KUMARAGURUCOLLEGE OF TECHNOLOGY,

An autonomous Institution Affiliated to Anna University, Chennai

COIMBATORE – 641 049.

M.TECH., DATA SCIENCE

REGULATIONS 2018

CURRICULUM AND SYLLABI

I to IV Semesters

Department of Information Technology

Signature of BOS Chairman, IT

VISION

The department of Information Technology aspires to become a **school of excellence** in providing **quality education, constructive research** and **professional opportunities in Information Technology**.

MISSION

- To provide academic programs that engage, enlighten and empower the students to **learn technology through practice, service and outreach**
- To educate the students about **social responsibilities and entrepreneurship**
- To encourage **research through continuous improvement** in infrastructure, curriculum and faculty development in collaboration with industry and institutions

PROGRAMEDUCATIONAL OBJECTIVES (PEOs)

PEO1 : Graduates of the program will be employed in industry, government and entrepreneurial endeavors to have a successful professional career.

PEO2 : Graduates of the program will pursue higher education and /or research.

PEO3 : Graduates of the program utilize the acquired technical skills and knowledge for the benefit of society.

PROGRAMOUTCOMES (POs)

PO1 : An ability to independently carry out research /investigation and development work to solve practical problems

PO2 : An ability to write and present a substantial technical report/document

PO3 : Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Understand the various processes involved in application development in the Context of data science.

PSO2: Develop realistic solutions to meet the requirements of the society and the industry using the acquired data analytics skills.

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KUMARAGURU COLLEGE OF TECHNOLOGY

COIMBATORE – 641 049

REGULATIONS 2018

M.TECH DATA SCIENCE

CURRICULUM

SEMESTER I							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18MAT1107	Mathematics for Data Science	Theory	3	1	0	0	4
P18INT0001	Research Methodology and Statistics	Theory	3	0	0	0	3
P18ITT1002	Machine Learning	Theory	3	0	0	0	3
P18ITI1203	Data Mining Techniques	Embedded	3	0	2	0	4
P18ITI1204	Data Science and Analytics with Python	Embedded	3	0	2	0	4
						Total Credits	**18**
						Total Hours per week	**21**
SEMESTER-II							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18ITI2205	Deep Learning	Embedded	3	0	2	0	4
P18ITI2206	Data Visualization	Embedded	3	0	2	0	4
P18ITI2207	Big Data Technologies	Embedded	3	0	2	0	4
P18ITE____	Professional Elective I	Theory	3	0	0	0	3
						Total Credits	**15**
						Total Hours per week	**18**
SEMESTER-III							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18ITE____	Professional Elective II	Theory	3	0	0	0	3
P18ITP3701	Project Phase I / Industry Project	Project	0	0	0	30	15
						Total Credits	**18**
						Total Hours per week	**33**
SEMESTER-IV							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18ITP4701	Project Phase II/Industry Project	Project	0	0	0	30	15
						Total Credits	**15**
						Total Hours per week	**30**

Grand Total Credits: 66

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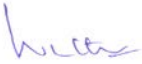
LIST OF PROFESSIONAL ELECTIVES

Code No.	Course Title	Course Type	L	T	P	J	C
P18ITE0010	Recommender System	Theory	3	0	0	0	3
P18ITE0011	Artificial Intelligence	Theory	3	0	0	0	3
P18ITE0012	Streaming Analytics	Theory	3	0	0	0	3
P18ITE0013	Reinforcement learning	Theory	3	0	0	0	3
P18ITE0014	Social Media Analytics	Theory	3	0	0	0	3
P18ITE0015	Advanced Algorithms	Theory	3	0	0	0	3
P18ITE0016	Blockchain Technology	Theory	3	0	0	0	3
P18ITE0017	Big Data Security	Theory	3	0	0	0	3
P18ITE0018	Information Retrieval Techniques	Theory	3	0	0	0	3
P18INT0002	Product Design and Development	Theory	3	0	0	0	3

AUDIT COURSE

Code No.	Course Title	Semester
P18ITA0001	English for Research Paper Writing	II



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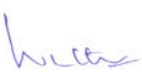
SEMESTER I



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P18MAT1107 MATHEMATICS FOR DATA SCIENCE
(Common to M.E.(CSE)and M.Tech.(Data Science))

L	T	P	J	C
3	1	0	0	4

COURSE OUTCOME

On the successful completion of the course, the students would be able to

CO1: Check linear dependency of vectors and identify Eigen values, Eigen vectors and derivative of a matrix, which will form the basis for Principal Component Analysis.

CO2: Apply the concept of probability and random variables, which will help in learning Bayesian classifiers.

CO3: Apply the concepts of two dimensional random variables, central limit theorem and multivariate normal distribution, which lay the foundation for Machine Learning.

CO4: Fit curves to given data, analyse the correlation and regression and find the maximum likelihood estimate

CO5: Learn and apply multivariate analysis necessary for Principal Component Analysis.

CO6: Determine the extreme values of functions without constraint, and with equality Constraints

Pre-requisite : NIL

CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak					
Cos	**PROGRAMME OUTCOMES (POs)**			**PSO**	
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	M				
CO2	S		M	M	M
CO3	M				
CO4	M		M	M	
CO5	M				

Course Assessment methods

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

MATRICES **5 + 2 hours**

Linearly dependent and independent vectors - Eigenvalues and eigenvectors - Inner product and outer product of vectors - Derivative of a matrix - Jacobian matrix – Area differential.

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PROBABILITY AND RANDOM VARIABLES **9+ 3 Hours**

Axioms of probability - Conditional probability – Statistical independence - Law of total probability – Baye's theorem - Random variable – Discrete and Continuous random variables - Probability mass function – Probability density function – Expected value of a random variable –Moments.

TWO DIMENSIONAL RANDOM VARIABLES **11 + 3 Hours**

Pairs of random variables - Marginal and conditional distributions – Expected values of functions of two variables– Central limit theorem - Normal distribution –properties - Fitting of Normal distribution-Bivariate Normal distribution - Multivariate Normal distribution

REGRESSION ANALYSIS AND ESTIMATION **10 + 3 Hours**

Curve fitting by method of least squares - Correlation – Properties of correlation coefficient – Linear regression – Least square estimation of regression coefficients – Regression lines – Maximum Likelihood Estimation

MULTIVARIATE ANALYSIS **5 + 2 Hours**

Random vector –MeanVector – Correlation Matrix - Covariance Matrix – Principal Components – Population Principal Components - Principal Components from standardized variables

CLASSICAL OPTIMIZATION THEORY **5 + 2 Hours**

Unconstrained extremal problems – Equality constraints – Lagrange's method

REFERENCES

1. Veerarajan T., Engineering Mathematics (for First Year), Tata McGraw Hill Pub. Co. Ltd., New Delhi, Revised Edition, 2007
2. Gupta S.C. & Kapoor V.K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 2007.
3. Freund John, E and Miller, Irvin, "Probability and Statistics for Engineering", Duxbury Press; 6 edition, 2003.
4. Veerarajan. T., "Probability, Statistics and Random Process", Tata McGraw Hill,2003
5. Richard A. Johnson and Dean W. Wichern, ―Applied Multivariate Statistical Analysis‖, 5th Edition, Pearson Education, Asia, 2012.
6. Anderson, T. W ,An Introduction to Multivariate Statistical Analysis, John Wiley and Sons, 2003
7. Sharma J. K., "Operations Research", Macmillan India Ltd, Delhi, 2nd Edition, 2003

Websites

https://www.coursera.org/specializations/mathematics-machine-learning
www.coursera.org/learn/datasciencemathskills
http://home.iitk.ac.in/~psraj/mth101/lecture_notes/lecture31.pdf

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Lab Assignments (Self-study)

Assignments will be given to the students on the following topics and their knowledge will be assessed through a lab practical test (which will be included in the internal assessment)

Determine determinants, inverse of a matrix, eigen values and eigenvectors using MATLAB
Graphical Representation(Simple Bar graphs and Pie charts) in R
Finding Mean, Median, Mode and SD using R.
Curve fitting, finding Correlation and Regression lines using R
Solving problems involving Normal distribution using R

Theory: 45 Tutorial: 15 Practical: 0 Project: 0 Total: 60 Hours

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L	T	P	J	C
3	0	0	0	3

P18INT0001 RESEARCH METHODOLOGY AND STATISTICS

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Understand and apply the concepts of research

CO2: Apply statistical and other research tools to analyze and interpret data

CO3: Demonstrate skills in writing research topics

Pre-requisite : NIL

CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak					
Cos	**PROGRAMME OUTCOMES (POs)**			**PSO**	
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	M				
CO2	S		M	M	M
CO3	M				
CO4	M		M	M	
CO5	M				

COURSE ASSESSMENT METHODS:

Direct
1. Mid Term Examination 2. Research Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

UNIT I: Introduction to Research Methods **9 Hours**

Definition and Objectives of Research, Scientific Methods, Various Steps in Scientific Research, Research planning , Selection of a Problem for Research , Formulation of the Selected Problems, Purpose of the Research, Formulation of research objectives, Formulation of research questions, Hypotheses Generation and Evaluation, Literature search, and review, Research abstract

UNIT II: Introduction to Statistics **9 Hours**

Population and Sample, Sampling and sample size, Population Proportion and Population Mean, Sample Proportion and Sample Mean, Estimation of Standard Error and confidence Interval, Identifying the dependent and independent variables, Introduction to data, Types of data and their importance, Descriptive Statistics and Inferential Statistics, Summarizing and describing data, Measures of Central Tendency and Measures of Dispersion, Mean, Median, Mode, Range, Variance, Standard Deviation

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UNIT III: Statistical Modeling and Analysis **12 Hours**

Probability Distributions, Normal, Binomial, Poisson, Fundamentals of Statistical Analysis and Inference, Hypothesis Testing, Confidence interval, Test of Significance, Comparison of Means (T test, Z test), Analysis of variance (ANOVA), Measures of association/Relationship, Chi-square test, Simple Regression Analysis, Multiple Regression analysis, Correlation, Data visualization techniques

UNIT IV: Research Design/Plan **6 Hours**

Types and Methods of Research, Classification of Research, Research Ethics, Sampling Techniques, Methods of Collecting Primary Data, Use of Secondary Data, Experimentation, Design of Experiments, Survey Research and Construction of Questionnaires, Pilot Studies and Pre-tests, Data Collection methods, Processing of Data, Editing, Classification and Coding, Transcription, Tabulation, Validity and Reliability,

UNIT V: Research Reports **9 Hours**

Structure and Components of Research Report/thesis, Types of Report, Planning of Report/thesis Writing, Research Report Format, Layout of Research Report, Presentation of data and Data Analysis Reporting, Mechanism of writing a research report, Principles of Writing, Writing of Report

REFERENCE BOOKS:

1. C.R. Kothari, Research Methodology Methods and Techniques, 3/e, New Age International Publishers, 2014.
2. Ranjit Kumar, Research Methodology A Step-by-Step Guide for Beginners, 4th Edition, Sage Publishing, 2014
3. R. Pannerselvam, Research Methodology, 2nd edition, Prentice Hall India, 2014
4. Devore, J.L., Probability and statistics for Engineering and the Sciences, Cengage Learning, ebook, 8th edition, 2010

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

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P18ITT1002 **MACHINE LEARNING**

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- To have a thorough understanding of the Supervised and Unsupervised learning techniques
- To study the various probability-based learning techniques
- To understand graphical models of machine learning algorithms

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Explain the working of various machine learning algorithms
CO2: Apply the appropriate machine learning strategy for any given problem
CO3: Explain the ensemble learning and probability based learning techniques
CO4: Construct the decision tree for the given application.
CO5: Explain the Dimensionality reduction techniques and Graph based models

Pre-requisite : NIL

CO/PO MAPPING

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M				
CO2	S		M	M	M
CO3	M				
CO4	M		M	M	
CO5	M				

Course Assessment methods

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION **9 Hours**

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

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LINEAR MODELS **9 Hours**

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multilayer Perceptron in Practice – Examples of using the MLP – Overview – Deriving Back Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines.

TREE AND PROBABILISTIC MODELS **9 Hours**

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map

DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS **9 Hours**

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms – Reinforcement Learning – Overview – Getting Lost Example – Markov Decision Process

GRAPHICAL MODELS **9 Hours**

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models – Tracking Methods

REFERENCE BOOKS:

1. Ethem Alpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)‖, Third Edition, MIT Press, 2014
2. Kevin P. Murphy , Machine Learning A Probabilistic Perspective, The MIT Press,2012
3. Jason Bell, ―Machine learning – Hands on for Developers and Technical Professionals‖, First Edition, Wiley, 2014
4. Peter Flach, ―Machine Learning: The Art and Science of Algorithms that Make Sense of Data‖, First Edition, Cambridge University Press, 2012.
5. Stephen Marshland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
6. Tom M Mitchell, ―Machine Learning‖, First Edition, McGraw Hill Education, 2013
7. Bishop**,** Christopher, "Pattern Recognition and Machine Learning", springer,2011

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

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P18ITI1203 DATA MINING TECHNIQUES

L	T	P	J	C
3	0	2	0	4

COURSE OBJECTIVES:

- Identify the scope and necessity of Data Mining algorithms.
- To understand various tools of Data Mining and their techniques to solve the real time problems.

COURSE OUTCOMES:
After successful completion of this course, the students should be able to

CO1: Explain the techniques for data pre processing
CO2: Apply association rules algorithm for correlation analysis
CO3: Apply decision tree algorithm for classification
CO4: Apply Bayesian networks algorithm for classification
CO5: Apply various clustering algorithms for different datasets
CO6: Estimate the classifier accuracy with training, testing and cross validation datasets

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M				
CO2	M				M
CO3	M				M
CO4	M				M
CO5	M				M
CO5	M	M			M

Course Assessment methods

Direct
1. Mid Term Examination (Theory component) 2. Assignment, Group Presentation (Theory component) 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) 4. Model examination (Lab component) 5. End Semester Examination (Theory and Lab components)
Indirect
1. Course-end survey

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INTRODUCTION TO DATA MINING AND PREPROCESSING 9 Hours

Data mining - Related technologies - Machine Learning, DBMS, OLAP, Statistics - Data Mining Goals - Stages of the Data Mining Process - Data Mining Techniques - Knowledge Representation Methods – Applications.

Data preprocessing- Data cleaning- Data transformation - Data reduction - Discretization and generating concept hierarchies

CLASSIFICATION ALGORITHMS I 9 Hours

Association rules: Basic idea: item sets - Generating item sets and rules efficiently - Correlation analysis

Classification: Basic learning/mining tasks - Inferring rudimentary rules: 1R algorithm - Decision trees - Bayes Classification Methods - Rule-Based Classification - Model Evaluation and Selection - Techniques to Improve Classification Accuracy

CLASSIFICATION ALGORITHMS 9 Hours

Bayesian Belief Networks - Classification by Back propagation - Support Vector Machines - Classification Using Frequent Patterns - k-Nearest-Neighbor Classifiers - Case-Based Reasoning- Multiclass Classification - Semi-Supervised Classification- Mining Time series Data, Periodicity Analysis for time related sequence data

CLUSTERING 9 Hours

Basic issues in clustering - First conceptual clustering system: Cluster/2 - Partitioning methods: k-means, expectation maximization (EM) - Hierarchical methods: distance-based agglomerative and divisible clustering - Conceptual clustering: Cobweb

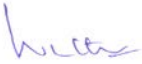
OUTLIER DETECTION 9 Hours

Outliers and Outlier Analysis, Outlier Detection Methods, Statistical Approaches, Proximity-Based Approaches, Clustering-Based Approaches, Classification-Based Approaches, Mining Contextual and Collective Outliers, Outlier Detection in High-Dimensional Data

REFERENCE BOOKS:

1. Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Fourth Edition), Morgan Kaufmann, 2016
2. Jiawei Han, MichelineKamber, Jian Pei, “Data Mining Concepts and Techniques”, Morgan Kaufman Publications, Third Edition, 2011.
3. Pang-NingTan,Michael Steinbach, Vipin Kumar,” Introduction to Data Mining”,Pearson,2016

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours



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LAB COMPONENTS: Using Data mining Tools

1. Accessing and Analyzing the data
2. Association rule analysis
3. Classification – Decision Trees
4. Classification- Bayesian networks
5. Classification – Back propagation
6. Classification – Support Vector Machines
7. Classification - k-Nearest-Neighbor Classifiers
8. Clustering - Hierarchical methods

Theory: 0 Tutorial: 0 Practical: 30 Project: 0 Total: 30 Hours

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P18ITI1204 DATA SCIENCE AND ANALYTICS WITH PYTHON

L	T	P	J	C
3	0	2	0	4

COURSE OBJECTIVES:

- To provide an in-depth knowledge of the various libraries and packages required to perform data analysis, data visualization, web scraping and machine learning using python

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Explain the roles and stages of data science projects

CO2: Describe the data structures provided by numpy library for arrays and vectorized computation

CO3: Explain data structures provided by pandas library for data analysis

CO4: Perform data wrangling, cleaning and transformation using python

CO5: Use matplot lib for plotting and visualizing the datasets

CO6: Demonstrate data aggregation and time series analysis using python programming Language

Pre-requisite: NIL

CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak					
Cos	**PROGRAMME OUTCOMES (POs)**			**PSO**	
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	M				
CO2	M				
CO3	M				
CO4	M	M			M
CO5	M				M
CO6	M	M			M

Course Assessment methods

Direct
1. Mid Term Examination (Theory component) 2. Assignment, Group Presentation (Theory component) 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) 4. Model examination (Lab component) 5. End Semester Examination (Theory and Lab components)
Indirect
1. Course-end survey

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INTRODUCTION TO DATA SCIENCE **9 Hours**

Data science process – roles, stages in data science project – working with data from files – working with relational databases – exploring data – managing data – cleaning and sampling for modeling and validation.

NUMPY BASICS: ARRAYS

The NumPy ndarray: A Multidimensional Array Object – Universal Functions: Fast Element-wise Array Functions – Data Processing Using Arrays

VECTORIZED COMPUTATION AND PANDAS **9 Hours**

File Input and Output with Arrays – Linear Algebra – Random Number Generation – Random Walks. Introduction to pandas Data Structures – Essential Functionality – Summarizing and Computing Descriptive Statistics – Handling Missing Data – Hierarchical Indexing – Other pandas Topics

DATA LOADING, STORAGE, AND FILE FORMATS & DATA WRANGLING: CLEAN, TRANSFORM, MERGE, RESHAPE **9 Hours**

DATA LOADING, STORAGE, AND FILE FORMATS**:** Reading and Writing Data in Text Format – Binary Data Formats – Interacting with HTML and Web APIs – Interacting with Databases

DATA WRANGLING: CLEAN, TRANSFORM, MERGE, RESHAPE

Combining and Merging Data Sets – Reshaping and Pivoting – Data Transformation – String Manipulation – USDA Food Database

PLOTTING AND VISUALIZATION **9 Hours**

A Brief matplot lib API Primer – Plotting Functions in pandas – Plotting Maps: Visualizing Haiti Earthquake Crisis Data – Python Visualization Tool Ecosystem

DATA AGGREGATION AND GROUP OPERATIONS & TIME SERIES **9 Hours**

DATA AGGREGATION AND GROUP OPERATIONS**:** GroupBy Mechanics – Data Aggregation – Group-wise Operations and Transformations – Pivot Tables and Cross-Tabulation

TIME SERIES: Date and Time Data Types and Tools – Time Series Basics – Date Ranges, Frequencies, and Shifting – Time Zone Handling – Periods and Period Arithmetic – Resampling and Frequency Conversion – Time Series Plotting – Moving Window Functions – Performance and Memory Usage Notes

REFERENCES:

1. Wes McKinney, "*Python* for *Data Analysis*", O'Reilly Media.2012
2. Sebastian Raschka, “Python Machine Learning”,Packpub.com,2015
3. https://www.datacamp.com/courses/statistical-thinking-in-python-part-1

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

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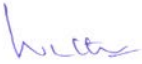
LAB COMPONENTS

1. Data Manipulation using Numpy
2. Data Manipulation using Pandas
3. Building Random Forest Model
4. Computing descriptive statistics using pandas
5. Handling missing data using pandas
6. Exploring Machine Learning Dataset
7. Plotting and Visualizing data
8. Plotting and Analyzing Time Series Data

Theory: 0 Tutorial: 0 Practical: 30 Project: 0 Total: 30 Hours



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SEMESTER II

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P18ITI2205 DEEP LEARNING

L	T	P	J	C
3	0	2	0	4

COURSE OBJECTIVES:

- Introduce major deep learning algorithms, the problem settings, and their applications to solve real world problems.

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: understand the fundamental principles, theory and approaches for learning with deep neural networks

CO2: understand the key concepts, issues and practices when training and modelling deep neural networks

CO3: understand convolution neural networks and various popular CNN architectures in literature

CO4: apply neural networks in applications like - object detection, face recognition, neural style transfer

CO5: understand the variations of neural network for sequence data, apply RNN in applications like - Sentiment classification, Language translation, Speech Recognition and Trigger word detection.

Pre-requisite : NIL

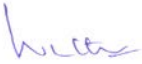
CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak					
Cos	**PROGRAMME OUTCOMES (POs)**			**PSO**	
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	M				
CO2	M				
CO3	M				
CO4	S	M	M	M	M
CO5	M				M

Course Assessment methods

Direct
1. Mid Term Examination (Theory component) 2. Assignment, Group Presentation (Theory component) 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) 4. Model examination (Lab component) 5. End Semester Examination (Theory and Lab components)
Indirect
1. Course-end survey

INTRODUCTION TO DEEP LEARNING **9 Hours**

Neural Network, Supervised Learning with Neural Network, Logistic Regression, Gradient Descent, Computational Graphs, Vectorization, Activation Functions, Deep Neural Network, Forward and Backward Propagation



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IMPROVING DEEP NEURAL NETWORK **9 Hours**

Bias and Variance, L2 Regularization, Dropout Regularization, Vanishing and Exploding Gradients, Mini Batch Gradient Descent, Gradient Descent with Momentum, RMSProp, Adam Optimization, Softmax Classifier, Tensor Flow Introduction

CONVOLUTION NEURAL NETWORKS **9 Hours**

Computer Vision, Edge Detection, Convolutions, Padding and Strided Convolutions Pooling Layers, Fully Connected Layer, CNN Case Studies : LeNet5, AlexNet, VGG16 , Resnets, Inception Network, Transfer Learning

CONVOLUTION NEURAL NETWORK APPLICATIONS **9 Hours**

Object Localization, Landmark Detection, Object Detection: IoU, Anchor Boxes, Nonmax Suppression, Yolo Algorithm, Face Recognition: One Shot Learning, Siamese Network, Triplet Loss, Neural Style Transfer

SEQUENCE MODELS **9 Hours**

RNN Model, Back Propagation through time, Language Model, GRU, LSTM, Bidirectional RNN, Deep RNN, Word Representation, Learning Word Embeddings, Applications: Sentiment Classification, Picking most likely sentence, Attention Model, Speech Recognition, Trigger Word Detection

REFERENCE BOOKS:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, The MIT Press
2. Rajiv Chopra, Deep Learning: A Practical Approach, Khanna Publication
3. François Chollet, ”Deep Learning with Python”, Manning Publications Company,2017
4. MOOC, Deep Learning By Google, https://in.udacity.com/course/deep-learning--ud730
5. MOOC, Deep Learning https://www.coursera.org/specializations/deep-learning

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

LAB COMPONENTS

1. Build Logistic Regression Classifier to recognise cats
2. Implement single layer neural network for binary classification
3. Building Deep Neural Network for image classification
4. Training Deep Neural Network with various ways of initialization
5. Apply L2 Regularisation and Dropout Regularisation to improve accuracy of Model
6. Optimization of Deep Neural Network using Mini Batch Gradient Descent and Adam Optimization
7. Implement Convolution and Pooling Layers using Numpy
8. Implement ConvNet using Tensor Flow
9. Building RNN in Numpy
10. Building Character Level Language Model

Theory: 0 Tutorial: 0 Practical: 30 Project: 0 Total: 30 Hours

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P18ITI2206 **DATA VISUALISATION**

L	T	P	J	C
3	0	2	0	4

COURSE OBJECTIVES:

- To understand visualization for time-series, ranking and deviation analysis
- To understand visualization for distribution, correlation and multivariate analysis.
- To understand issues and best practices in information dashboard design.

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

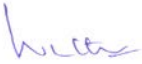
CO1: Explain principles of visual perception
CO2: Apply core skills for visual analysis
CO3: Describe visualization for time-series analysis and ranking analysis.
CO4: Explain visualization for deviation analysis and distribution analysis.
CO5: Describe visualization for correlation analysis and multivariate analysis
CO6: Summarize issues and best practices in information dashboard design.

Pre-requisite : NIL

CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak					
Cos	**PROGRAMME OUTCOMES (POs)**			**PSO**	
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	M				
CO2	S		M	M	M
CO3	M	M			
CO4	M				
CO5					
CO6		M			

Course Assessment methods

Direct
1. Mid Term Examination (Theory component) 2. Assignment, Group Presentation (Theory component) 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) 4. Model examination (Lab component) 5. End Semester Examination (Theory and Lab components)
Indirect
1. Course-end survey



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CORE SKILLS FOR VISUAL ANALYSIS **9 Hours**

Information visualization – effective data analysis – traits of meaningful data – visual perception –making abstract data visible – building blocks of information visualization – analytical interaction – analytical navigation – optimal quantitative scales – reference lines and regions – trellises and crosstabs – multiple concurrent views – focus and context – details on demand – over-plotting reduction – analytical patterns – pattern examples.

TIME-SERIES, RANKING, AND DEVIATION ANALYSIS **9 Hours**

Time-series analysis – time-series patterns – time-series displays – time-series best practices – part-to-whole and ranking patterns – part-to-whole and ranking displays – best practices – deviation analysis – deviation analysis displays – deviation analysis best practices.

DISTRIBUTION, CORRELATION, AND MULTIVARIATE ANALYSIS **9 Hours**

Distribution analysis – describing distributions – distribution patterns – distribution displays – distribution analysis best practices – correlation analysis – describing correlations – correlation patterns – correlation displays – correlation analysis techniques and best practices – multivariate analysis – multivariate patterns – multivariate displays – multivariate analysis techniques and best practices.

INFORMATION DASHBOARD DESIGN **9 Hours**

Information dashboard – Introduction– dashboard design issues and assessment of needs – Considerations for designing dashboard-visual perception – Achieving eloquence.

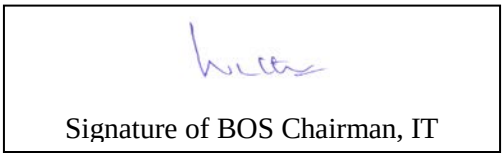
GRAPHICS AND CRITICAL DESIGN PRACTICES **9 Hours**

Advantages of Graphics _Library of Graphs – Designing Bullet Graphs – Designing Sparklines – Dashboard Display Media –Critical Design Practices – Putting it all together- Unveiling the dashboard**.**

REFERENCE BOOKS:

1. Ben Fry, "Visualizing data: Exploring and explaining data with the processing environment", O'Reilly, 2008.
2. Edward R. Tufte, "The visual display of quantitative information", Second Edition, Graphics Press, 2001.
3. Evan Stubbs, "The value of business analytics: Identifying the path to profitability", Wiley, 2011.
4. Gert H. N. Laursen and JesperThorlund, "Business Analytics for Managers: Taking business intelligence beyond reporting", Wiley, 2010.
5. Nathan Yau, "Data Points: Visualization that means something", Wiley, 2013.
6. Stephen Few, "Information dashboard design: Displaying data for at-a-glance monitoring", second edition, Analytics Press, 2013.
7. Stephen Few, "Now you see it: Simple Visualization techniques for quantitative analysis", Analytics Press, 2009.
8. Tamara Munzner, Visualization Analysis and Design, AK Peters Visualization Series, CRC Press, Nov. 2014

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**



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LAB COMPONENTS: Using Visualization tools

1. Consumer Behaviour using Click stream Data
2. Mointoring Health of the machine using IoT data
3. Analyzing customer sentiments using social media

Theory: 0 Tutorial: 0 Practical: 30 Project: 0 Total: 30 Hours

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P18ITI2207 BIG DATA TECHNOLOGIES

L	T	P	J	C
3	0	2	0	4

COURSE OBJECTIVES:

- Understand the Big Data Platform and its use cases
- Provide an overview of Hadoop architecture.
- Develop data analytics solutions using Hadoop

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Identify applications require big data technologies
CO2: Explain Hadoop Architecture - HDFS, YARN and Map Reduce
CO3: Perform administration and configuration of Hadoop Ecosystem
CO4: Write basic queries and scripts in Hive and Pig
CO5: Write advanced queries and scripts using hive and pig - aggregation, joins, sorting
CO6: Discuss the need of HBase and write queries to use HBase as data source for Big Data

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M		M	M	M
CO2	M	M		M	
CO3	M			M	
CO4	S		M	M	
CO5	M			M	
CO6	M			M	

Course Assessment methods

Direct
1. Mid Term Examination (Theory component) 2. Assignment, Group Presentation (Theory component) 3. Pre/Post - experiment Test/Viva; Experimental Report for each experiment (Lab component) 4. Model examination (Lab component) 5. End Semester Examination (Theory and Lab components)
Indirect
1. Course-end survey

INTRODUCTION TO BIG DATA **9 Hours**

Introduction – distributed file system – Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications. Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce.

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INTRODUCTION HADOOP **9 Hours**

Big Data – Apache Hadoop & Hadoop EcoSystem – Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization.

HADOOP ARCHITECTURE **9 Hours**

Hadoop Architecture, Hadoop Storage: HDFS, Common Hadoop Shell commands , Anatomy of File Write and Read., NameNode, Secondary NameNode, and DataNode, Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers - Cluster Setup – SSH & Hadoop Configuration – HDFS Administering –Monitoring & Maintenance.

HADOOP ECOSYSTEM AND YARN **9 Hours**

Hadoop ecosystem components - Schedulers - Fair and Capacity, Hadoop 2.0 New Features- NameNode High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.

HIVE AND HIVEQL, HBASE **9 Hours**

Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins &Subqueries, HBase concepts- Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.

REFERENCE BOOKS:

1. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, Wiley, ISBN: 9788126551071, 2015.
2. Chris Eaton, Dirk derooset al. , “Understanding Big data ”, McGraw Hill, 2012.
3. Tom White, “HADOOP: The definitive Guide” , O Reilly 2012.
4. VigneshPrajapati, “Big Data Analytics with R and Haoop”, Packet Publishing 2013.
5. Tom Plunkett, Brian Macdonald et al, “Oracle Big Data Handbook”, Oracle Press, 2014.
6. http://www.bigdatauniversity.com/
7. JyLiebowitz, “Big Data and Business analytics”,CRC press, 2013.

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

LAB COMPONENTS:

1. Setting up Hadoop Cluster using Ambari/Cloudera
2. Using hdfs commands for data processing on distributed filesystem
3. Using Hue/Ambari console to manage cluster
4. Write hive queries for real world datasets
5. Write pig scripts for real world datasets
6. Apply ML algorithms on Big Data – Clustering/Classification using Spark

Theory: 0 Tutorial: 0 Practical: 30 Project: 0 Total: 30 Hours

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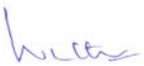
ELECTIVE COURSES



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P18ITE0010 RECOMMENDER SYSTEM

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- To learn techniques for making recommendations, including non-personalized, content-based, and collaborative filtering.
- To automate a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Explain the filtering techniques and issues in the recommender system
CO2: Explain the content –based filtering and collaborative filtering
CO3: Explain Hybrid approaches in the Recommender system
CO4: Design recommendation system for a particular application domain.
CO5: Evaluate recommender systems on the basis of metrics such as accuracy, rank accuracy, diversity, product coverage, and serendipity
CO6: Explain special types recommendation systems

Pre-requisite : NIL

CO/PO MAPPING (S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak					
Cos	**PROGRAMME OUTCOMES (POs)**			**PSO**	
	PO1	**PO2**	**PO3**	**PSO1**	**PSO2**
CO1	M				
CO2	M				
CO3	M				
CO4	S	M	M	M	M
CO5	S	M	M	M	M
CO6	M				

Course Assessment methods

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION **9 Hours**

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

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CONTENT-BASED FILTERING **8 Hours**

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

COLLABORATIVE FILTERING **9 Hours**

User-based recommendation, Item-based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems.

HYBRID APPROACHES **8 Hours**

Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies

EVALUATING RECOMMENDER SYSTEM **14 Hours**

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

TYPES OF RECOMMENDER SYSTEMS: Recommender systems in personalized web search, knowledge-based recommender system, Social tagging recommender systems, Trust-centric recommendations, Group recommender systems.

REFERENCE BOOKS:

1. Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction, Cambridge University Press (2011), 1st edition
2. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer (2016), 1st edition.
3. Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook, Springer(2011), 1st edition.
4. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems For Learning, Springer (2013), 1st edition.

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

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P18ITE0011 ARTIFICIAL INTELLIGENCE

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- To introduce an overview of artificial intelligence (AI) principles and approaches.
- Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic, and learning

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Identify problems that are amenable to solution by AI methods.
CO2: Identify appropriate AI methods to solve a given problem.
CO3: Formalize a given problem in the language/framework of different AI methods.
CO4: Implement basic AI algorithms.
CO5: Summarize the need for AI in Robotics

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M				
CO2	M				
CO3	M				
CO4	M		M	M	M
CO5	M		M	M	M

COURSE ASSESSMENT METHODS

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION TO Al AND PRODUCTION SYSTEMS 9 Hours

Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized production system- Problem solving methods - Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction - Related algorithms, Measure of performance and analysis of search algorithms.

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REPRESENTATION OF KNOWLEDGE **9 Hours**

Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge.

KNOWLEDGE INFERENCE **9 Hours**

Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.

LEARNING **9 Hours**

Forms of learning – Knowledge in learning – Statistical learning methods –reinforcement learning, communication, perceiving and acting, Probabilistic language processing, perception.

AI IN ROBOTICS **9 Hours**

Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics

REFERENCES:

1. Kevin Night and Elaine Rich, Nair B., “Artificial Intelligence (SIE)”, Mc Graw Hill-2008
2. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education, 2007.
3. David Jefferis, “Artificial Intelligence: Robotics and Machine Evolution”, Crabtree Publishing Company, 19992
4. Peter Jackson, “Introduction to Expert Systems”, 3 rd Edition, Pearson Education, 2007.
5. Stuart Russel and Peter Norvig “AI – A Modern Approach”, 2 nd Edition, Pearson Education 2007.
6. Deepak Khemani “Artificial Intelligence”, Tata Mc Graw Hill Education 2013.
7. http://nptel.ac.in

Theory: 45 Tutorial: 0 Practical: 0Project: 0 Total: 45 Hours

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P18ITE0012 STREAMING ANALYTICS

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- To provide students with the knowledge and skillsets to work with very large datasets and continuous streaming data which need to be processed in real-time
- To provide hands-on experience with the technologies that enable the ingestion and management of Big Data and real-time data.

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Explain the need for stream computing
CO2: Comprehend the architecture of stream analytics
CO3: Build data flow management pipelines for streams.
CO4: Process the streaming data
CO5: Deliver the results of streaming analytics

Pre-requisite : NIL

CO/PO MAPPING

(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

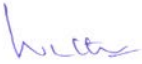
Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M			M	
CO2	M			M	
CO3	M			M	
CO4	M			M	
CO5	M		M	M	

COURSE ASSESSMENT METHODS

Direct
1. Mid Term Examination (Theory component) 2. Assignment, Group Presentation (Theory component) 3. End Semester Examination (Theory and Lab components)
Indirect
1. Course-end survey

INTRODUCTION TO STREAM COMPUTING 9 Hours

Streaming Data – Sources – Difference between Streaming Data and Static Data. Overview of Large Scale Stream Processing Engines – Issues in Stream Processing.



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STREAMING ANALYTICS ARCHITECTURE **9 Hours**

Phases in Streaming Analytics Architecture - Vital Attributes - High Availability – Low Latency – Horizontal Scalability-Fault Tolerance - Service Configuration and Management - Apache ZooKeeper.

DATA FLOW MANAGEMENT **9 Hours**

Distributed Data Flows – At Least One Delivery – Apache Kafka – Apache Flume – Zero MQ - Messages, Events, Tasks& File Passing.

PROCESSING & STORING STREAMING DATA **9 Hours**

Distributed Stream Data Processing: Co-ordination, Partition and Merges, Transactions. Duplication Detection using Bloom Filters - Apache Spark Streaming Examples Choosing a storage system – NoSQL Storage Systems.

DELIVERING STREAMING METRICS **9 Hours**

Visualizing Data – Mobile Streaming Apps –Times Counting and Summation - Stochastic Optimization – Delivering Time Series Data.

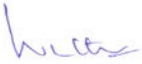
REFERENCE BOOKS:

1. Byron Ellis, “Real-Time Analytics: Techniques to Analyze and Visualize Streaming Data”, Wiley, 1st edition, 2014.
2. SherifSakr, “Large Scale and Big Data: Processing and Management”, CRC Press, 2014. 2014.
3. Bill Franks, “Taming The Big Data Tidal Wave Finding Opportunities In Huge Data Streams With Advanced Analytics”, Wiley, 2012.
4. Jure Leskovec, AnandRajaraman, Jeffrey D. Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2014.
5. Paul C Zikopoulos, Chris Eaton, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGraw-Hil, 1st edition, 2011.
6. kafka.apache.org
7. flume.apache.org
8. zookeeper.apache.org
9. spark.apache.org
10. zeromq.org

LAB COMPONENTS:

1. Writing and Reading from Apache Kafka
2. State management using Apache Zookeeper
3. Analyze streaming data using apache spark
4. Storing streaming data into MongoDB
5. Visualizing streaming time series data on grafana

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**



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P18ITE0013 **REINFORCEMENT LEARNING**

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- To introduce the basic mathematical foundations of reinforcement learning
- To model the trial-and-error learning process that is needed in many problem situations where explicit instructive signals are not available.

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Explain the reward function and Markov Decision Process

CO2: Solve problems using Dynamic Programming.

CO3: Apply temporal difference (TD) learning method for reinforcement learning problem

CO4: Apply Gradient methods for Reinforcement Learning

CO5: Solve case studies like Elevator dispatching, Samuel's checker player, TDgammon using RL algorithms

CO6: Apply Hierarchical Reinforcement Learning Algorithms

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M				
CO2	M				
CO3	M		M	M	M
CO4	M		M	M	M
CO5	M			M	M
CO6	M		M		

Course Assessment methods

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

REINFORCEMENT LEARNING PROBLEM **9 Hours**

Evaluative feedback, nonassociative learning, Rewards and returns, Markov Decision Processes, Value functions, optimality and approximation

Bandit Problems: Explore-exploit dilemma, Binary Bandits, Learning automata, exploration schemes

DYNAMIC PROGRAMMING **9 Hours**

Value iteration, policy iteration, asynchronous DP, generalized policy iteration

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Monte-Carlo methods:
Policy evaluation, roll outs, on policy and off policy learning, importance sampling

TEMPORAL DIFFERENCE LEARNING **9 Hours**
TD prediction, Optimality of TD(0), SARSA, Q-learning, R-learning, Games and after states

ELIGIBILITY TRACES
n-step TD prediction, TD(lambda), forward and backward views, Q(lambda), SARSA(lambda), replacing traces and accumulating traces.

FUNCTION APPROXIMATION **9 Hours**
Value prediction, gradient descent methods, linear function approximation, Control algorithms, Fitted Iterative Methods

POLICY GRADIENT METHODS
non-associative learning - REINFORCE algorithm, exact gradient methods, estimating gradients, approximate policy gradient algorithms, actor-critic methods

HIERARCHICAL RL **9 Hours**
MAXQ framework, Options framework, HAM framework, Option discovery algorithms
Case studies:
Elevator dispatching, Samuel's checker player, TDgammon, Acrobot, Helicopter piloting, Computational Neuroscience

REFERENCE BOOKS:

1. R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. Second edition 2017.
2. D. P. Bertsikas and J. N. Tsitsiklis. Neuro-dynamic programming. Athena Scientific. 1996.
3. K. S. Narendra and M. A. L. Thathachar. Learning Automata - An Introduction. Prentice-Hall, USA. 1989
4. A. G. Barto and S. Mahadevan, Recent Advances in Hierarchical Reinforcement Learning, Discrete Event Systems Journal, Volume 13, Special Issue on Reinforcement Learning, pp. 41-77. 2003.
5. R. J. Williams, Simple Statistical Gradient-following algorithms for Connectionist Reinforcement Learning, Machine Learning, 8:229-256. 1992
6. J. Baxter, P. L. Bartlett, Infinite-Horizon Gradient-Based Policy Search, Journal of Artificial Intelligence Research, 15: 319-350. 2001.
7. V. R. Konda and J. N. Tsitsiklis, "Actor-Critic Algorithms" , SIAM Journal on Control and Optimization, Vol. 42, No. 4, pp. 1143-1166. 2003.

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

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P18ITE0014 **SOCIAL MEDIA ANALYTICS**

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- To make sense of the social and information networks that have been fuelled and rendered accessible by the internet
- To Analyse social networks by finding communities, identifying important nodes, and influence propagation

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Explain the Evolution of Social Networks

CO2: Analyse the structure of Social Networks

CO3: Explore the knowledge from disciplines as diverse as sociology, mathematics, computer science.

CO4: Discuss the Online interactive demonstrations and hands-on analysis of real-world data sets.

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M			M	M
CO2	M				
CO3	M				
CO4	M				

Course Assessment methods

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

INTRODUCTION **9 hours**

Overview: Social network data-Formal methods- Paths and Connectivity-Graphs to represent social relations-Working with network data- Network Datasets-Strong and weak ties - Closure, Structural Holes, and Social Capital.

SOCIAL INFLUENCE **9 hours**

Homophily: Mechanisms Underlying Homophily, Selection and Social Influence, Affiliation,Tracking Link Formation in OnLine Data, Spatial Model of Segregation - Positive and Negative Relationships - Structural Balance - Applications of Structural Balance, Weaker Form of Structural Balance.

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INFORMATION NETWORKS AND THE WORLD WIDE WEB 9 hours

The Structure of the Web- World Wide Web- Information Networks, Hypertext, and Associative Memory- Web as a Directed Graph, Bow-Tie Structure of the Web- Link Analysis and Web Search- Searching the Web: Ranking, Link Analysis using Hubs and Authorities- Page Rank- Link Analysis in Modern Web Search, Applications, Spectral Analysis, Random Walks, and Web Search.

SOCIAL NETWORK MINING 9 hours

Clustering of Social Network graphs: Betweenness, Girvan newman algorithm-Discovery of communities- Cliques and Bipartite graphs-Graph partitioning methods-Matrices-Eigen values Simrank.

NETWORK DYNAMICS 9 hours

Cascading Behavior in Networks: Diffusion in Networks, Modeling Diffusion - Cascades and Cluster, Thresholds, Extensions of the Basic Cascade Model- Six Degrees of Separation- Structure and Randomness, Decentralized Search- Empirical Analysis and Generalized Models- Analysis of Decentralized Search.

REFERENCE BOOKS:

1. Easley and Kleinberg, "Networks, Crowds, and Markets: Reasoning about a highly connected world", Cambridge Univ. Press, 2010.
2. Robert A. Hanneman and Mark Riddle, "Introduction to social network methods", University of California, 2005.
3. Jure Leskovec,Stanford Univ.Anand Rajaraman, Milliway Labs, Jeffrey D. Ullman, "Mining of Massive Datasets", Cambridge University Press, 2 edition, 2014.
4. Wasserman, S., & Faust, K, "Social Network Analysis: Methods and Applications", Cambridge University Press; 1 edition, 1994.
5. Borgatti, S. P., Evercloudett, M. G., & Johnson, J. C., "Analyzing social networks", SAGE Publications Ltd; 1 edition, 2013.
6. John Scott , "Social Network Analysis: A Handbook" , SAGE Publications Ltd; 2nd edition, 2000.

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

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P18ITE0015 **ADVANCED ALGORITHMS**

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- To analyse the asymptotic performance of algorithms.
- To synthesize efficient algorithms in common engineering design situations.
- Apply important algorithmic design paradigms and methods of analysis.

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Analyze algorithms to determine algorithm correctness
CO2: Analyze algorithms to determine time efficiency
CO3: Master a variety of advanced data structures and their implementations
CO4: Master a variety of different algorithm design techniques
CO5: Apply and implement the learnt algorithm design techniques to solve problems
CO6: Explain the NP completeness

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M		M		
CO2	M		M		
CO3	M		M		
CO4	M		M		
CO5	M		M	M	M
CO6	M				

Course Assessment methods

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

BASICS OF ALGORITHM ANALYSIS **9 Hours**

Computational Tractability – Asymptotic Order of Growth – Implementing the Stable Matching Algorithm Using Lists and Arrays – A survey of common running times – A more Complex Data Structure: Priority Queues

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GRAPHS AND GREEDY ALGORITHMS **9 Hours**

Graphs: Basic Definitions and Applications – Graph connectivity and Graph traversal – Implementing Graph Traversal using Queues and Stacks – Testing Bipartiteness: An application of Breadth First search

Greedy Algorithms: Interval Scheduling: The Greedy Algorithm Stays Ahead – Optimal Caching: A More Complex Exchange Argument – The Minimum Spanning Tree Problem – Implementing Kruskal's Algorithm: The Union-Find Data Structure – Clustering – Huffman Codes and Data Compression

DIVIDE AND CONQUER **9 Hours**

A First Recurrence: The Mergesort Algorithm – Further Recurrence Relations – Counting Inversions – Finding the Closest Pair of Points – Integer Multiplication

Dynamic Programming: Weighted Interval Scheduling: A Recursive Procedure – Principles of Dynamic Programming: Memoization or Iteration over Subproblems – **Segmented Least Squares:** Multi-way Choices – Subset Sums and Knapsacks: Adding a variable – Shortest Paths in a Graph – Shortest Paths and Distance Vector Protocols – Negative Cycles in a Graph

NETWORK FLOW **9 Hours**

The Maximum-Flow Problem and the Ford-Fulkerson Algorithm – Maximum Flows and Minimum Cuts in a Network – Choosing Good Augmenting Paths – A First Application: The Bipartite Matching Problem – Disjoint Paths in Directed and Undirected Graphs

NP AND COMPUTATIONAL INTRACTABILITY **9 Hours**

Polynomial-Time Reductions – Efficient Certification and the Definition of NP – NP-Complete Problems – Sequencing Problems – Partitioning Problems – Graph Coloring – Co-NP and the Asymmetry of NP.

REFERENCE BOOKS:

1. Jon Kleinberg, ÉvaTardos, "Algorithm Design",Pearson Education Limited 2014.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", MIT Press, 2009.
3. Ellis Horowitz, SartajSahni and SanguthevarRajasekaran, "Fundamentals of Computer Algorithms", Second Edition, Universities Press, Hyderabad, 2008.
4. AnanyLevitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education Asia, 2008.

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

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P18ITE0016 **BLOCKCHAIN TECHNOLOGY**

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- To acquire the basic knowledge and understandings of Bitcoin
- To understand the mechanisms of Bitcoin, Ethereum, Hyperledger
- To understand the current trends of Blockchain

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1 Discover the secure and efficient transactions with Bitcoin
CO2 Identify and analyze the applications of Bitcoin script
CO3 Experiment with Bitcoin mining
CO4 Develop private Block chain environment and develop a smart contract on Ethereum
CO5 Build the Hyperledger architecture and the consensus mechanism applied in the Hyperledger

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M				
CO2	M		M		M
CO3	M		M	M	
CO4	M		M		
CO5	M		M		M

Course Assessment methods:

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

CRYPTOCURRENCY AND BLOCKCHAIN- INTRODUCTION 9 Hours

Cryptography and Cryptocurrency- Anonymity and Pseudonymity in Cryptocurrencies-Digital Signatures-Crypto currency Hash Codes. Distributed networks-Block chain- An Introduction Distinction between databases and Block chain- Distributed ledger-Block chain ecosystem-Block chain structure- Block chain technology- Working -Permissioned and permission-less Block chain

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BITCOIN AND BLOCKCHAIN **9 Hours**

Bitcoin – history- Bitcoin- usage, storage, selling, transactions, working- Invalid Transactions- Parameters that invalidate the transactions- Scripting language in Bitcoin- Applications of Bitcoin script- Nodes and network of Bitcoin- Bitcoin ecosystem

BITCOIN MINING **9 Hours**

Purpose of mining- Algorithm used in mining- Mining hardware- Bitcoin mining pools- cloud mining of Bitcoin -Mining Incentives-Security and centralizations

ETHEREUM **9 Hours**

The Ethereum ecosystem, DApps and DAOs - Ethereum working- Solidity- Contract classes, functions, and conditionals- Inheritance & abstract contracts- Libraries- Types & optimization of Ether- Global variables- Debugging- Future of Ethereum- Smart Contracts on Ethereum- different stages of a contract deployment- Viewing Information about blocks in Blockchain- Developing smart contract on private Blockchain- Deploying contract from web and console

HYPERLEDGER **9 Hours**

Hyperledger Architecture- Consensus- Consensus & its interaction with architectural layers- Application programming interface- Application model -Hyperledger frameworks- Hyperledger Fabric -Various ways to create Hyperledger Fabric Blockchain network- Creating and Deploying a business network on Hyperledger Composer Playground- Testing the business network definition- Transferring the commodity between the participants

Theory:45 Tutorial:0 Practical: 0 Project: 0 Total: 45 Hours

REFERENCES

1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas M Antonopoulos 2018
2. Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations-2016.

Other Online Courses

1. https://www.coursera.org/learn/ibm-blockchain-essentials-for-developers
2. https://www.coursera.org/learn/blockchain-basics

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P18ITE0017 **BIG DATA SECURITY**

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- Understand the characteristics of Big Data Security
- Learn the basics of apache kerberos
- Understand the key components of the Hadoop ecosystem security

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO1: Understand the significance of privacy, ethics in big data environment
CO2: Understand the Intellectual Property Challenge
CO3: Analyze the steps to secure big data
CO4: Build security in Hadoop Kerberos
CO5: Outline security in Hadoop environment and its ecosystem.
CO6: Analyze data security and event logging

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M			M	
CO2		M		M	
CO3	M			M	
CO4	M			M	
CO5	M			M	
CO6	M			M	M

Course Assessment methods

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

BIG DATA PRIVACY, ETHICS AND SECURITY **9 Hours**

Privacy – Reidentification of Anonymous People – Why Big Data Privacy is self-regulating – Ethics – Ownership – Ethical Guidelines – Big Data Security – Organizational Security.

SECURITY, COMPLIANCE, AUDITING, AND PROTECTION **9 Hours**

Steps to secure big data – Classifying Data – Protecting – Big Data Compliance – Intellectual Property Challenge – Research Questions in Cloud Security – Open Problems.

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HADOOP SECURITY DESIGN **9 Hours**

Kerberos – Default Hadoop Model without security - Hadoop Kerberos Security Implementation & Configuration.

HADOOP ECOSYSTEM SECURITY **9 Hours**

Configuring Kerberos for Hadoop ecosystem components – Pig, Hive, Oozie, Flume, HBase, Sqoop**.**

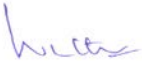
DATA SECURITY & EVENT LOGGING **9 Hours**

Integrating Hadoop with Enterprise Security Systems - Securing Sensitive Data in Hadoop – SIEM system – Setting up audit logging in hadoop cluster

Reference Books:

1. Mark Van Rijmenam, "Think Bigger: Developing a Successful Big Data Strategy for Your Business", Amazon, 1 edition, 2014.
2. Frank Ohlhorst John Wiley & Sons, "Big Data Analytics: Turning Big Data into Big Money", John Wiley & Sons, 2013.
3. Sherif Sakr, "Large Scale and Big Data: Processing and Management", CRC Press, 2014.
4. Sudeesh Narayanan, "Securing Hadoop", Packt Publishing, 2013.
5. Ben Spivey, Joey Echeverria, "Hadoop Security Protecting Your Big Data Problem", O'Reilly Media, 2015.
6. Top Tips for Securing Big Data Environments: e-book (http://www.ibmbigdatahub.com/whitepaper/top-tips-securing-big-data-environments-ebook)
7. http://www.dataguise.com/?q=securing-hadoop-discovering-and-securing-sensitive-datahadoop-data-stores
8. Gazzang for Hadoop http://www.cloudera.com/content/cloudera/en/solutions/enterprisesolutions/security-for-hadoop.html
9. eCryptfs for Hadoop https://launchpad.net/ecryptfs.
10. Project Rhino - https://github.com/intel-hadoop/project-rhino/

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**



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P18ITE0018 INFORMATION RETRIEVAL TECHNIQUES

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES:

- To understand the basics of information retrieval with pertinence to modeling, query operations and indexing
- To get an understanding of machine learning techniques for text classification and clustering.
- To understand the various applications of information retrieval giving emphasis to multimedia IR, web search
- To understand the concepts of digital libraries

COURSE OUTCOMES:
After successful completion of this course, the students should be able to

CO1: Build an Information Retrieval system using the available tools
CO2: Identify and design the various components of an Information Retrieval system
CO3: Apply machine-learning techniques to text classification which is used for efficient Information Retrieval
CO4: Apply machine-learning techniques to text clustering
CO5: Design an efficient search engine and analyze the Web content structure

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M				
CO2	M				M
CO3	M		M		M
CO4	M		M		
CO5	M		M		

Course Assessment methods

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

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INTRODUCTION: MOTIVATION **9 Hours**

Basic Concepts – Practical Issues - Retrieval Process – Architecture - Boolean Retrieval –Retrieval Evaluation – Open Source IR Systems–History of Web Search – Web Characteristics–The impact of the web on IR ―IR Versus Web Search–Components of a Search engine

MODELING **9 Hours**

Taxonomy and Characterization of IR Models – Boolean Model – Vector Model - Term Weighting – Scoring and Ranking –Language Models – Set Theoretic Models - Probabilistic Models – Algebraic Models – Structured Text Retrieval Models – Models for Browsing

INDEXING **9 Hours**

Static and Dynamic Inverted Indices – Index Construction and Index Compression. Searching - Sequential Searching and Pattern Matching. Query Operations -Query Languages – Query Processing - Relevance Feedback and Query Expansion - Automatic Local and Global Analysis – Measuring Effectiveness and Efficiency

CLASSIFICATION AND CLUSTERING **9 Hours**

Text Classification and Naïve Bayes – Vector Space Classification – Support vector machines and Machine learning on documents. Flat Clustering – Hierarchical Clustering –Matrix decompositions and latent semantic indexing – Fusion and Meta learning

UNIT V – SEARCHING THE WEB **9 Hours**

Searching the Web –Structure of the Web –IR and web search – Static and Dynamic Ranking – Web Crawling and Indexing – Link Analysis - XML Retrieval Multimedia IR: Models and Languages – Indexing and Searching Parallel and Distributed IR – Digital Libraries

Reference Books:

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, ―Introduction to Information Retrieval‖, Cambridge University Press, First South Asian Edition, 2008.
2. Implementing and Evaluating Search Engines‖, The MIT Press, Cambridge, Massachusetts London, England, 2010
3. Ricardo Baeza – Yates, Berthier Ribeiro – Neto, ―Modern Information Retrieval: The concepts and Technology behind Search‖ (ACM Press Books), Second Edition, 2011.
4. Stefan Buttcher, Charles L. A. Clarke, Gordon V. Cormack, ―Information Retrieval

Theory: 45 **Tutorial: 0** **Practical: 0** **Project: 0** **Total: 45 Hours**

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P18INT0002 **PRODUCT DESIGN AND DEVELOPMENT**
(Common to all branches)

L	T	P	J	C
3	0	0	0	3

COURSE OBJECTIVES

- Understand the basic concepts of product design and development.
- Know the implications in product architecture and the importance of industrial design.
- Understand prototyping basics and influence of diverse factors on project success.

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1 Apply concepts of product development and outline product planning process
CO2 Apply relative importance of customer needs in establishing product specifications
CO3 Identify concept generation activities and summarize the methodology involved in concept selection and testing
CO4 Outline supply chain considerations in product architecture and understand the industrial design process
CO5 Apply design for manufacturing concepts in estimating manufacturing costs
CO6 Apply principles of prototyping in product development economics and highlight importance of managing projects

Pre-requisite : NIL

CO/PO MAPPING
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

Cos	PROGRAMME OUTCOMES (POs)			PSO	
	PO1	PO2	PO3	PSO1	PSO2
CO1	M		M	S	
CO2			M	M	
CO3	M		M		
CO4			S		M
CO5			S	S	
CO6				S	

Course Assessment methods

Direct
1. Mid Term Examination 2. Assignment, Group Presentation 3. End Semester Examination
Indirect
1. Course-end survey

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INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING **9 Hours**

Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development.

A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. The product planning process, identify opportunities.
Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATION **9 Hours**

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING **9 Hours**

The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

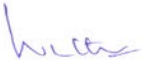
PRODUCT ARCHITECTURE - INDUSTRIAL DESIGN - DESIGN FOR MANUFACTURING **9 Hours**

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING - PRODUCT DEVELOPMENT ECONOMICS - MANAGING PROJECTS

9 Hours

Prototyping basics, principles of prototyping, technologies, planning for prototypes, Elements of economic analysis, base case financial mode,. Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.



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REFERENCES

1. Karl Ulrich,T, Steven Eppinger, D, “Product Design and Development”, McGrawHill, 2015.
2. Chitale, AK, Gupta, RC, “Product Design and Manufacturing” PHI, 2013.
3. Timjones, “New Product Development:An Introduction to a multifunctional process”, Butterworth-Heinemann, 1997.
4. Geoffery Boothroyd, Peter Dewhurst and Winston Knight,A, “Product Design for Manufacture and Assembly”, CRC Press, 2011.

Theory: 45 Tutorial: 0 Practical: 0 Project: 0 Total: 45 Hours

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AUDIT COURSE

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P18ITA0001 ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	J	C
2	0	0	0	0

COURSE OUTCOMES:
After successful completion of this course, the students should be able to

CO1: Understand that how to improve your writing skills and level of readability
CO2: Learn about what to write in each section
CO3: Understand the skills needed when writing a Title
CO4: Ensure the good quality of paper at very first-time submission

4 Hours

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

4 Hours

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.
Introduction

4 Hours

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

4 Hours

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

4 Hours

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions
Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

REFERENCE:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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