: social media: the what, why and how
Unit 2 Strategic social media marketing, Who uses what, Social media and the digital transformation ,Ownership and measurement , Social service and support , Social customer relationship management , Social media monitoring for market intelligence
Unit 3 Operational social media marketing, Introduction, Management and staff , Viral marketing and influencers , Contents , Blogging , Consumer reviews , Social networking and online communities
Unit4. Social sharing , Social service and support , Real-time social media marketing , Event social media marketing , Online public relations and reputation management , Advertising on social media .

Evaluation scheme

Test-I	15 Marks
Test-II	25 Marks
Test-III	35 Marks
Tutorial evaluation	5 Marks
Assignment	10 Marks
Quiz	5 Marks
Attendance	5 Marks
Total	**100 Marks**

Required Text and Materials

An introduction to social media marketing,**alancharlesworth**,Routledge, 31-oct-2014 - **business & economics** - 228 pages

Title: Introduction to E-commerce **Code: 21B11HS975**
L-T-P scheme: 3-0-0 **Credit: 3**

Prerequisite: None

Objective:

This course focuses on principles of e-commerce from a business perspective, providing an overview of business and technology topics, business models, virtual value chains and social innovation and marketing strategies. In addition, some of the major issues associated with e-commerce - security, privacy, intellectual property rights, public safety, e-tail, auctions - will be explored.

Learning Outcomes:

Course Outcome	Description
CO1	Analyze the impact of E-commerce on business models and strategy.
CO2	Describe the major types of E-commerce.
CO3	Explain the process that should be followed in building an E-commerce presence.
CO4	Identify the key security threats in the E-commerce environment.
CO5	To identify the main barriers to the growth and development of e-commerce in organizations.
CO6	Describe how procurement and supply chains relate to B2B E-commerce.

Course Content:

Unit-1: Introduction to E-commerce, unique features of E-commerce technology, types; E-commerce infrastructure, The Internet and The Web, features, mobile apps; Imagine your E-commerce presence, building your E-commerce presence, choosing software and hardware, other E-commerce site tools, developing mobile website and building mobile applications.

Unit-2: E-commerce security environment, security threats, technology solutions, managing policies, business procedure, public laws, E-commerce payment systems; E-commerce business models, major B2C and B2B business models, how E-commerce changes business – strategy, structure, and process; Internet audience and consumer behaviour, digital commerce marketing and advertising strategies and tools, Internet marketing technologies, costs and benefits.

Unit-3: Introduction to social, mobile and local marketing, social marketing process, mobile marketing features, location-based marketing; Understanding ethical, social and political issues in

E-commerce, privacy and information rights, intellectual property rights, governance, public safety and welfare; Online media content, online publishing industry, online entertainment industry.

Unit-4: Social network and online communities, online auctions, e-commerce portals; Online retail sector, analyzing the viability of online firms, E-tailing business models, service sector, online financial services, online travel services, online career services, on-demand service companies; Overview of B2B e-commerce, procurement process and supply chains, trends in supply chain management, net marketplace, private industrial networks.

Teaching Methodology:

The course is a mix of classroom teaching (power point slides) which includes case studies, quiz, and assignments.

Evaluation Scheme:

Exams	Marks	Coverage
Test-1	15 Marks	Based on Unit-1 & Unit-2
Test-2	25 Marks	Based on Unit-3 around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 and around 30% from coverage of Test-2
Assignment	10 Marks	
Case Studies	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Lectures, case-studies and e-books on 'Introduction to E-commerce' (are added from time to time): Digital copy will be available on the JUET server.

Text Book:

[1] Laudon & Traver, Business, Technology, Society, 16th Edition, Pearson Education.

Reference Books/Material:

[1] Kutz, Introduction to E-commerce: Combining Business and Information Technology, bookboon.com.

[2] Jaiswal, Doing business on the Internet - E-Commerce, Galgotia.

[3] Qin, Introduction to E-commerce, Springer.

[4] Lee, E-commerce, E-business and E-service, CRC Press.

Course Name: Digital Marketing Analytics **Code: 18B11HS930**
L-T-P Scheme: 3-0-0 **Credit: 3**

Prerequisite: None

Objective:

The objective of this course is to train students to apply concepts and techniques in digital marketing so that they become acquainted with the duties of a digital marketing manager. More specifically, students will be exposed to the development, evaluation, and implementation of digital marketing analytics in a variety of business environments.

Learning Outcomes:

CO1	Develop awareness about the basic concepts of digital marketing analytics. Discuss the key elements of a digital marketing analytics.
CO2	Develop a clear understanding of the Digital Media Landscape, Digital Analytics Concepts, Tools of the Trade.
CO3	Develop a clear understanding of the tools for Social Media Listening, Search Analytics,audience analysis, Content Analysis,engagement analysis
CO4	Devise a plan based on a sound conceptual framework to implement the digital marketing analytics.
CO5	Develop understanding of digital Influence and Developing Social Media Listening Program
CO6	Make strategic digital marketing decisions based on learnings from various concepts of digital marketing analytics.

Course Contents

Unit 1

1. **Understanding the Digital Media Landscape:**Digital Media Types ,Paid Media ,Owned Media
2. **Understanding Digital Analytics Concepts:** Determining Your Owned and Earned Social Metrics, Owned Social Metrics Earned Social Media Metrics , Demystifying Web Data,Searching for the Right Metrics , Paid Searches , Organic Searches , Aligning Digital and Traditional Analytics , Primary Research , Traditional Media Monitoring

Unit 2

3. **Picking the Tools of the Trade:** Identifying a Social Media Listening Tool, Data Capture ,Spam Prevention, , Integration with Other Data Sources , Cost, , Mobile Capability, Consistent User Interface , Workflow Functionality, Understanding Social Media Engagement Software , Robust Analytics Dashboards
4. **Tools: Social Media Listening:** Social Media Listening Evolution, Social Media Listening in the Present Day, International Listening: The New Frontier, What's Next for Social Media Listening?

Unit 3

5. **Tools: Search Analytics:** Understanding the Basics of Search, Search Analytics Use Cases , Free Tools for Collecting Insights Through Search Data, Google Trends , YouTube Trends ,The Google AdWords Keyword Tool , Yahoo! Clues, Paid Tools for Collecting Insights Through Search Data , The BrightEdge SEO Platform, Wrapping up Search Analytics

6. **Tools: Audience Analysis:** What Is Audience Analysis?,Audience Analysis Use Cases , Digital Strategy , Content Strategy, Engagement Strategy,Search Engine Optimization ,Content ,User Experience Design, Audience Segmentation , Audience Analysis Tool Types , Additional Audience Analysis Techniques , Conversation Typing

Unit 4

7. **Tools: Content Analysis:** Content Audits, Content Audit Checklist, Real-Time Analytics, Optimizing Content Distribution, Analyzing Content Consumption, Learning Agendas , Classifying Results for Content Analysis
8. **Tools: Engagement Analysis:** Introducing SMES, Using Robust Analytics Dashboards ,Scheduling Content, Posting to All Major Social Media Networks , Uploading Multimedia Content ,Geo-Targeting Posts, Post Tagging, , Using an SMES Tool for a Small to Medium-Size Business

Unit 5

9. **Understanding Digital Influence:** Understanding the Reality of Digital , The "Tipping Point" Phenomenon , The Community Rules Phenomenon, Developing a Modern-Day Media List , Using the Tools of the Trade
10. **Developing Your Social Media Listening Program:** How Other Companies Are Listening Today ,Using Listening Data for Program Planning , Utilizing Listening Data for Ongoing, Proactive Communications , Understanding What Listening Can Do, Real-Time Content Development , Developing Better Relationships with Customers , Gaining Product Knowledge Through Listening
11. **How to Use Listening to Inform Marketing Programs:** Understanding the Conversation Audit Scoping the Conversation Audit , Elements of a Conversation , Fitting the Conversation Audit into the Program Planning Continuum , Identifying Online Influencers , Conducting Social Brand

Evaluation Scheme:

Exams	**Marks**	**Coverage**
Test-1	15 Marks	Based on Unit-1,
Test-2	25 Marks	Based on Unit-2 & Unit-3 and around 30% from coverage of Test-1
Test-3	35 Marks	Based on Unit-4 to Unit-5 and around 30% from coverage of Test-2
Assignment	10 Marks	
Tutorials	5 Marks	
Quiz	5 Marks	
Attendance	5 Marks	
Total	**100 Marks**	

Learning Resources:

Case studies, and lecture slides on Marketing Management (will be added from time to time): Digital copy will be available on the JUET server.

Text Book:

- **Digital Marketing Management**, , by Chuk Hemann and Ken Burbury, Que Publication ,USA.

Title of Course: Minor Project **Course Code: 18B17HS973**
L-T-P scheme: 0-0-4 **Course Credits: 2**

Course Learning Outcome:

After successful completion of this course student will be able to:

Course Outcome	Description
CO1	Acquire practical knowledge within the chosen area of technology for project development
.CO2	Identify, analyze, formulate and handle digital marketing projects with a comprehensive and systematic approach.
CO3	Contribute as an individual or in a team in development of technical projects.
CO4	Develop effective communication skills for presentation of project related activities.
CO5	Critiques about the social trends that influence digital and social media tools and strategy.

Syllabus:

A project to be developed based on one or more of the following concepts.

Introduction to Digital Marketing, Strategies in Digital Marketing
Search Engine Optimization – (Understand the search engine as default entry point to internet. Learn how to get website listed among top search engine results) - Search Engine working, Crawlers, ranking algorithm and techniques, Types of search engines, white hat SEO, black hat and grey hat SEO, on page optimization and techniques.
Search Engine Marketing – Basics of marketing, Inbound and outbound marketing, Appreciate the role of pay per click in website listing. Learn how to effectively run ads on Search Engines. Email Marketing– Learn how to effectively build your users lists, deliver e-mails & generate relevant clicks.
Social Media Marketing– Learn how to build brand, generate leads & aggregate audience on Social Media. Inbound Marketing– Learn how to attract & convert customers by earning their trust through various techniques such as content marketing.
Web Analytics – Basic web analytics process, web analytics technologies, log file analysis, Best Web Analytics Tools: Clickstream Analysis Tools, Content and Blog Marketing– Increasing audience engagement through content marketing. Learn to use white paper, brochure, and case studies for unique interaction.
Mobile Marketing– Strategizing marketing through smart devices. Learn App-based marketing, QR codes, Location-based marketing, SMS marketing.

Evaluation scheme:

Exam	Marks
P1	12 marks
P2	25 marks
P3	35 marks
Weekly report	5 marks
Day to day work	10 marks
Project Report	10 marks
Total	**100 marks**