

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

**COURSE STRUCTURE & SYLLABUS M.Tech CSE for
DATA SCIENCE PROGRAMME**

(Applicable for batches admitted from 2019-2020)



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

I SEMESTER

S.No	Course Code	Courses	Category	L	T	P	C
1	MTDS1101	Program Core-1 Data Predictive Analytics	PC	3	0	0	3
2	MTDS1102	Program Core-2 Data Science Applications with Python	PC	3	0	0	3
3	MTDS1103	Program Elective-1 1. Advanced Graph Theory 2. Data Warehousing 3. Artificial Intelligence	PE	3	0	0	3
4	MTDS1104	Program Elective-2 1. Internet of Things 2. Social Network and Semantic Web 3. Big Data Analytics	PE	3	0	0	3
5	MTDS1105	Research Methodology and IPR	CC			0	2
6	MTDS1106	Laboratory-1 Data Science Applications with Python Lab	LB	0	0	4	2
7	MTDS1107	Laboratory-2 Advanced Computing with Python-1 Lab	LB	0	0	4	2
8	MTDS1108	Audit Course-1*	AC	2	0	0	0
Total Credits							18

**Student has to choose any one audit course listed below.*

II SEMESTER

S.No	Course Code	Courses	Category	L	T	P	C
1	MTDS1201	Program Core-3 Advance Algorithms	PC	3	0	0	3
2	MTDS1202	Program Core-4 Machine Learning Techniques	PC	3	0	0	3
3	MTDS1203	Program Elective-3 1. Natural Language Processing 2. High Performance Computing 3. Cloud Computing	PE	3	0	0	3
4	MTDS1204	Program Elective-4 1. Principles of Deep Learning 2. Image and Video Analytics 3. Principles of Data Security	PE	3	0	0	3
5	MTDS1205	Laboratory-3 Advance Algorithms Lab	LB	0	0	4	2
6	MTDS1206	Laboratory-4 Advanced Computing with Python-2 Lab	LB	0	0	4	2
7	MTDS1207	Mini Project with Seminar	MP	2	0	0	2
8	MTDS1208	Audit Course-2*	AC	2	0	0	0
Total Credits							18

**Student has to choose any one audit course listed below.*

Audit Course 1 & 2:

- | | |
|---------------------------------------|--|
| 1. English for Research Paper Writing | 5. Constitution of India |
| 2. Disaster Management | 6. Pedagogy Studies |
| 3. Sanskrit for Technical Knowledge | 7. Stress Management by Yoga |
| 4. Value Education | 8. Personality Development through Life Enlightenment Skills |

III SEMESTER

S.No	Course Code	Courses	Category	L	T	P	C
1	MTDS2101	Program Elective-5 1. Multivariate Analysis 2. Next Generation Databases 3. MOOCs-1 through NPTEL/SWAYAM 12 Week Program related to the programme which is not listed in the course structure	PE	3	0	0	3
2	MTDS2102	Open Elective 1. MOOCs-2 through NPTEL/SWAYAM - Any 12 week course on Engineering/ Management/ Mathematics offered by other than parent department 2. Course offered by other departments in the college	OE	3	0	0	3
3	MTDS2103	Dissertation-I/Industrial Project	PJ	0	0	20	10
Total Credits							16

**Students going for Industrial Project/Thesis will complete these courses through MOOCs*

IV-SEMESTER

S.No	Course Code	Courses	Category	L	T	P	C
1	MTDS2201	Dissertation-II	PJ	0	0	32	16
Total Credits							16

Open Electives offered by the Department of Computer Science and Engineering for other Departments students

1. Python Programming
2. Principles of Cyber Security
3. Internet of Things
4. Machine Learning
5. Deep Learning
6. Next Generation Databases

I Year - I Semester	L	T	P	C
	3	0	0	3
Data Predictive Analytics (MTDS1101)				

Course Objective:

- To learn, how to develop models to predict categorical and continuous outcomes, using such techniques as neural networks, decision trees, logistic regression, support vector machines and Bayesian network models.
- To know the use of the binary classifier and numeric predictor nodes to automate model selection.
- To advice on when and how to use each model. Also learn how to combine two or more models to improve prediction

Course Outcomes:

After completion of course, students would be:

- Understand the process of formulating business objectives, data selection/collection preparation and process to successfully design, build, evaluate and implement predictive models for a various business application.
- Analyze Probability and Random experiments.
- Define sampling techniques and apply various distribution models.
- Solving Testing of Hypothesis Problems.
- Apply predictive modeling approaches using a suitable package.

UNIT I: Statistic Fundamentals- Frequency Distributions and Measures of Central Tendency - Frequency Distribution, Graphic Representation of a Frequency Distribution, Averages or Measures of Central Tendency or measures of Location, Requisites for an Ideal Measure of Central Tendency, Arithmetic Mean, Median, Mode, Geometric Mean, Harmonic Mean, Selection of an Average, Partition Values, Measures of Dispersion, Skewness and Kurtosis – Dispersion, Characteristics for an Ideal Measure of Dispersion, Measures of Dispersion, Range, Quartile Deviation, Mean Deviation, Standard Deviation and Root Mean Square Deviation, Coefficient of Dispersion, Moments, Skewness, Kurtosis;

UNIT II: Probability and Random Variables- Basic Probability - Random Experiments, Sample Spaces Events, The Concept of Probability, The Axioms of Probability, Some Important Theorems on Probability, Assignment of Probabilities, Conditional Probability, Theorems on Conditional Probability, Independent Events, Bayes Theorem or Rule, Discrete Random Variables, Continuous Random Variables and examples of Random Variables.

UNIT III: Sampling- Sampling-Introduction, Types or Sampling, Parameter and Statistic, Tests of Significance, Null Hypothesis, Errors in Sampling, Critical Region and Level of Significance, Sampling of Attributes, Sampling of Variable, Unbiased Estimate for population Mean and Variance, Standard Error of Sample Mean, Test of Significance for Single Mean, Difference of Means and Difference of Standard Deviations; Chi-Square Variate, Derivation of the Chi-square Distribution, Applications or Chi-square Distribution

UNIT IV: Inferential Statistics- Introduction, Characteristics of Estimators, Methods or Estimation, Confidence Interval and Confidence Limits, Statistical Hypothesis-Simple and Composite, Steps in Solving Testing of Hypothesis Problem, Optimum Test Under Different Situations, Neyman-Pearson Lemma

UNIT V: Linear Models and Regression- Overview of Supervised Learning - Two Simple Approaches to Prediction, Statistical Decision Theory, Statistical Models, Supervised Learning and Function Approximation, Structured Regression Models, Classes of Restricted Estimators; Linear Methods for Regression- Linear Regression Models and Least Squares, Subset Selection, Shrinkage Methods, Methods Using Derived Input Directions, Lasso and Related Path Algorithms; Logistic Regression

Text Books:

1. Fundamentals of mathematical statistics; S.C. Gupta, V.K. Kapoor; Sultan Chand & Sons.

2. Probability and statistics; Murray R. Spiegel, John Schiller and R. Alu Srinivasan; Schaum's outline series, McGraw-Hill.
3. The Elements of Statistical Learning; Trevor Hastie, Robert Tibshirani, Jerome Friedman; Springer.

Reference Books:

1. Applied Linear Statistical Models, Michael H. Kutner, Christopher J. Nachtsheim, John Neter; McGraw Hill
2. Applied logistic Regression, David W. Hosmer, Stanley Lemeshow; Wiley
3. Practical Statistics for Data Scientists, Peter Bruce & Andrew Bruce, O'Reilly

I Year - I Semester	L	T	P	C
	3	0	0	3
Data Science Applications with Python (MTDS1102)				

Course Objectives:

- Provide you with the knowledge and expertise to become a proficient data scientist.
- Demonstrate an understanding of statistics and machine learning concepts that are vital for data science.
- Produce Python code to statistically analyze a dataset.
- Critically evaluate data visualizations based on their design and use for communicating stories from data.

Course Outcomes:

After the completion of the course, student will be able to

- Explain how data is collected, managed and stored for data science.
- Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists.
- Implement data collection and management scripts using Python Pandas.

UNIT I: PYTHON Basics and Programming Concepts: Introducing Python, Types and Operations - Numbers, Strings, Lists, Tuples, Dictionaries, Files, Numeric Types, Dynamic Typing; Statements and Syntax - Assignments, Expressions, Statements, Loops, iterations, comprehensions; Functions - Function Basics, Scopes, Arguments, Advanced Functions; Modules - Module Coding Basics, Module Packages, Advanced Module Topics; Classes and OOP - Class, Operator Overloading, Class Designing; Exceptions and Tools - Exception Basics, Exception Coding Details, Exception Objects, Designing With Exceptions, Parallel System Tools

UNIT II: GUI Programming: Graphical User Interface - Python gui development options, Adding Widgets, GUI Coding Techniques, Customizing Widgets; Internet Programming - Network Scripting, Client-Side scripting, Pymailgui client, server-side scripting, Pymailcgi server; Tools and Techniques - databases and persistence, data structures, text and language, python/c integration

UNIT III: Pandas and NumPy: Numpy Basics - Fast Element wise array functions, Multidimensional Array, Data Processing using arrays, file i/o with arrays; Pandas - Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics, Handling Missing Data, Hierarchical Indexing

UNIT IV: Data Preprocessing: Data Loading, Storage, and FileFormats - 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; Data Aggregation and Group Operations – Group by Mechanics, Data Aggregation, Groupby Operations and and Transformations, Pivot Tables and Cross-Tabulation

UNIT V: Data Visualization: A Brief matplotlib API Primer, Plotting Functions in pandas, Time Series, Financial and Economic Data Applications

Text Books:

1. Learning Python , OReilly, Mark Lutz
2. Programming Python, OReilly, Mark Lutz
3. Python For Data Analysis (O Reilly, Wes Mckinney)

Reference Books:

1. Python: The Complete Reference, Martin C. Brown, McGraw Hill Education
2. Head First Python, Paul Barry, O'Reilly

I Year - I Semester		L	T	P	C
		3	0	0	3
Advanced Graph Theory (MTDS11XX)					

Course Objectives:

From the course the student will learn

- All elementary concepts such as coloring, covering, hamiltonicity, planarity, connectivity and so on, it will also introduce the students to some advanced concepts.
- The student will know the definitions of relevant vocabulary and various algorithms from graph theory.

Course Outcomes:

- Demonstrate basic concepts in graph theory: coloring, planar graphs.
- Evaluate precise and accurate mathematical definitions of objects in graph theory.
- Determine and solve some real time problems using concepts of graph theory (e.g., scheduling problems).
- Build some classical graph algorithms in order to find sub graphs with desirable properties.
- Compile and deduce properties of chromatic numbers and polynomials and identify certain problems as graph colouring problems.

UNIT-I: Basic Concepts- Graphs and digraphs, incidence and adjacency matrices, isomorphism, the automorphism group, **Trees-** Equivalent definitions of trees and forests, Cayley's formula, the Matrix-Tree theorem.

UNIT-II: Connectivity- Cut vertices, cut edges, bonds, the cycle space and the bond space, blocks, Menger's theorem, **Paths and Cycles-** Euler tours, Hamilton paths and cycles, theorems of Dirac, Ore, Bondy and Chvatal, circumference, the Chinese Postman Problem, the Travelling Salesman problem, diameter and maximum degree.

UNIT-III: Matchings- Berge's Theorem, perfect matchings, Hall's theorem, Tutte's theorem, Konig's theorem, Petersen's theorem, algorithms for matching and weighted matching (in both bipartite and general graphs), factors of graphs (decompositions of the complete graph), Tutte's f-factor theorem, **Extremal problems-** Independent sets and covering numbers, Turan's theorem, Ramsey theorems.

UNIT-IV: Colorings- Brooks theorem, the greedy algorithm, the Welsh-Powell bound, critical graphs, chromatic polynomials, girth and chromatic number, Vizing's theorem, **Graphs on surfaces-** Planar graphs, duality, Euler's formula, Kuratowski's theorem, toroidal graphs, 2-cell embeddings, graphs on other surfaces.

UNIT–V: Directed graphs- Tournaments, directed paths and cycles, connectivity and strongly connected digraphs, **Networks and flows-** Flow cuts, max flow min cut theorem, **Selected topics-** Dominating sets, the reconstruction problem.

Text Books:

1. Introduction to Graph Theory, Douglas B. West, Prentice Hall of India
2. Graph Theory with Applications to Engineering and Computer Science, Narsingh Deo, Prentice-Hall

Reference Books:

1. Graph Theory, Frank Harary, Narosa
2. Network Flows: Theory, Algorithms, and Applications, R.Ahuja, T. Magnanti, and J. Orlin, Prentice-Hall

I Year - I Semester	L	T	P	C
	3	0	0	3
Data Warehousing (MTDS11XX)				

Course Objective:

- Able to learning the basic definition and concepts of Data warehouses.
- Able to learn Data Warehousing architecture and operations.
- Describe the process used in developing and managing Data warehouses.
- Understand the role of Data Warehouses in decision support.

Course Outcomes:

After completion of course, students would be:

- Understanding Compelling Needs for Data Warehousing.
- Analyze business requirements and data design.
- Identify different Data Warehouse Architecture and need of meta data.
- Apply Dimensional Modeling, Data Extraction, Transformation, and Loading techniques.
- Identifies tool for analyzing Data quality and perform OLAP operations.

UNIT I: The Compelling Need for Data Warehousing- Escalating Need for Strategic Information, Failures of Past Decision-Support Systems, Operational Versus Decision-Support Systems, Data Warehousing—The Only Viable Solution, Data Warehouse Defined, **Data Warehouse: The Building Blocks-** Defining Features, Data Warehouses and Data Marts, Overview of the Components, Metadata in the Data Warehouse, **Trends in Data Warehousing-** Continued Growth in Data Warehousing, Significant Trends, Emergence of Standards, Web-Enabled Data Warehouse.

UNIT II:

Planning and Project Management- Planning Your Data Warehouse, The Data Warehouse Project, The Project Team, Project Management Considerations, **Defining the Business Requirements-** Dimensional Analysis, Information Packages—A New Concept, Requirements Gathering Methods, Requirements Definition: Scope and Content, **Requirements as the Driving Force for Data Warehousing-** Data Design, The Architectural Plan, Data Storage Specifications, Information Delivery Strategy

UNIT III: The Architectural Components- Understanding Data Warehouse Architecture, Distinguishing Characteristics, Architectural Framework, Technical Architecture, **Infrastructure as the Foundation for Data Warehousing-** Infrastructure Supporting Architecture, Hardware and Operating Systems, Database Software, Collection of Tools, **The Significant Role of Metadata-** Why Metadata is Important, Metadata Types by Functional Areas, Business Metadata, Technical Metadata, How to Provide Metadata,

UNIT - IV: Principles of Dimensional Modeling- Requirements to Data Design, The STAR Schema, STAR Schema Keys, Advantages of the STAR Schema, **Dimensional Modeling: Advanced Topics-** Updates to the Dimension Tables, Miscellaneous Dimensions, The Snowflake Schema, Aggregate Fact Tables, Families of STARS, **Data Extraction, Transformation, and Loading-** ETL Overview, Data Extraction, Data Transformation, Data Loading, ETL Summary.

UNIT - V: Data Quality: A Key to Success- Why is Data Quality Critical?, Data Quality Challenges, Data Quality Tools, Data Quality Initiative, **OLAP in the Data Warehouse-** Demand for Online Analytical Processing, Major Features and Functions, OLAP Models, OLAP Implementation Considerations.

Text Books:

1. Data Warehousing: Fundamentals for IT Professionals, 2ed ,by Paulraj Ponniah,2010

Reference Books:

1. Data Warehouse Systems Design Implementation Vaisman Alejandro, Springer-Verlag Berlin and Heidelberg GmbH & Co. K

I Year - I Semester	L	T	P	C
	3	0	0	3
Artificial Intelligence (MTDS11XX)				

Course Objectives:

- Gain a historical perspective of AI and its foundations.
- Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
- Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.
- Experience AI development tools such as an ‘AI language’, expert system shell, and/or data mining tool. Experiment with a machine learning model for simulation and analysis.
- Explore the current scope, potential, limitations, and implications of intelligent systems.

Course Outcomes(COs): At the end of the course, student will be able to

- Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents.
- Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them.
- Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing.
- Attain the capability to represent various real life problem domains using logic based techniques and use this to perform inference or planning.
- Solve problems with uncertain information using Bayesian approaches.

UNIT-I:

Introduction to artificial intelligence: Introduction , history, intelligent systems, foundations of AI, applications, tic-tac-tie game playing, development of AI languages, current trends in AI, **Problem solving: state-space search and control strategies:** Introduction, general problem solving, characteristics of problem, exhaustive searches, heuristic search techniques, iterative-deepening a*, constraint satisfaction

UNIT-II:

Problem reduction and game playing: Introduction, problem reduction, game playing, alpha-beta pruning, two-player perfect information games, **Logic concepts:** Introduction, propositional calculus, propositional logic, natural deduction system, axiomatic system, semantic tableau system in propositional logic, resolution refutation in propositional logic, predicate logic

UNIT-III:

Knowledge representation: Introduction, approaches to knowledge representation, knowledge representation using semantic network, extended semantic networks for KR, knowledge representation using frames, **advanced knowledge representation techniques:** Introduction, conceptual dependency theory, script structure, cyc theory, case grammars, semantic web.

UNIT-IV:

Uncertainty measure: probability theory: Introduction, probability theory, Bayesian belief networks, certainty factor theory, Dempster-Shafer theory ,

UNIT-V:

Fuzzy sets and fuzzy logic: Introduction, fuzzy sets, fuzzy set operations, types of membership functions, multi valued logic, fuzzy logic, linguistic variables and hedges, fuzzy propositions, inference rules for fuzzy propositions, fuzzy systems.

Text Books:

1. Artificial Intelligence- Saroj Kaushik, CENGAGE Learning,
2. Artificial intelligence, A modern Approach, 2nd ed, Stuart Russel, Peter Norvig, PEA
3. Artificial Intelligence- 3rd ed, Rich, Kevin Knight, Shiv Shankar B Nair, TMH
4. Introduction to Artificial Intelligence, Patterson, PHI

Reference Books:

1. Artificial intelligence, structures and Strategies for Complex problem solving, 5th ed, George F Luger, PEA
2. Introduction to Artificial Intelligence, Ertel, Wolf Gang, Springer
3. Artificial Intelligence, A new Synthesis, Nils J Nilsson, Elsevier

I Year - I Semester	L	T	P	C
	3	0	0	3
Internet of Things (MTDS11XX)				

Course Objectives:

- Vision and Introduction to IoT.
- Understand IoT Market perspective.
- Data and Knowledge Management and use of Devices in IoT Technology.
- Understand State of the Art – IoT Architecture.
- Understand Real World IoT Design Constraints, Industrial Automation and Commercial.
- Building Automation in IoT.

Course Outcomes (COs): At the end of the course, student will be able to

- Explain in a concise manner how the general Internet as well as Internet of Things work.
- Understand constraints and opportunities of wireless and mobile networks for Internet of Things.
- Use basic sensing and measurement and tools to determine the real-time performance of network of devices.
- Develop prototype models for various applications using IoT technology.

UNIT I:

The Internet of Things: An Overview of Internet of things, Internet of Things Technology, behind Io Ts Sources of the Io Ts, M2M Communication, Examples of IoTs, Design Principles For Connected Devices Internet Connectivity Principles, Internet connectivity, Application Layer Protocols: HTTP, HTTPS, FTP, Telnet.

UNIT II:

Business Models for Business Processes in the Internet of Things ,IoT/M2M systems LAYERS AND designs standardizations ,Modified OSI Stack for the IoT/M2M Systems ,ETSI M2M domains and High-level capabilities ,Communication Technologies, Data Enrichment and Consolidation and Device Management Gateway Ease of designing and affordability

UNIT III:

Design Principles for the Web Connectivity for connected-Devices, Web Communication protocols for Connected Devices, Message Communication protocols for Connected Devices, Web Connectivity for connected-Devices.

UNIT IV:

Data Acquiring, Organizing and Analytics in IoT/M2M, Applications /Services /Business Processes, IOT/M2M Data Acquiring and Storage, Business Models for Business Processes in the Internet Of Things, Organizing Data, Transactions, Business Processes, Integration and Enterprise Systems.

UNIT V:

Data Collection, Storage and Computing Using a Cloud Platform for IoT/M2M Applications/Services, Data Collection, Storage and Computing Using cloud platform Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively (Pachube/COSM), Nimbits and other platforms Sensor, Participatory Sensing, Actuator, Radio Frequency Identification, and Wireless, Sensor Network Technology, Sensors Technology ,Sensing the World.

Text Books:

1. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education
2. Internet of Things, A. Bahgya and V. Madiseti, Univesity Press, 2015

Reference Books:

1. Designing the Internet of Things, Adrian McEwen and Hakim Cassimally, Wiley

2. Getting Started with the Internet of Things CunoPfister , Oreilly

I Year - I Semester	L	T	P	C
	3	0	0	3
Social Network and Semantic Web (MTDS11XX)				

Course Objectives:

- Explain the fundamentals of Semantic Web technologies. Implementation of semantic web applications and the architectures of social networking
- Social network performance analysis

Course Outcomes:

After completion of course, students would be-

- Demonstrate the semantic web technologies like RDF Ontology and others
- Learn the various semantic web applications
- Identify the architectures and challenges in building social networks
- Analyze the performance of social networks using electronic sources

UNIT I:

Web Intelligence Thinking and Intelligent Web Applications, The Information Age ,The World Wide Web, Limitations of Today's Web, The Next Generation Web, Machine Intelligence, Artificial Intelligence, Ontology, Inference engines, Software Agents, Berners-Lee www, Semantic Road Map, Logic on the semantic Web.

UNIT II:

Knowledge Representation for the Semantic Web Ontologies and their role in the semantic web, Ontologies Languages for the Semantic Web – Resource Description Framework(RDF) / RDF Schema, Ontology Web Language(OWL), UML, XML/XML Schema

UNIT III:

Ontology Engineering, Ontology Engineering, Constructing Ontology, Ontology Development Tools, Ontology Methods, Ontology Sharing and Merging, Ontology Libraries and Ontology Mapping, Logic, Rule and Inference Engines.

UNIT IV:

Semantic Web Applications, Services and Technology Semantic Web applications and services, Semantic Search, e-learning, Semantic Bioinformatics, Knowledge Base, XML Based Web Services, Creating an OWL-S Ontology for Web Services, Semantic Search Technology, Web Search Agents and Semantic Methods.

UNIT V:

Social Network Analysis and semantic web What is social Networks analysis, development of the social networks analysis, Electronic Sources for Network Analysis – Electronic Discussion networks, Blogs and Online Communities, Web Based Networks. Building Semantic Web Applications with social network features

Text Books:

1. Thinking on the Web - Berners Lee, Godel and Turing, Wiley inter science, 2008.
1. Social Networks and the Semantic Web, Peter Mika, Springer, 2007.

Reference Books:

1. Semantic Web Technologies, Trends and Research in Ontology Based Systems.
2. Semantic Web and Semantic Web Services -Liyang Lu Chapman and Hall/CRC Publishers, (Taylor & Francis Group).
3. Programming the Semantic Web, T.Segaran, C.Evans, J.Taylor, O'Reilly.

I Year - I Semester	L	T	P	C
	3	0	0	3
Big Data Analytics (MTDS11XX)				

Course Objectives:

This course is aimed at enabling the students to

- To provide an overview of an exciting growing field of big data analytics.
- To introduce the tools required to manage and analyze big data like Hadoop, NoSQL, Map Reduce, HIVE, Cassandra, Spark.
- To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
- To optimize business decisions and create competitive advantage with Big Data analytics

Course Outcomes:

After the completion of the course, student will be able to

- Illustrate on big data and its use cases from selected business domains.
- Interpret and summarize on No SQL, Cassandra
- Analyze the HADOOP and Map Reduce technologies associated with big data analytics and explore on Big Data applications Using Hive.
- Make use of Apache Spark, RDDs etc. to work with datasets.
- Assess real time processing with Spark Streaming.

UNIT I: What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, credit risk management, big data and algorithmic trading, big data and healthcare, big data in medicine, advertising and big data, big data technologies, introduction to Hadoop, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics.

UNIT II: Introduction to NoSQL, aggregate data models, aggregates, key-value and document data models, relationships, graph databases, schema less databases, materialized views, distribution models, sharding, master-slave replication, peer- peer replication, sharding and replication, consistency, relaxing consistency, version stamps, Working with Cassandra ,Table creation, loading and reading data.

UNIT III: Data formats, analyzing data with Hadoop, scaling out, Architecture of Hadoop distributed file system (HDFS), fault tolerance ,with data replication, High availability, Data locality , Map Reduce Architecture, Process flow, Java interface, data flow, Hadoop I/O, data integrity, compression, serialization. Introduction to Hive, data types and file formats, HiveQL data definition, HiveQL data manipulation, Logical joins, Window functions, Optimization, Table partitioning, Bucketing, Indexing, Join strategies.

UNIT IV: Apache spark- Advantages over Hadoop, lazy evaluation, In memory processing, DAG, Spark context, Spark Session, RDD, Transformations- Narrow and Wide, Actions, Data frames ,RDD to Data frames, Catalyst optimizer, Data Frame Transformations, Working with Dates and Timestamps, Working with Nulls in Data, Working with Complex Types, Working with JSON, Grouping, Window Functions, Joins, Data Sources, Broadcast Variables, Accumulators, Deploying Spark- On-Premises Cluster Deployments, Cluster Managers- Standalone Mode, Spark on YARN , Spark Logs, The Spark UI- Spark UI History Server, Debugging and Spark First Aid

UNIT V: Spark-Performance Tuning, Stream Processing Fundamentals, Event-Time and State full Processing - Event Time, State full Processing, Windows on Event Time- Tumbling Windows, Handling Late Data with Watermarks, Dropping Duplicates in a Stream, Structured Streaming Basics - Core Concepts, Structured Streaming in Action, Transformations on Streams, Input and Output.

Text Books:

1. Big Data, Big Analytics: Emerging, Michael Minnelli, Michelle Chambers, and Ambiga Dhiraj
2. SPARK: The Definitive Guide, Bill Chambers & Matei Zaharia, O'Reilley, 2018 Edition
3. Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013
4. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World Polyglot Persistence", Addison-Wesley Professional, 2012
5. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012

Reference Books:

1. "Hadoop Operations", O'Reilley, Eric Sammer, 2012
2. "Programming Hive", O'Reilley, E. Capriolo, D. Wampler, and J. Rutherglen, 2012
3. "HBase: The Definitive Guide", O'Reilley, Lars George, 2011
4. "Cassandra: The Definitive Guide", O'Reilley, Eben Hewitt, 2010
5. "Programming Pig", O'Reilley, Alan Gates, 2011

I Year - I Semester	L	T	P	C
	2	0	0	2
RESEARCH METHODOLOGY AND IPR				

UNIT 1:

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

UNIT 2:

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT 3:

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

UNIT 4:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT 5:

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:

- (1) Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
- (2) Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- (3) Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- (4) Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
- (5) Mayall, "Industrial Design", McGraw Hill, 1992.
- (6) Niebel, "Product Design", McGraw Hill, 1974.
- (7) Asimov, "Introduction to Design", Prentice Hall, 1962.
- (8) (8) Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
- (9) T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

I Year - I Semester		L	T	P	C
		0	0	4	2
Data Science Applications with Python Lab (MTDS1106)					

Course Outcomes:

After the completion of the course, student will be able to

- Implement data science operations like data collection, management and storing.
- Apply Python programming concepts in data science, including their real-world applications.
- Implement data collection and management scripts using Python Pandas.

List of Experiments:

Experiment 1:

Write a Python Program to Find the Sum of the Series: $1 + 1/2 + 1/3 + .. + 1/N$

Experiment 2:

Write a Python Program to Split the array and add the first part to the end

Experiment 3:

Write a Python Program to Create a List of Tuples with the First Element as the Number and Second Element as the Square of the Number

Experiment 4:

Write a Python program to count number of vowels using sets in given string

Experiment 5:

Write a program to implement permutation of a given string using inbuilt function.

Experiment 6:

Write a python program to sort list of dictionaries by values in Python – Using lambda function.

Experiment 7:

Write a Python Program for following sorting:

- i. Quick Sort
- ii. Heap Sort

Experiment 8:

Write a Python Program to Reverse a String Using Recursion

Experiment 9:

Write a Python Program to Count the Number of Words in a Text File

Experiment 10:

Write a Python Program to Read the Contents of a File in Reverse Order

Experiment 11:

Write a program to Merge and Join DataFrames with Pandas in Python

Experiment 12:

Write a program to implement Merge and Join DataFrames with Python Pandas

Experiment 13:

Write a Python Program to Append the Contents of One File to Another File

Experiment 14:

How to install and Load CSV files to Python Pandas

Experiment 15:

Write a program to implement Data analysis and Visualization with Python using pandas.

Experiment 16:

Write a program to Implement Plotting Functions in python pandas.

I Year - I Semester		L	T	P	C
		0	0	4	2
Advanced Computing with Python-1 Lab (MTDS1107)					

Course Outcomes:

- Implement various heuristics search techniques.
- Solve problems with uncertain information using Bayesian approaches.

List of Experiments:

Experiment 1:

Write a python program to implement following Best First Heuristic Search in artificial intelligence.

Experiment 2:

Write a python program to implement following A* Heuristic Search in artificial intelligence.

Experiment 3:

Write a python program to implement following Hill climbing Heuristic Search in artificial intelligence.

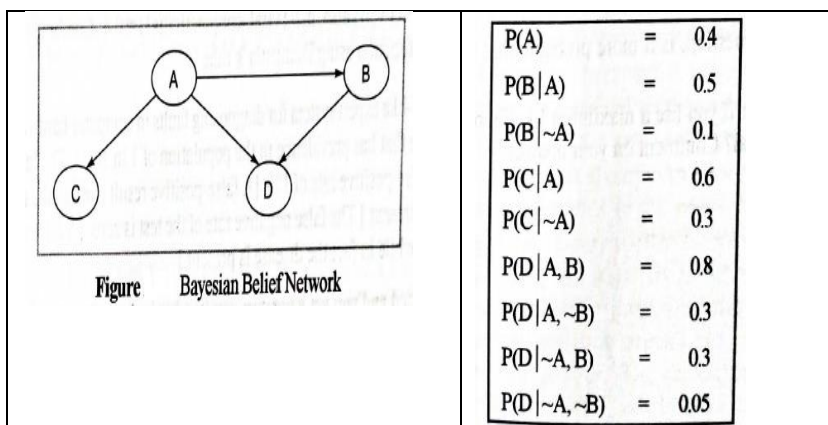
Experiment 4:

Write a python program to implement following Bidirectional Heuristic Search in artificial intelligence.

Experiment 5:

Do the following case study:

- i) For the Bayesian network given in fig below and the corresponding probabilities, generate the conditional probability table.
- ii) Also the compute the following probabilities:
 - a) Joint probability $P(A,B, C, D)$
 - b) $P(A|B)$
 - c) $P(A|C)$
 - d) $P(A|B,C)$



BIG DATA ANALYTICS Programs

Course Outcomes:

- Implement data summarization, query, and analysis.
- Applying data modelling techniques to large data sets.
- Creating applications for Big Data analytics.
- Building a complete business data analytic solution.

Experiment 6:

- (a) Perform setting up and Installing Hadoop in its two operating modes:

- i. Pseudo distributed,
 - ii. Fully distributed.
- (b) Use web based tools to monitor your Hadoop setup.

Experiment 7:

- (a) Implement the following file management tasks in Hadoop:
- i. Adding files and directories
 - ii. Retrieving files
 - iii. Deleting files
- (b) Benchmark and stress test an Apache Hadoop cluster

Experiment 8:

- (a) Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
- i. Find the number of occurrence of each word appearing in the input file(s)
 - ii. Performing a MapReduce Job for word search count (look for specific keywords in a file)

Experiment 9:

Stop word elimination problem:

Input:

- i. A large textual file containing one sentence per line
- ii. A small file containing a set of stop words (One stop word per line)

Output:

- iii. A textual file containing the same sentences of the large input file without the words appearing in the small file.

Experiment 10:

Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather large volume of log data, which is a good candidate for analysis with MapReduce, since it is semi structured and record-oriented.

Data available at: <https://github.com/tomwhite/hadoopbook/tree/master/input/ncdc/all>.

- (a) Find average, max and min temperature for each year in NCDC data set?
- (b) Filter the readings of a set based on value of the measurement, Output the line of input files associated with a temperature value greater than 30.0 and store it in a separate file.

Experiment 11:

Install and Run Pig then write Pig Latin scripts to sort, group, join, project, and filter your data.

Experiment 12:

Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes.

Experiment 13:

Install, Deploy & configure Apache Spark Cluster. Run apache spark applications using Scala.

Experiment 14:

Perform Data analytics using Apache Spark on Amazon food dataset, find all the pairs of items frequently reviewed together.

Write a single Spark application that:

- (a) Transposes the original Amazon food dataset, obtaining a PairRDD of the type: $\langle \text{user_id} \rangle \rightarrow \langle \text{list of the product_ids reviewed by user_id} \rangle$
- (b) Counts the frequencies of all the pairs of products reviewed together;
- (c) Writes on the output folder all the pairs of products that appear more than once and their frequencies. The pairs of products must be sorted by frequency.

I Year - II Semester	L	T	P	C
	3	0	0	3
Advanced Algorithms				

COURSE OBJECTIVE

- Introduce students to the advanced methods of designing and analyzing algorithms.
- The student should be able to choose appropriate algorithms and use it for a specific problem.
- To familiarize students with basic paradigms and data structures used to solve advanced algorithmic problems.
- Students should be able to understand different classes of problems concerning their computation difficulties.
- To introduce the students to recent developments in the area of algorithmic design.

COURSE OUTCOMES

After completion of course, students would be able to:

- Analyze the complexity/performance of different algorithms.
- Determine the appropriate data structure for solving a particular set of problems.
- Categorize the different problems in various classes according to their complexity.
- Students should have an insight of recent activities in the field of the advanced data structure.

Syllabus:

UNIT I: Sorting: Review of various sorting algorithms, topological sorting **Graph:** Definitions and Elementary Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components, emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

UNIT II: Matroids: Introduction to greedy paradigm, algorithm to compute a maximum weight maximal independent set. Application to MST. **Graph Matching:** Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

UNIT III: Flow-Networks: Maxflow-mincut theorem, Ford-Fulkerson Method to compute maximum flow, Edmond-Karp maximum-flow algorithm.

Matrix Computations: Strassen's algorithm and introduction to divide and conquer paradigm, inverse of a triangular matrix, relation between the time complexities of basic matrix operations, LUP-decomposition.

UNIT IV: Shortest Path in Graphs: Floyd-Warshall algorithm and introduction to dynamic programming paradigm. More examples of dynamic programming. **Modulo Representation of integers/polynomials:** Chinese Remainder Theorem, Conversion between base-representation and modulo-representation. Extension to polynomials. Application: Interpolation problem.

Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring. Fast Fourier Transform algorithm. Schonhage-Strassen Integer Multiplication algorithm

UNIT V:Linear Programming: Geometry of the feasibility region and Simplex algorithm. **NP-completeness:** Examples, proof of NP-hardness and NP-completeness. One or more of the following topics based on time and interest Approximation algorithms, Randomized Algorithms, Interior Point Method,Advanced Number Theoretic AlgorithmRecent Trands in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.

Text Books:

1. "Introduction to Algorithms", 3rd Edition, by Cormen, Leiserson, Rivest, Stein, PHP,

2017.

2. "The Design and Analysis of Computer Algorithms" 1st edition by Aho, Hopcroft, Ullman, Pearson, 1974.
3. "Algorithms" Robert Sedgewick, Addison-Wesley Publications, 1983

Reference Books:

1. "Algorithm Design" 1st Edition by Kleinberg and Tardos, Pearson 2013.

I Year - II Semester	L	T	P	C
	3	0	0	3
Machine learning Techniques				

Course Objectives:

Machine Learning course will

- Develop an appreciation for what is involved in learning from data.
- Demonstrate a wide variety of learning algorithms.
- Demonstrate how to apply a variety of learning algorithms to data.
- Demonstrate how to perform evaluation of learning algorithms and model selection.

Course Outcomes:

After the completion of the course, student will be able to

- Domain Knowledge for Productive use of Machine Learning and Diversity of Data.
- Demonstrate on Supervised and Computational Learning
- Analyze on Statistics in learning techniques and Logistic Regression
- Illustrate on Support Vector Machines and Perceptron Algorithm
- Design a Multilayer Perceptron Networks and classification of decision tree

UNIT-I: Introduction-Towards Intelligent Machines, Well posed Problems, Example of Applications in diverse fields, Data Representation, Domain Knowledge for Productive use of Machine Learning, Diversity of Data: Structured / Unstructured, Forms of Learning, Machine Learning and Data Mining, Basic Linear Algebra in Machine Learning Techniques.

UNIT-II: Supervised Learning- Rationale and Basics: Learning from Observations, Bias and Why Learning Works: Computational Learning Theory, Occam's Razor Principle and Overfitting Avoidance Heuristic Search in inductive Learning, Estimating Generalization Errors, Metrics for assessing regression, Metrics for assessing classification.

UNIT-III: Statistical Learning- Machine Learning and Inferential Statistical Analysis, Descriptive Statistics in learning techniques, Bayesian Reasoning: A probabilistic approach to inference, K-Nearest Neighbor Classifier. Discriminant functions and regression functions, Linear Regression with Least Square Error Criterion, Logistic Regression for Classification Tasks, Fisher's Linear Discriminant and Thresholding for Classification, Minimum Description Length Principle.

UNIT-IV: Support Vector Machines (SVM)- Introduction, Linear Discriminant Functions for Binary Classification, Perceptron Algorithm, Large Margin Classifier for linearly separable data, Linear Soft Margin Classifier for Overlapping Classes, Kernel Induced Feature Spaces, Nonlinear Classifier, Regression by Support vector Machines.

Learning with Neural Networks: Towards Cognitive Machine, Neuron Models, Network Architectures, Perceptrons, Linear neuron and the Widrow-Hoff Learning Rule, The error correction delta rule.

UNIT -V: Multilayer Perceptron Networks and error back propagation algorithm, Radial Basis Functions Networks. **Decision Tree Learning:** Introduction, Example of classification decision tree, measures of impurity for evaluating splits in decision trees, ID3, C4.5, and CART decision trees, pruning the tree, strengths and weakness of decision tree approach.

Textbooks:

1. Applied Machine Learning, M.Gopal, Mc Graw Hill Education

References:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)

3. Christopher Bishop, *Pattern Recognition and Machine Learning*, Springer, 2007.

I Year - II Semester	L	T	P	C
	3	0	0	3
Natural Language Processing				

Objectives:

- This course introduces the fundamental concepts and techniques of natural language processing (NLP).
- Students will gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information.
- The course examines NLP models and algorithms using both the traditional symbolic and the more recent statistical approaches.
- Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Course Outcomes:

After completion of this course

- Demonstrate a given text with basic Language features
- To design an innovative application using NLP components
- Explain a rulebased system to tackle morphology/syntax of a language
- To design a tag set to be used for statistical processing for real-time applications
- To compare and contrast the use of different statistical approaches for different types of NLP applications.

Syllabus:

UNIT I:INTRODUCTION

Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance.

UNIT II:WORD LEVEL ANALYSIS

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

UNIT III: SYNTACTIC ANALYSIS

Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures

UNIT IV: SEMANTICS AND PRAGMATICS

Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

UNIT V:

DISCOURSE ANALYSIS AND LEXICAL RESOURCES

Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC).

Text Books:

1. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech, 2nd Edition, Daniel Jurafsky, James H. Martin—Pearson Publication, 2014.
2. Natural Language Processing with Python, First Edition, Steven Bird, Ewan Klein and Edward Loper, OReilly Media, 2009.

Reference Books:

1. Language Processing with Java and LingPipe Cookbook, 1st Edition, Breck Baldwin, Atlantic Publisher, 2015.
2. Natural Language Processing with Java, 2nd Edition, Richard M Reese, OReilly Media, 2015.
3. Handbook of Natural Language Processing, Second, Nitin Indurkha and Fred J. Damerau, Chapman and Hall/CRC Press, 2010. Edition
4. Natural Language Processing and Information Retrieval, 3rd Edition, Tanveer Siddiqui, U.S. Tiwary, Oxford University Press, 2008.

I Year - II Semester	L	T	P	C
	3	0	0	3
High Performance Computing				

Objectives:

The objective of the subject is to

- Introduce the basic concepts related to HPC architecture and parallel computing
- To discuss various computational techniques for studying soft matter systems.
- To apply these concepts to examine complex biomolecular/materials systems that generally require large-scale HPC platform with hybrid CPU-GPU architectures –

Course Outcomes: After completion of this course

- Design, formulate, solve and implement high performance versions of standard single threaded algorithms.
- Demonstrate the architectural features in the GPU and MIC hardware accelerators.
- Design programs to extract maximum performance in a multicore, shared memory execution environment processor.
- Analyze Symmetric and Distributed architectures.
- Develop and deploy large scale parallel programs on tightly coupled parallel systems using the message passing paradigm.

Syllabus:

UNIT I: Graphics Processing Units-Introduction to Heterogeneous Parallel Computing, GPU architecture, Thread hierarchy, GPU Memory Hierarchy.

UNIT II: GPGPU Programming-Vector Addition, Matrix Multiplication algorithms. 1D, 2D, and 3D Stencil Operations, Image Processing algorithms – Image Blur, Gray scaling. Histogramming, Convolution, Scan, Reduction techniques.

UNIT III: Many Integrated Cores-Introduction to Many Integrated Cores. MIC, Xeon Phi architecture. Thread hierarchy. Memory Hierarchy. Memory Bandwidth and performance considerations.

UNIT IV: Shared Memory Parallel Programming- Symmetric and Distributed architectures. OpenMP Introduction. Thread creation, Parallel regions. Worksharing, Synchronization.

UNIT V: Message Passing Interface-MPI Introduction, Collective communication, Data grouping for communication.

Text Books:

1. Programming Massively Parallel Processors A Hands-on Approach, 3e Wen-Mei W Hwu, David B Kirk, Morgan Kaufmann, 2013.
2. Using OpenMP, Scientific and Engin edition, Barbara Chapman, Gabriele Jost, Ruud van der Pas, MIT Press, 2008.

Reference Books:

1. Intel Xeon Phi Coprocessor Architecture and Tools, RezaurRahman, Apress Open, 2013.
2. Using MPI, Gropp, Lusk, Skjellum, The MIT press, 2014.
3. Recent publications in IPDPS, PACT, and similar.

I Year - II Semester	L	T	P	C
	3	0	0	3
Cloud Computing				

Course Objectives:

- To implement Virtualization
- To implement Task Scheduling algorithms.
- Apply Map-Reduce concept to applications.
- To build Private Cloud.
- Broadly educate to know the impact of engineering on legal and societal issues involved.

Course Outcomes: At the end of the course, student will be able to

- Interpret the key dimensions of the challenge of Cloud Computing
- Examine the economics, financial, and technological implications for selecting cloud computing for own organization.
- Assessing the financial, technological, and organizational capacity of employer’s for actively initiating and installing cloud-based applications
- Evaluate own organizations’ needs for capacity building and training in cloud computing-related IT areas.
- To Illustrate Virtualization for Data-Center Automation.

Syllabus:

UNIT I: Introduction: Network centric computing, Network centric content, peer-to –peer systems, cloud computing delivery models and services, Ethical issues, Vulnerabilities, Major challenges for cloud computing. **Parallel and Distributed Systems:** Introduction, architecture, distributed systems, communication protocols, logical clocks, message delivery rules, concurrency, model concurrency with Petri Nets.

UNIT II: Cloud Infrastructure: At Amazon, The Google Perspective, Microsoft Windows Azure, Open Source Software Platforms, Cloud storage diversity, Inter cloud, energy use and ecological impact, responsibility sharing, user experience, Software licensing, **Cloud Computing :** Applications and Paradigms: Challenges for cloud, existing cloud applications and new opportunities, architectural styles, workflows, The Zookeeper, The Map Reduce Program model, HPC on cloud, biological research.

UNIT III: Cloud Resource virtualization: Virtualization, layering and virtualization, virtual machine monitors, virtual machines, virtualization- full and para, performance and security isolation, hardware support for virtualization, Case Study: Xen, vBlades, **Cloud Resource Management and Scheduling:** Policies and Mechanisms, Applications of control theory to task scheduling, Stability of a two-level resource allocation architecture, feedback control based on dynamic thresholds, coordination, resource bundling, scheduling algorithms, fair queuing, start time fair queuing, cloud scheduling subject to deadlines, Scheduling Map Reduce applications, Resource management and dynamic application scaling.

UNIT IV: Storage Systems: Evolution of storage technology, storage models, file systems and database, distributed file systems, general parallel file systems. Google file system. Apache Hadoop, Big Table, Megastore (text book 1), Amazon Simple Storage Service(S3) (Text book 2), **Cloud Security:** Cloud security risks, security – a top concern for cloud users, privacy and privacy impact assessment, trust, OS security, Virtual machine security, Security risks.

UNIT V: Cloud Application Development: Amazon Web Services : EC2 – instances, connecting clients, security rules, launching, usage of S3 in Java, Installing Simple Notification Service on Ubuntu 10.04, Installing Hadoop on Eclipse, Cloud based simulation of a Distributed trust algorithm, Cloud service for adaptive data streaming (Text Book 1), **Google:** Google App Engine, Google Web Toolkit (Text Book 2), **Microsoft:** Azure Services Platform, Windows live, Exchange Online, Share Point Services, Microsoft Dynamics CRM (Text Book 2).

Text Books:

1. Cloud Computing, Theory and Practice, Dan C Marinescu, MK Elsevier
2. Cloud Computing, A Practical Approach, Anthony T Velte, Toby J Velte, Robert Elsenpeter, TMH

Reference book:

1. Mastering Cloud Computing, Foundations and Application Programming, Raj Kumar Buyya, Christen vecctiola, S Tammarai selvi, TMH

I Year - II Semester	L	T	P	C
	3	0	0	3
Principles of Deep Learning				

Course Objectives:

- To acquire knowledge on the basics of neural networks.
- To implement neural networks using computational tools for variety of problems.
- To explore various deep learning algorithms.

Course Outcomes:

Students will be able to:

- Develop algorithms simulating human brain.
- Implement Neural Networks in Tensor Flow for solving problems.
- Explore the essentials of Deep Learning and Deep Network architectures.
- Define, train and use a Deep Neural Network for solving real world problems that require artificial Intelligence based solutions.

Syllabus:

Unit I: Basics of Deep learning- Deep learning architectures, Convolution Neural Networks, Neurons in Human Vision-The Shortcomings of Feature Selection-Vanilla Deep Neural Networks Don't Scale-Filters and Feature Maps-Full Description of the Convolution Layer-Max Pooling-Full Architectural Description of Convolution Networks-Closing the Loop on MNIST with Convolutional Networks-Image Preprocessing Pipelines Enable More Robust Models-Accelerating Training with Batch Normalization-Building a Convolutional Network for CIFAR-10-Visualizing Learning in Convolutional Networks-Leveraging Convolutional Filters to Replicate Artistic Styles-Learning Convolutional Filters for Other Problem Domains-Training algorithms.

Unit II: Memory Augmented Neural Networks : Neural Turing Machines-Attention-Based Memory Access-NTM Memory Addressing Mechanisms-Differentiable Neural Computers-Interference-Free Writing in DNCs-DNC Memory Reuse-Temporal Linking of DNC Writes-Understanding the DNC Read Head-The DNC Controller Network- Visualizing the DNC in Action-Implementing the DNC in TensorFlow-Teaching a DNC to Read and Comprehend.

Unit III: Deep Reinforcement Learning: Deep Reinforcement Learning Masters Atari Games- What Is Reinforcement Learning?-Markov Decision Processes (MDP)-Explore Versus Exploit-Policy versus Value Learning-Pole-Cart with Policy Gradients-Q-Learning and Deep Q-Networks-Improving and Moving Beyond DQN.

Unit IV: Implementing Neural Networks in TensorFlow : What Is TensorFlow?-How Does TensorFlow Compare to Alternatives?-Installing TensorFlow-Creating and Manipulating TensorFlow Variables-TensorFlow Operations-Placeholder Tensors-Sessions in TensorFlow-Navigating Variable Scopes and Sharing Variables-Managing Models over the CPU and GPU-Specifying the Logistic Regression Model in TensorFlow-Logging and Training the Logistic Regression Model-Leveraging TensorBoard to Visualize

Unit V: Computation Graphs and Learning-Building a Multilayer Model for MNIST in TensorFlow. Applications: Deep learning for computer vision, Deep Learning Applications at the Enterprise Scale, Deep Learning Models for Healthcare Applications.

Text Books:

1. “Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms”, Nikhil Buduma, Nicholas Locascio, O'Reilly Media, 2017.
- 2.”Deep Learning (Adaptive Computation and Machine Learning series”, Ian Goodfellow, Yoshua Bengio, Aaron Courville, MIT Press, 2017.

Reference Books:

1. Deep learning from first principle,2nd edition,tinniam v Ganesh,2018
2. Introduction to Deep Learning ,1st edition, by Eugene charniak,The MIT Press,2019

I Year - II Semester	L	T	P	C
	3	0	0	3
Image and Video Analytics				

Course Objectives:

- To teach the fundamentals of digital image processing, image and video analysis.
- To understand the real time use of image and video analytics.
- To demonstrate real time image and video analytics applications and others.

Course Outcomes:

Students will be able to:

- Describe the fundamental principles of image and video analysis and have an idea of their application.
- Apply image and video analysis in real world problems.

Unit I:Digital image representation- Visual Perception- Sampling and Quantization- Basic Relations between Pixels- Mathematical Tools Used in Digital Image Processing: Fundamental Operations –Vector and Matric Operations- Image Transforms (DFT, DCT, DWT, Hadamard).

Unit II:Fundamentals of spatial filtering: spatial correlation and convolution-smoothingblurring-sharpening- edge detection - Basics of filtering in the frequency domain: smoothing-blurring- sharpening- -Histograms and basic statistical models of image.

Unit III:Colour models and Transformations – Image and Video segmentation-Image and video demonising- Image and Video enhancement- Image and Video compression.

Unit IV:Object detection and recognition in image and video-Texture models Image and Video classification models- Object tracking in Video.

Unit V:Applications and Case studies- Industrial- Retail- Transportation & Travel- Remote sensing- Video Analytics in WSN: IoT Video Analytics Architectures.

Text Books:

1. " Digital Image Processing". 3rd Edition, R.C. Gonzalez and R.E. Woods Addison Wesley, 2007.
2. "Computer Vision: Algorithms and Applications", Richard Szelisk, Springer 2011.

Reference Books:

1. "Nonparametric and Semi parametric Models", W. Härdle, M. Müller, S. Sperlich, A. Werwatz, Springer, 2004.
2. "Intelligent Video Surveillance Systems", Jean-Yves Dufour, Wiley, 2013.
3. "Video Analytics for Business Intelligence", Caifeng Shan, Fatih Porikli, Tao Xiang, Shaogang Gong, Springer, 2012.
4. "Intelligent Transport Systems: Technologies and Applications", AsierPerallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola, Wiley,2015.
5. "Analysis of Urban Growth and Sprawl from Remote Sensing Data", Basudeb Bhatta, Springer, 2010

I Year - II Semester	L	T	P	C
	3	0	0	3
Principles of Data Security				

Course Objectives:

In the course the student will learn

- This course provides an overview of modern cryptographic theories and techniques, mainly focusing on their application into real systems.
- Topics include Database and Cloud Security, Malicious Software, Denial-of-Service Attacks, Software Security, Operating System Security, Wireless Network Security and mobile device security.

Course Outcomes:

- After the completion of the course, student will be able to Describe the key security requirements of confidentiality, integrity, and availability, types of security threats and attacks and summarize the functional requirements for computer security.
- Explain the basic operation of symmetric block encryption algorithms, use of secure hash functions for message authentication, digital signature mechanism
- Discuss the issues involved and the approaches for user authentication and explain how access control fits into the broader context that includes authentication, authorization, and audit
- Explain the basic concept of a denial-of-service attack, nature of flooding attacks, distributed denial-of-service attacks and describe how computer security vulnerabilities are a result of poor programming practices
- List the steps used to secure the base operating system, specific aspects of securing Unix/Linux systems, Windows systems, and security in virtualized systems and describe the security threats and countermeasures for wireless networks.

Syllabus:

Unit I: Introduction: Computer Security Concepts, Threats, Attacks, and Assets, Security Functional Requirements, Fundamental Security Design Principles, Attack Surfaces and Attack Trees, Computer Security Strategy. **Cryptographic Tools:** Confidentiality with Symmetric Encryption, Message Authentication and Hash Functions, Public-Key Encryption, Digital Signatures and Key Management, Random and Pseudorandom Numbers.

Unit II: User Authentication: Electronic User Authentication Principles, Password-Based Authentication, Token-Based Authentication, Biometric Authentication, Remote User Authentication, Security Issues for User Authentication. **Access Control:** Access Control Principles, Subjects, Objects, and Access Rights, Discretionary Access Control, Example: UNIX File Access Control, Role-Based Access Control, Attribute-Based Access Control, Identity, Credential, and Access Management, Trust Frameworks.

Unit III: Database and Cloud Security: The Need For Database Security, Database Management Systems, Relational Databases, Sql Injection Attacks, Database Access Control, Database Encryption, Cloud Computing, Cloud Security Risks And Countermeasures, Data Protection In The Cloud, Cloud Security As A Service. **Malicious Software:** Types of Malicious Software (Malware), Advanced Persistent Threat, Propagation, Infected Content, Viruses, Propagation, Vulnerability Exploit, Worms, Propagation, Social Engineering, Spam E-Mail, Trojans, Payload, System Corruption, Payload, Attack Agent, Zombie, Bots, Payload, Information Theft, Key loggers, Phishing, Spyware, Payload, Stealthing, Backdoors, Root kits, Countermeasures.

Unit IV: Denial-of-Service Attacks: Denial-of-Service Attacks, Flooding Attacks, Distributed Denial-of-Service Attacks, Application-Based Bandwidth Attacks, Reflector and Amplifier Attacks, Defenses Against Denial-of-Service Attacks, Responding to a Denial-of-Service Attack. **Software Security:** Software Security Issues, Handling Program Input, Writing Safe Program Code, Interacting with the

Operating System and Other Programs.

Unit V: Operating System Security: Introduction To Operating System Security, System Security Planning, Operating Systems Hardening, Application Security, Security Maintenance, Linux/Unix Security, Windows Security, Virtualization Security. **Wireless Network Security:** Wireless Security, Mobile Device Security, IEEE 802.11 Wireless LAN Overview, IEEE 802.11i Wireless LAN Security.

Text Book:

1. Computer Security: Principles and Practices, 3e, William Stallings, Lawrie Brown, Pearson

Reference book:

1. Network Security Essentials, Principles and Practices, William Stallings, Pearson

I Year - II Semester	L	T	P	C
	3	0	0	3
Advanced algorithms Lab				

Course Objectives:

From the course the student will learn

- Knowing about oops concepts for a specific problem.
- Various advanced data structures concepts like arrays, stacks, queues, linked lists, graphs and trees.

Course Outcomes:

- Identify classes, objects, members of a class and relationships among them needed for a specific problem.
- Examine algorithms performance using Prior analysis and asymptotic notations.
- Organize and apply to solve the complex problems using advanced data structures (like arrays, stacks, queues, linked lists, graphs and trees.)
- Apply and analyze functions of Dictionary

List of Experiments

Experiment 1:

Implement Multi stacks.

Experiment 2:

Implement Double Ended Queue (Dequeues) & Circular Queues.

Experiment 3:

Implement various Recursive operations on Binary Search Tree.

Experiment 4:

Implement various Non-Recursive operations on Binary Search Tree.

Experiment 5:

Implement BFS for a Graph

Experiment 6:

Implement DFS for a Graph.

Experiment 7:

Implement Merge & Heap Sort of given elements.

Experiment 8:

Implement Quick Sort of given elements.

Experiment 9:

Implement various operations on AVL trees.

Experiment 10:

Implement B: Tree operations.

Experiment 11:

Implementation of Binary trees and Traversals (DFT, BFT)

Experiment 12:

Implement Krushkal's algorithm to generate a min-cost spanning tree.

Experiment 13:

Implement Prim's algorithm to generate a min-cost spanning tree.

Experiment 14:

Implement functions of Dictionary using Hashing.

I Year - II Semester	L	T	P	C
	2	0	0	2
Advanced Computing with Python-2 Lab				

Cloud Computing Lab

Course Objectives:

- To implement Virtualization
- Apply Map-Reduce concept to applications.
- Broadly educate to know the impact of engineering on legal and societal issues involved.

Course Outcomes: At the end of the course, student will be able to

- Assessing the financial, technological, and organizational capacity of employer's for actively initiating and installing cloud-based applications
- Evaluate own organizations' needs for capacity building and training in cloud computing-related IT areas.
- To Illustrate Virtualization for Data-Center Automation.

Experiment 1:

To study & Implement Web services in SOAP for JAVA Applications

Experiment 2:

Implementation of Para-Virtualization using VM Ware's Workstation/ Oracle's Virtual Box and Guest O.S.

Experiment 3:

Installation and Configuration of Hadoop

Experiment 4:

Create an application (Ex: Word Count) using Hadoop Map/Reduce

Experiment 5:

Case Study: PAAS (Face book, Google App Engine)

DeepLearning Lab

Course Objectives:

From the course the student will learn

- Describe supervised and unsupervised learning differences.
- Introducing data science, with a focus on the job outlook and market Requirements.
- Graphics and Data Visualization Libraries in Python.
- Machine Learning algorithms, Models and Case Studies with Python.

Course Outcomes:

- Use Deep Learning techniques to build concise representations of the meanings of words in all significant languages
- Use Voice Recognition application using
- Develop a feed forward, convolution and recurrent neural networks.
- Examine Object Recognition application

Get Familiarity with popular deep learning frame works such asTensor Flow, PyTorch, Keras,etc.. For applications like

Experiment 6

Implement Face Recognition application using any one of frame works

Experiment 7

Implement Voice Recognition application using any one of frame works

Experiment 8

Implement Object Recognition application using any one of frame works

Experiment 9

Implement Object Counting application using any one of frame works

Experiment 10

Implement Sentiment Analysis application using any one of frame works

Experiment 11

Implement Detection of Fake News application using any one of frame works, etc....

I Year - II Semester		L	T	P	C
		2	0	0	2
Image and Video Analytics Lab					

Image and Video Analytics Lab

Course Objectives:

- To teach the fundamentals of digital image processing, image and video analysis.
- To understand the real time use of image and video analytics.
- To demonstrate real time image and video analytics applications and others.

Course Outcomes:

Students will be able to:

- Describe the fundamental principles of image and video analysis and have an idea of their application.
- Apply image and video analysis in real world problems.

Experiment 12

Edge detection using Operators.

Experiment 13

2-D DFT and DCT.

Experiment 14

Filtering in frequency domain.

Experiment 15

Display of color images.

Experiment 16

DWT of images.

Experiment 17

Segmentation using watershed transform.

II Year - I Semester	L	T	P	C
	3	0	0	3
Multivariate Analysis				

Course Objects:

- understand the main features of multivariate data.
- To be able to use exploratory and confirmatory multivariate statistical methods properly.
- To be able to carry out multivariate statistical techniques and methods efficiently and effectively.

Course Outcomes:

The course learning objectives include the following:

- To perform multivariate data analysis using R
- To interpret the results and test the assumptions of a multivariate data analysis.
- To understand academic research employing multivariate techniques.

Syllabus:

Unit I: Organization and Display of Data. Matrix Algebra and Random Vectors. Characterizing data, defining and classifying variables. Multivariate Normal Distribution, Multivariate analysis of variance, multivariate analysis of covariance.

Unit II: Simple Linear Regression and Correlation analysis, Multiple Regression and Correlation, Variable Selection in Regression analysis, missing values, dummy variables, constraints on parameters and multicollinearity.

Unit III: Canonical Correlation analysis: analyzing two sets of variables. Discriminant Analysis: Analyzing cases, adjusting the value of the dividing point, and the goodness of the discriminant function, classification in more than two groups.

Unit IV: Logistic Regression: categorical, continuous and mixed variables. Log-linear regression model. Principal Component Analysis: Understanding inter correlations, interpretation and use of PCA in regression and other applications. Factor Analysis: examining the relationship among p variables, initial factor extraction, factor rotations and assigning factor scores.

Unit V: Multidimensional Scaling: measures of similarity and dissimilarity, Classical scaling and Ordinal scaling. Cluster Analysis: distance measures and analytical clustering techniques. Log-linear analysis: analyzing categorical data, test of hypothesis and models for two way tables, sample size issues and the logic model.

Textbook:

1. Introduction to Multivariate Analysis by C. Chatfield and A.J. Collins, T&F/CRC Press

Reference Books:

1. Applied Multivariate Statistical Analysis by Richard A. Johnson , Dean W. Wichern, Pearson.
2. Multivariate Data Analysis by Joseph H. Hair, William C. Black, Barry J. Babin and Rolph E.Anderson, Pearson.
3. Computer-Aided Multivariate Analysis by A.A. Afifi, CRC press.

II Year - I Semester	L	T	P	C
	3	0	0	3
Next Generation Databases				

Course Objectives:

- To explore the concepts of NoSQL Databases.
- To understand and use columnar and distributed database patterns.
- To learn to use various Data models for a variety of databases.

Course Outcomes: Students will be able to:

- Explore the relationship between Big Data and NoSQL databases
- Work with NoSQL databases to analyze the big data for useful business applications.
- Work with different data models to suit various data representation and storage needs.

Unit-I: Database Revolutions- System Architecture- Relational Database- Database Design Data Storage- Transaction Management- Data warehouse and Data Mining- Information Retrieval.

UnitII: Big Data Revolution- CAP Theorem- Birth of NoSQL- Document Database—XML Databases- JSON Document Databases- Graph Databases.

UnitIII: Column Databases— Data Warehousing Schemes- Columnar Alternative- Sybase IQ- CStore and Vertica- Column Database Architectures- SSD and In-Memory Databases— InMemory Databases- Berkeley Analytics Data Stack and Spark.

UnitIV: Distributed Database Patterns— Distributed Relational Databases- Non-relational Distributed Databases- MongoDB - Sharing and Replication- HBase- CassandraConsistency Models— Types of Consistency- Consistency MongoDB- HBase Consistency- Cassandra Consistency.

UnitV: Data Models and Storage- SQL- NoSQL APIs- Return SQL- Advance Databases— PostgreSQL- Riak- CouchDB- NEO4J- Redis- Future Databases— Revolution RevisitedCounter revolutionaries- Oracle HQ- Other Convergent Databases- Disruptive Database Technologies.

Text Books:

1. “Next Generation Databases”,1st Edition, Guy Harrison, Apress, 2015.

References Books:

1. Database System Concepts”, Sixth Edition, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGrawHill,2010.
2. “Seven Databases in Seven Weeks”, Eric Redmond, Jim R Wilson, LLC. 2012.
3. “NoSQL for Mere Mortals”, Dan Sullivan, Addison-Wesley, 2015.
4. “NoSQL for Dummies “,Adam Fowler, John Wiley & Sons, 2015.

Open Electives offered by the Department of CSE for other Departments students

1. Python Programming
2. Principles of Cyber Security
3. Internet of Things
4. Machine Learning
5. Deep Learning
6. Next Generation Databases

Open Electives offered by the Department of CSE for other Departments students

II Year - I Semester	L	T	P	C
	3	0	0	3
Python Programming				

Course Objectives:

- To acquire programming skills in core Python.
- To acquire Object Oriented Skills in Python.
- To develop the skill of designing Graphical user Interfaces in Python.
- To develop the ability to write database applications in Python.

Course Outcomes(COs): At the end of the course, student will be able to

- Understand and comprehend the basics of python programming.
- Demonstrate the principles of structured programming and be able to describe, design, implement, and test structured programs using currently accepted methodology.
- Explain the use of the built-in data structures list, sets, tuples and dictionary.
- Make use of functions and its applications.
- Identify real-world applications using oops, files and exception handling provided by python.

UNIT – I:

Introduction: History of Python, Need of Python Programming, Applications Basics of Python Programming Using the REPL(Shell), Running Python Scripts, Variables, Assignment, Keywords, Input-Output, Indentation.

UNIT – II:

Types, Operators and Expressions: Types - Integers, Strings, Booleans; Operators- Arithmetic Operators, Comparison (Relational) Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Expressions and order of evaluations Control Flow- if, if-elif-else, for, while, break, continue, pass

UNIT – III:

Data Structures-Lists- Operations, Slicing, Methods, Tuples, Sets, Dictionaries, Sequences, Comprehensions.

UNIT – IV:

Functions - Defining Functions, Calling Functions, Passing Arguments, Keyword Arguments, Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions (Function Returning Values), Scope of the Variables in a Function - Global and Local Variables, **Modules:** Creating modules, import statement, from. Import statement, name spacing, **Python packages**, Introduction to PIP, Installing Packages via PIP, Using Python Packages

UNIT – V:

Object Oriented Programming OOP in Python: Classes, 'self variable', Methods, Constructor Method, Inheritance, Overriding Methods, Data hiding, **Error and Exceptions:** Difference between an error and Exception, Handling Exception, try except block, Raising Exceptions, User defined Exceptions, **Brief Tour of the Standard Library** - Operating System Interface - String Pattern Matching, Mathematics, Internet Access, Dates and Times, Data Compression, Multithreading, GUI Programming, Turtle Graphics, **Testing:** Why testing is required ?, Basic concepts of testing, Unit testing in Python, Writing Test cases, Running Tests.

Text Books:

1. Fundamentals of Python First Programs, Kenneth. A. Lambert, Cengage
2. Introduction to Programming Using Python, Y. Daniel Liang, Pearson

Reference Books:

1. Introduction to Python Programming, Gowrishankar.S, Veena A, CRC Press
2. Think Python, Allen Downey, Green Tea Press
3. Core Python Programming, W. Chun, Pearson

II Year - I Semester	L	T	P	C
	3	0	0	3
Principles of Cyber Security				

Course Objectives:

- To learn threats and risks within context of the cyber security architecture.
- Student should learn and Identify security tools and hardening techniques.
- To learn types of incidents including categories, responses and timelines for response.

Course Outcomes: At the end of the course, student will be able to

- Apply cyber security architecture principles.
- Describe risk management processes and practices.
- Appraise cyber security incidents to apply appropriate response.
- Distinguish system and application security threats and vulnerabilities.
- Identify security tools and hardening techniques

Syllabus:

UNIT-I: Introduction to Cyber Security-Cyber security objectives, roles, differences between information security and cyber security, Cyber security principles-confidentiality, integrity, availability, authentication and non repudiation

UNIT-II: Information Security within Lifecycle Management-Lifecycle management landscape, Security architecture processes, Security architecture tools, Intermediate lifecycle management concepts, **Risks & Vulnerabilities-**Basics of risk management, Operational threat environments, Classes of attacks

UNIT-III: Incident Response-Incident categories, Incident response, Incident recovery, **Operational security protection-**Digital and data assets, ports and protocols, Protection technologies, Identity and access Management, configuration management

UNIT-IV: Threat Detection and Evaluation Monitoring-Vulnerability management, Security logs and alerts, Monitoring tools and appliances, **Analysis-**Network traffic analysis, packet capture and analysis

UNIT-V: Introduction to backdoor System and security-Introduction to metasploit, backdoor, demilitarized zone (DMZ), Digital signature, Brief study on Harding of operating system.

Text Books:

1. NASSCOM: Security Analyst Student Hand Book, Dec 2015
2. **Information Security Management Principles, Updated Edition**, [David Alexander](#), [Amanda Finch](#), [David Sutton](#), BCS publishers, June 2013

Reference Books:

1. *Cyber Security Fundamentals-Cyber Security, Network Security and Data Governance Security, 2nd Edition, ISACA Publishers*

II Year - I Semester	L	T	P	C
	3	0	0	3
Internet of Things				

Course Objectives:

- To Understand Smart Objects and IoT Architectures.
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications.

Course Outcomes:

After the completion of the course, student will be able to

- Summarize on the term 'internet of things' in different contexts.
- Analyze various protocols for IoT
- Design a PoC of an IoT system using Raspberry Pi/Arduino
- Apply data analytics and use cloud offerings related to IoT
- Analyze applications of IoT in real time scenario

Syllabus:

UNIT I: FUNDAMENTALS OF IoT- Evolution of Internet of Things, Enabling Technologies, IoT Architectures, oneM2M, IoT World Forum (IoTWF) and Alternative IoT models, Simplified IoT Architecture and Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

UNIT II: IoT PROTOCOLS- IT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks, Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks, Application Transport Methods: Supervisory Control and Data Acquisition, Application Layer Protocols: CoAP and MQTT.

UNIT III: DESIGN AND DEVELOPMENT- Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks, Arduino, Board details, IDE programming, Raspberry Pi, Interfaces and Raspberry Pi with Python Programming.

UNIT IV: DATA ANALYTICS AND SUPPORTING SERVICES- Structured Vs Unstructured Data and Data in Motion Vs Data in Rest, Role of Machine Learning – No SQL Databases, Hadoop Ecosystem, Apache Kafka, Apache Spark, Edge Streaming Analytics and Network Analytics, Xively Cloud for IoT, Python Web Application Framework, Django, AWS for IoT, System Management with NETCONF-YANG.

UNIT V: CASE STUDIES/INDUSTRIAL APPLICATIONS- Cisco IoT system, IBM Watson IoT platform, Manufacturing, Converged Plant wide Ethernet Model (CPwE), Power Utility Industry, Grid Blocks Reference Model, Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control.

Text Books:

1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017

Reference Books:

1. Internet of Things – A hands-on approach, Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015
2. The Internet of Things – Key applications and Protocols, Olivier Hersent, David Boswarthick, Omar Elloumi and Wiley, 2012 (for Unit 2).
3. “From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence”, Jan Ho" ller, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle and Elsevier, 2014.
4. Architecting the Internet of Things, Dieter Uckelmann, Mark Harrison, Michahelles and Florian (Eds), Springer, 2011.
5. Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, Michael Margolis, Arduino Cookbook and O'Reilly Media, 2011.

II Year - I Semester	L	T	P	C
	3	0	0	3
Machine learning				

Course Objectives:

Machine Learning course will

- Develop an appreciation for what is involved in learning from data.
- Demonstrate a wide variety of learning algorithms.
- Demonstrate how to apply a variety of learning algorithms to data.
- Demonstrate how to perform evaluation of learning algorithms and model selection.

Course Outcomes:

After the completion of the course, student will be able to

- Domain Knowledge for Productive use of Machine Learning and Diversity of Data.
- Demonstrate on Supervised and Computational Learning
- Analyze on Statistics in learning techniques and Logistic Regression
- Illustrate on Support Vector Machines and Perceptron Algorithm
- Design a Multilayer Perceptron Networks and classification of decision tree

UNIT I: Supervised Learning (Regression/Classification) Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Na ve Bayes Linear models: Linear Regression, Logistic Regression, Generalized Linear Models Support Vector Machines, Nonlinearity and Kernel Methods Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

UNIT II: Unsupervised Learning Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (mixture models and latent factor models)

UNIT III: Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)

UNIT IV: Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning

UNIT V: Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference, Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.

Textbooks:

1. Applied Machine Learning, 1st edition, M.Gopal, Mc Graw Hill Education,2018

References:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 2007.

II Year - I Semester	L	T	P	C
	3	0	0	3
Deep Learning				

Course Objectives:

- The objective of this course is to cover the fundamentals of neural networks as well as some advanced topics such as recurrent neural networks, long short term memory cells and convolutional neural networks.
- The course also requires students to implement programming assignments related to these topics.

COURSE OBJECTIVE

- To design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
- Explore supervised and unsupervised learning paradigms of machine learning.

COURSE OUTCOMES

After completion of course, students would be able to:

- To explore Deep learning techniques and various feature extraction strategies.
- To mathematically understand the deep learning approaches and paradigms
- To apply the deep learning techniques for various applications

Syllabus

UNIT I: Basics- Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.

UNIT II: Feedforward Networks- Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization, regularization, autoencoders.

Deep Neural Networks: Difficulty of training deep neural networks, Greedy layerwise training.

UNIT III: Better Training of Neural Networks- Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

UNIT IV: Recurrent Neural Networks- Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs

Convolutional Neural Networks: LeNet, AlexNet.

Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.

UNIT V: Recent trends- Variational Autoencoders, Generative Adversarial Networks, Multi-task Deep Learning, Multi-view Deep Learning

Applications: Vision, NLP, Speech (just an overview of different applications in 2-3 lectures)

Textbooks

1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.

References:

1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996
2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007

II Year - I Semester	L	T	P	C
	3	0	0	3
NEXT GENERATION DATABASES				

Course Objectives:

- To explore the concepts of NoSQL Databases.
- To understand and use columnar and distributed database patterns.
- To learn to use various Data models for a variety of databases.

Course Outcomes: Students will be able to:

- Explore the relationship between Big Data and NoSQL databases
- Work with NoSQL databases to analyze the big data for useful business applications.
- Work with different data models to suit various data representation and storage needs.

Unit-I: Database Revolutions- System Architecture- Relational Database- Database Design Data Storage- Transaction Management- Data warehouse and Data Mining- Information Retrieval.

UnitII: Big Data Revolution- CAP Theorem- Birth of NoSQL- Document Database—XML Databases- JSON Document Databases- Graph Databases.

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UnitIV: Distributed Database Patterns— Distributed Relational Databases- Non-relational Distributed Databases- MongoDB - Sharing and Replication- HBase- CassandraConsistency Models— Types of Consistency- Consistency MongoDB- HBase Consistency- Cassandra Consistency.

UnitV: Data Models and Storage- SQL- NoSQL APIs- Return SQL- Advance Databases— PostgreSQL- Riak- CouchDB- NEO4J- Redis- Future Databases— Revolution RevisitedCounter revolutionaries- Oracle HQ- Other Convergent Databases- Disruptive Database Technologies.

Text Books:

1. “Next Generation Databases”,1st Edition, Guy Harrison, Apress, 2015.

References Books:

1. Database System Concepts”, Sixth Edition, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGrawHill,2010.
2. “Seven Databases in Seven Weeks”, Eric Redmond, Jim R Wilson, LLC. 2012.
3. “NoSQL for Mere Mortals”, Dan Sullivan, Addison-Wesley, 2015.
4. “NoSQL for Dummies “,Adam Fowler, John Wiley & Sons, 2015.

AUDIT 1 and 2: ENGLISH FOR RESEARCH PAPER WRITING

Course objectives:

Students will be able to:

Understand that how to improve your writing skills and level of readability

Learn about what to write in each section

Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission

Syllabus		
Units	CONTENTS	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	4
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	4
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	4
4	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	4
5	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	4
6	useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	4

Suggested Studies:

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'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011



AUDIT 1 and 2: DISASTER MANAGEMENT

Course Objectives: -Students will be able to:

learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus		
Units	CONTENTS	Hours
1	Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	4
2	Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man- made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	4
3	Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	4
4	Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	4
5	Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	4
6	Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	4



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Suggested Readings:

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies
“New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)” Disaster Mitigation Experiences And Reflections”, Prentice Hall
Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies” ,Deep &Deep
Publication Pvt. Ltd., New Delhi.



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KAKINADA – 533 003, Andhra Pradesh, India

AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Syllabus

Unit	Content	Hours
1	Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences	4
2	Order Introduction of roots Technical information about Sanskrit Literature	4
3	Technical concepts of Engineering-Electrical,	4
4	Technical concepts of Engineering - Mechanical.	4
5	Technical concepts of Engineering - Architecture.	4
6	Technical concepts of Engineering – Mathematics.	4

Suggested reading

1. “Abhyastakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students



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KAKINADA – 533 003, Andhra Pradesh, India

AUDIT 1 and 2: VALUE EDUCATION

Course Objectives

Students will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Syllabus

Unit	Content	Hours
1	Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements	4
2	Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism.Love for nature ,Discipline	4
3	Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking.	4
4	Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature	4
5	Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence ,Humility, Role of Women.	4
6	All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively	4

Suggested reading

1 Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Course outcomes

- Students will be able to
- 1.Knowledge of self-development
 - 2.Learn the importance of Human values
 - 3.Developing the overall personality



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
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AUDIT 1 and 2: CONSTITUTION OF INDIA

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Syllabus		
Units	Content	Hours
1	History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)	4
2	Philosophy of the Indian Constitution: Preamble Salient Features	4
3	Contours of Constitutional Rights & Duties: Fundamental Rights Right to Equality Right to Freedom Right against Exploitation Right to Freedom of Religion Cultural and Educational Rights Right to Constitutional Remedies Directive Principles of State Policy Fundamental Duties.	4
4	Organs of Governance: Parliament Composition Qualifications and Disqualifications Powers and Functions Executive President Governor Council of Ministers Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions	4
5	Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CE of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	4



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6	Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.	4
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Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.



JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA – 533 003, Andhra Pradesh, India

AUDIT 1 and 2: PEDAGOGY STUDIES

Course Objectives:

Students will be able to:

4. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
5. Identify critical evidence gaps to guide the development.

Syllabus		
Units	Content	Hours
1	Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.	4
2	Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.	4
3	Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?	4
4	Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.	4
5	Professional development: alignment with classroom practices and follow-up support Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes	4
6	Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.	4



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Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, *Compare*, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, *Journal of Curriculum Studies*, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? *International Journal Educational Development*, 33 (3): 272–282.
5. Alexander RJ (2001) *Culture and pedagogy: International comparisons in primary education*. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes:

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?



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AUDIT 1 and 2: STRESS MANAGEMENT BY YOGA

Course Objectives

1. To achieve overall health of body and mind
2. To overcome stress

Syllabus

Unit	Content	Hours
1	Definitions of Eight parts of yog. (Ashtanga)	5
2	Yam and Niyam. Do`s and Don`t`s in life. Ahinsa, satya, astheya, bramhacharya and aparigraha	5
3	Yam and Niyam. Do`s and Don`t`s in life. Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	5
4	Asan and Pranayam Various yog poses and their benefits for mind & body	5
5	Regularization of breathing techniques and its effects-Types of pranayam	4

Suggested reading

1. ‘Yogic Asanas for Group Training-Part-I’ : Janardan Swami YogabhyasiMandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency



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AUDIT 1 and 2: PERSONALITY DEVELOPMENT THROUGH LIFE
ENLIGHTENMENT SKILLS

Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Syllabus

Unit	Content	Hours
1	Neetisatakam-Holistic development of personality Verses- 19,20,21,22 (wisdom) Verses- 29,31,32 (pride & heroism) Verses- 26,28,63,65 (virtue)	4
2	Neetisatakam-Holistic development of personality Verses- 52,53,59 (don't's) Verses- 71,73,75,78 (do's)	4
3	Approach to day to day work and duties. Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48,	4
4	Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.	4
5	Statements of basic knowledge. Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18	4
6	Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63	4

Suggested reading

1. “Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students
