SGT University, Chandu-Budhera, Gurugram

Faculty of Engineering & Technology

Department of Computer Science &Engineering

M. Tech. Computer Science & Engineering

Scheme & Syllabus (2021-22 Onwards)

Vision of SGT University

"Driven by Research & Innovation, we aspire to be amongst the top ten Universities in the Country by 2022"

M.Tech (Computer science & Engineering)

Semester 1st

S. No.	Subject Code	Subject Name	L	T	P	C	Internal	External	Total
1.		Data Science with Python	3	0	0	3	40	60	100
2.		Medical image processing	3	0	0	3	40	60	100
3.		Advanced DBMS	3	0	0	3	40	60	100
4.		Department Electives-XVI	3	0	0	3	40	60	100
5.		Data Science with Python Lab	0	0	2	1	60	40	100
6.		Advanced DBMS Lab	0	0	2	1	60	40	100
7.		Medical image processing Lab	0	0	2	1	60	40	100
8.		Department Electives-XVI Lab	0	0	2	1	60	40	100
9.		Value Added Courses-I	2	0	0	2	40	60	100
		Total	**14**	**0**	**8**	**18**	**440**	**460**	**900**

M.Tech (Computer science & Engineering)

Semester 2nd

S. No.	Subject Code	Subject Name	L	T	P	C	Internal	External	Total
1.		Advance Software Engineering & Testing	3	0	0	3	40	60	100
2.		Software Project Management	3	0	0	3	40	60	100
3.		Data Mining	3	0	0	3	40	60	100
4.		Department Electives-XVII	3	0	0	3	40	60	100
5.		Advance Software Engineering &Testing Lab	0	0	4	2	60	40	100
6.		Data Mining Lab	0	0	2	1	60	40	100
7.		Department Electives- XVII Lab	0	0	2	1	60	40	100
		Total	**12**	**0**	**8**	**16**	**340**	**360**	**700**

M.Tech (Computer science & Engineering)									
Semester 3rd									
S. No.	**Subject Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Internal**	**External**	**Total**
1.		Distributed Computing	3	0	0	3	40	60	100
2.		AI & Soft Computing	3	0	0	3	40	60	100
3.		Department Electives-XIII	3	0	0	3	40	60	100
4.		Department Electives-XIV	3	0	0	3	40	60	100
5.		Department Electives-XV	3	0	0	3	40	60	100
6.		AI & Soft Computing Lab	0	0	4	2	60	40	100
7.		Department Electives Lab-XIII	0	0	2	1	60	40	100
8.		Department Electives Lab-XV	0	0	2	1	60	40	100
9.		Distributed Computing Lab	0	0	2	1	60	40	100
10.		Value Added Courses-V	2	0	0	2	60	40	100
		Total	**17**	**0**	**10**	**22**	**500**	**500**	**1000**

M.Tech (Computer science & Engineering)								
Semester 4th								
S. No.	**Subject Code**	**Subject Name**	**L**	**P**	**C**	**Internal**	**External**	**Total**
1.		Dissertation	-	**20 W**			100	100
		Total			20		100	100

Semester 1st

Python for Data Science

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**Python for Data Science**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**4**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE ()**	
5. Pre-requisite (if any)	Basic Python	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

Data Science techniques enable us to automatically extract features from data so as to solve predictive tasks, such as speech recognition, object recognition, machine translation, question-answering, anomaly detection, medical diagnosis and prognosis, automatic algorithm configuration, personalization, robot control, time series forecasting, and much more. Learning systems adapt so that they can solve new tasks, related to previously encountered tasks, more efficiently.

9. LearningObjectives:

1. To aware students about the data science.
2. To promote the technique of merged data science and opportunities in domain.
3. To provide deep knowledge of data visualization in different data sets.
4. To aware the students about the machine learning algorithms.

10. Course Outcomes (COs):

The students will be able to: -

1. Identify the need for data science and solve basic problems using Python built-in data types and their methods.
2. Employ efficient storage and data operations using NumPy arrays.
3. Apply powerful data manipulations using Pandas.
4. Do data preprocessing and visualization using Pandas

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	

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

Unit – 2	**Number of lectures = 9**	

NumPy Basics: Arrays and Vectorized Computation- The NumPy ndarray- Creating ndarrays- Data Types for ndarrays- Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing-Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods-SortingUnique and Other Set Logic.

Unit – 3	**Number of lectures = 9**	

Introduction to pandas Data Structures: Series, DataFrame, Essential Functionality: Dropping. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format.Concept of Data Visualization, Libraries for Data Visualization, Matplotlib in-depth, Seaborn in-depth

Unit – 4	**Number of lectures = 9**	

Data Cleaning and Preparation: Handling Missing Data - Data Transformation: Removing Duplicates, ,Replacing Values, Detecting and Filtering Outliers- String Manipulation: What is Machine Learning, Machine Learning algorithms, Supervised Learning, Unsupervised Learning, Reinforcement Learning

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.
The link to the E-Learning portal.
https://elearning.sgtuniversity.ac.in/course-category/

13. Books Recommended

Text Books

1. Rajkumar Buyya, Amir Vahid Dastjerdi," Internet of Things: Principles and Paradigms", Elsevier,2016.
2. R. Chandrasekaran," Essentials of Cloud computing", 2nd Edition, Chapman and Hall/CRC, 2015.
3. Amita Kapoor, "Hands on Artificial intelligence for IoT", 1 st Edition, Packt Publishing, 2019.

14. Reference Books

1. John Soldatos, "Building Blocks for IoT Analytics", River Publishers,2016
2. John E. Rossman, "The Amazon way on IoT", Volume 2, John E. Rossman publication, 2016.

Python for Data Science Lab

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**Python for Data Science Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core (√)**	**PE( )**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 24**			

8. Course Description

9. Learning objectives:

Process of data science: -

1. Python and Jupiter notebooks
2. An applied understanding of how to manipulate and analyze uncrated datasets
3. Basic statistical analysis and machine learning methods
4. How to effectively visualize results

10. Course Outcomes (COs):

1. Apply data visualization in Data sets
2. Utilize EDA, inference and regression techniques
3. Apply data pre-processing techniques
4. Apply Basic Machine Learning Algorithms

11. List of Experiments

1. Merging two Data Frames
2. Applying functions to Data Frames
3. Descriptive Statistics in Python
4. Creating and manipulating a List and an Array
5. Creating a Data Frame and Matrix-like Operations on a Data Frame
6. Reading and writing different types of data sets
7. Data Visualizations
8. Correlation and Covariance
9. Regression Model
10. Simulate Machine Learning Algorithms.

12. Brief Description of self-learning / E-learning component

https://nlp-iiith.vlabs.ac.in/

http://vlab.co.in/participating-institute-iiit-hyderabad

Medical Image Processing

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**Medical Image Processing**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**4**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE ()**	
5. Pre-requisite (if any)	Basic Python	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

A study of methods for enhancing, analyzing, interpreting and visualizing information from two- and three-dimensional data obtained from a variety of medical imaging modalities.

9. Learning Objectives:

1. To define the principles of image sampling, quantization, enhancement and filtering techniques
2. To discover the different image compression methods and morphological based processes and machine learning techniques for image segmentation
3. To develop the methods of image registration and visualization for medical applications
4. To acquire the student with the techniques of shape analysis and image classification using neural networks for brain computer interface and computer aided diagnosis

10. Course Outcomes (COs):

The students will be able to: -

1. Comprehend image sampling and DFT
2. Process the given medical images to enhance them
3. Apply compression techniques and morphological operations for segmentation
4. Predict a machine learning algorithm on the given image for segmentation
5. Register images of different modalities, render their volumes for visualization
6. Use neural networks for image classification
7. Design and develop algorithms to process and visualize images from different modalities
8. Develop algorithms to process and visualize images from different modalities for diagnostic application

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Image Fundamentals

Image perception- Image model- Image sampling and quantization - 2D DFT and DCT.

Image Enhancement and Filtering: Image enhancement- Histogram modelling, Spatial operations - Image restoration, Noise models, Image degradation model, Wiener filtering, Maximum entropy restoration.

Unit – 2	**Number of lectures = 9**	Image Compression and Morphological Processing

Image compression - Lossy and lossless Compression, Predictive techniques - Dilation, Erosion, Open, Close, Skeleton operations, Top-hat algorithm - Morphology based segmentation

Image Segmentation : Machine Learning based segmentation algorithms - Singular Value Decomposition (SVD) - Principal Component Analysis and its applications - Support Vector Machine and its applications - Independent Component Analysis and its application.

Unit – 3	**Number of lectures = 9**	Image Registration and Visualization
Image Registration - Medical image Fusion, SPECT/CT, MR/CT, PET/CT - Image visualization - Volume Rendering, Surface rendering and Maximum Intensity Projection Shape Analysis and Image Classification: Topological attributes - Shape orientation descriptors, Fourier descriptors, - K means clustering, machine learning, Neural Network approaches- Statistical Parametric Mapping in Imaging - Regression analysis.		
Unit – 4	**Number of lectures = 9**	CAD and Brain Computer Interface
Applications of Computer Aided Design (CAD) - General Linear Model (GLM) and its application in functional brain mapping - Group analysis using t-test - Computer Aided Manufacturing (CAM) in Medical Imaging applications, Patient specific modelling - Brain Computer Interface (BCI) and its applications in Neuroscience.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

13. Books Recommended

Text Books

1. Reiner Salzer, "Biomedical Imaging: Principles and Applications", 2012, 1st Edition, Wiley, New Jersey

Reference Books

1. Jonathan Wolpaw, Elizabeth Winter, (Eds.) "Brain-Computer Interfaces: Principles and Practice", 2012, 1st Edition, Oxford University Press, Oxford.
2. Pears, Nick, Liu, Yonghuai, Bunting, Peter (Eds.) "3D Imaging, Analysis and Applications", 2012, 2nd Edition, Springer, Berlin

Advanced DBMS

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**Advanced Database Management System**	L	T		P	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**PE()**		**OE ()**	
5. Prerequisite (if any)	**DBMS**	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12weeks of one semester)						
Lectures = 36		Tutorials = 0	Practical = 0			

8. Course Description

This module aims to give students in depth information about system implementation techniques, data storage, representing data elements, database system architecture, the system catalog, query processing and optimization, transaction processing concepts, concurrency control techniques, database recovery techniques.

9. Learning objectives:

1. To understand the basic concepts and terminology related to DBMS and Relational Database Design
2. To the design and implement Distributed Databases.
3. To understand advanced DBMS techniques to construct tables and write effective queries, forms, and reports

10. Course Outcomes (COs):

1. Exposure for students to write complex queries including full outer joins, self-join, sub queries, and set theoretic queries.
2. Know-how of the file organization, Query Optimization, Transaction management, and database administration techniques

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	

Formal review of relational database and FDs Implication, Closure, its correctness

3NF and BCNF, Decomposition and synthesis approaches,Basics of query processing, external sorting, file scans

Unit – 2	**Number of lectures = 9**	

Processing of joins, materialized vs. pipelined processing, query transformation rules, DB transactions, ACID properties, interleaved executions, schedules, serializability

Unit – 3	**Number of lectures = 9**	
Correctness of interleaved execution, Locking and management of locks, 2PL, deadlocks, multiple level granularity, CC on B+ trees, Optimistic CC		
Unit – 4	**Number of lectures = 9**	
Time stamped, lock based techniques, Multiversion approaches, Comparison of CC methods, dynamic databases, Failure classification, recovery algorithm, XML and relational databases		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

13. Books Recommended

Text Books

1. A. Silberschatz, H. Korth, S. Sudarshan, Database system concepts, 5/e, McGraw Hill, 2008

Reference Books

1. K. V. Iyer, Lecture notes available as PDF file for classroom use.
2. R. Ramakrishnan, J. Gehrke, Database Management Systems, McGraw Hill, 2004

ADBMS Lab

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**ADBMS Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core (√)**	**PE()**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 24**			

8. Course Description: The aim of this course is to introduce students to the advanced concepts of database systems, focusing on the relational algebra and data model, query optimization and transactions.

9. Learning objectives:

1. To explore the features of a Database Management Systems.
2. To understand the internals of a database system.
3. To present SQL and procedural interfaces to SQL comprehensively.

10. Course Outcomes (COs):

1. Understand, appreciate and effectively explain the underlying concepts of database technologies
2. Design and implement a database schema for a given problem-domain
3. Normalize a database
4. Populate and query a database using SQL DML/DDL commands.
5. Declare and enforce integrity constraints on a database using a state-of-the-art DBMS

11. List of Experiments

1. Implementation of DDL commands of SQL with suitable examples :
    - Create table
    - Alter table
    - Drop table
2. Implementation of DML commands of SQL with suitable examples
    - Insert
    - Update
    - Delete
3. Implementation of different types of function with suitable examples
    - Number function
    - Aggregate Function
    - Character Function
    - Conversion Function
    - Date Function
4. Implementation of different types of operators in SQL
    - Arithmetic Operators
    - Logical Operators
    - Comparison Operator

- Special Operator
- Set Operation

5. Implementation of different types of Joins
    - Inner Join
    - Outer Join
    - Natural Join etc.
6. Study and Implementation of
    - Group By & having clause
    - Order by clause
    - Indexing
7. Study & Implementation of
    - Sub queries
    - Views
8. Study & Implementation of different types of constraints.
9. Study & Implementation of Database Backup & Recovery commands.
10. Study & Implementation of Rollback, Commit, Save point.
    - Creating Database /Table Space
    - Managing Users: Create User, Delete User
    - Managing roles:-Grant, Revoke.
11. Study & Implementation of PL/SQL.
12. Study & Implementation of SQL Triggers.

12. Brief Description of self-learning / E-learning component

https://www.nitt.edu/home/academics/departments/cse/programmes/mtech/curriculum/semester_2/advanced_dbms_laboratory/

Medical Image Processing Lab

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**Medical Image Processing Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core (√)**	**PE( )**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 24**			

8. Course Description: A study of methods for enhancing, analyzing, interpreting and visualizing information from two- and three-dimensional data obtained from a variety of medical imaging modalities.

9. Learning objectives:

1. To define the principles of image sampling, quantization, enhancement and filtering techniques
2. To discover the different image compression methods and morphological based processes and machine learning techniques for image segmentation
3. To develop the methods of image registration and visualization for medical applications
4. To acquire the student with the techniques of shape analysis and image classification using neural networks for brain computer interface and computer aided diagnosis

10. Course Outcomes (COs):

The students will be able to: -

1. Comprehend image sampling and DFT
2. Process the given medical images to enhance them
3. Apply compression techniques and morphological operations for segmentation
4. Predict a machine learning algorithm on the given image for segmentation
5. Register images of different modalities, render their volumes for visualization
6. Use neural networks for image classification
7. Design and develop algorithms to process and visualize images from different modalities
8. Develop algorithms to process and visualize images from different modalities for diagnostic application

11. List of Experiments

1. Using spatial filters enhance the given noisy image. Compare the performance of various filters.
2. Design suitable filters in frequency domain for noise removal from the given image
3. Using region growing algorithm segment the gray matter, white matter and CSF from the given MR brain image
4. Extract the features of interest from the given CT abdomen images and classify
5. Read the given PET and CT image and register them

Semester 2nd

Advance Software Engineering & Testing

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**Advanced Software Engineering & Testing**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (√)**	**PE()**		**OE ()**	
5. Pre-requisite (if any)	Computer Fundamental	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course aims to equip students to develop techniques of software-intensive systems through successful requirements engineering, design, testing, maintenance and evolution, and project and quality management. Students build on their basic software engineering knowledge by extending it with specific techniques for maintenance, evolution, dependability, reliability, safety, security, and resilience.

9. Learning objectives:

1. To Know the Basics of Software Architecture
2. To Understand various phases of Software Development Cycle
3. Sufficient programming skills for the team development project.
4. Appreciate the fundamentals of software testing and its application through the software life cycle.

10. Course Outcomes (COs):

1. Develop skills in designing and executing software tests suitable for different stages in the software life cycle.
2. Understand and appreciate the role of software testing in systems development, deployment and maintenance.
3. Develop a continuing interest in software testing, and obtain satisfaction from its study and practice.
4. Appreciate the responsibilities of software testers within software projects, the profession and the wider community.

11. Unit wise detailed content

Unit-1	**Number of lectures = 09**	

Introduction: Programs vs. software products, emergence of software engineering, software life cycle, models. Software project management: Project management concepts, software process, Project planning, COCOMO Model A Heuristic estimation techniques, staffing level estimation, team structures, staffing, risk analysis and management. Requirement Analysis and specification: Requirements engineering, partitioning Software, prototyping

Unit – 2	**Number of lectures = 08**	

Data Modeling, Functional Modeling and information flow: Data flow diagrams, data flow model, control flow model, the control and process specification, The data dictionary, Other classical analysis methods. System Design design principles, Functional independence, Cohesion, Coupling, Design documentation.

Unit – 3	**Number of lectures = 09**	

Testing and maintenance: Software Testing Techniques, Software testing Fundamentals, Verification Testing: Verification Methods, SRS Verification, User Documentation Verification, Functional Testing: Boundary Value Analysis, Equivalence Class Testing, Structural Testing: Identification of Independent Paths: Control Flow Graph. Use Case Testing: Use Case Diagrams and Use Cases. Prioritization of test cases for Regression Testing: Regression Testing, Regression Test Case Selection, Prioritization guidelines.

Unit – 4	**Number of lectures = 10**	

Testing Activities: Unit Testing, Levels of Testing, Integration Testing, System Testing, Metrics and Models in Software Testing: What are Software Metrics, categories of Metrics, object Oriented Metrics used in testing, What should we measure during testing? Prediction Model: Reliability Modes, Fault Prediction Model.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

13. Books Recommended

Text Books

1. Software Engineering - A Practitioner‟s Approach, Roger S. Pressman, MGH Publications, New Delhi, Eighth edition, 2019.
2. Effective Methods for Software Testing, William Perry, John Wiley & Sons, New York, Van Nostrand Reinhold, New York, 2nd Ed., 2006.

Reference Books

1. An Integrated Approach to Software Engineering by Pankaj Jalote, Narosa Publications, New Delhi, 2010.
2. Fundamentals of Software Engineering, Rajib Mall, PHI Learning; Fifth edition, 2019.
3. Software Testing ACraftsman‟s approach, Paul C. Jorgenson, CRC Press.
4. Testing Computer Software, CemKaner, Jack Falk, Nguyen Quoc, Van Nostrand Reinhold, New York, 2nd Ed.

Advanced Software Engineering & Testing Lab

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Advanced Software Engineering & Testing Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core (√)</td><td>PE()</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 24</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">9. Learning objectives:
1. Analyze the requirements for the given problem statement.
2. Design and implement various solutions for the given problem.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">1. Create appropriate document for the software artifact.</td></tr>
<tr><td colspan="8">2. Construct control flow graphs for the solution that is implemented.</td></tr>
<tr><td colspan="8">11. List of Experiments</td></tr>
<tr><td colspan="8">1. Write down the problem statement for a suggested system of relevance.
2. Do requirement analysis and develop Software Requirement Specification Sheet (SRS) for suggested system.
3. To perform the function oriented diagram: Data Flow Diagram (DFD) and Structured chart.
4. To perform the user‘s view analysis for the suggested system: Use case diagram.
5. To draw the structural view diagram for the system: Class diagram, object diagram.
6. To perform various testing using the testing tool unit testing, integration testing for a sample code of the suggested system.
7. Take any system (e.g. ATM system) and study its system specifications and report the various bugs.
8. Write the test cases for any known application(e.g. Banking application)
9. Create a test plan document for any application (e.g. Library Management System)
10. Study of any testing tool (e.g.Winrunner)
11. Study of any web testing tool (e.g. Selenium)
12. Study of any bug tracking tool (e.g. Bugzilla, bugbit)
13. Study of any test management tool (e.g. Test Director)
14. Study of any open source-testing tool (e.g. Test Link)</td></tr>
<tr><td colspan="8">12. Brief Description of self-learning / E-learning component

https://elearning.sgtuniversity.ac.in/course-category/</td></tr>
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Software Project Management

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**Software Project Management**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (√)**	**PE()**		**OE ()**	
5. Pre-requisite (if any)	Programming Language, Software Engg.	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course covers the concept of software management and its different phases.

9. Learning objectives:

1. Identify the different project contexts and suggest an appropriate management strategy.
2. Practice the role of professional ethics in successful software development.
3. Identify and describe the key phases of project management.
4. Determine an appropriate project management approach through an evaluation of the business context and scope of the project.

10. Course Outcomes (COs):

1. Understand the fundamental principles of Software Project management & will also have a good knowledge of responsibilities of project manager and how to handle these.
2. Be familiar with the different methods and techniques used for project management.
3. Will also be able to understand why majority of the software projects fails and how that failure probability can be reduced effectively.
4. Will be able to do the to do the Project Scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques Project Scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques.

11. Unit wise detailed content

Unit-1	**Number of lectures = 09**	**PROJECT CONCEPTS AND ITS MANAGEMENT**

Project life cycle models-ISO 9001 model-Capability Maturity Model-Project Planning-Project tracking-Project closure. Evolution of Software Economics – Software Management Process Framework: Phases, Artifacts, Workflows, Checkpoints – Software Management Disciplines: Planning / Project Organization and Responsibilities / Automation / Project Control – Modern Project Profiles

Unit – 2	**Number of lectures = 09**	**COST ESTIMATION**

Problems in Software Estimation – Algorithmic Cost Estimation Process, Function Points, SLIM (Software Life cycle Management), COCOMO II (Constructive Cost Model) – Estimating Web

Application Development – Concepts of Finance, Activity Based Costing and Economic Value Added (EVA) – Balanced Score Card.

Unit – 3	**Number of lectures = 09**	**SOFTWARE QUALITY MANAGEMENT**

Software Quality Factors – Software Quality Components – Software Quality Plan – Software Quality Metrics – Software Quality Costs – Software Quality Assurance Standard – Certification – Assessment.

Software Configuration Management – Risk Management: Risk Assessment: Identification / Analysis / Prioritization. Risk Control: Planning / Resolution / Monitoring.

Software Metrics – Classification of Software Metrics: Product Metrics: Size Metrics, Complexity Metrics, Halstead's Product Metrics, Quality Metrics, and Process metrics

Unit – 4	**Number of lectures = 09**	**PROJECT EVALUATION AND EMERGING TRENDS**

Strategic Assessment–Technical Assessment–Cost Benefit Analysis–Cash Flow Forecasting–Cost Benefit Evaluation Technique–Risk Evaluation–Software Effort Estimation. Emerging Trends: Import of the internet on project Management – people Focused Process Models.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

13. Books Recommended

Text Books

1. Bob hughes and Mike Cotterell, "Software Project Management" second edition,1999.
2. Royce, W. "Software Project Management: A Unified Framework", AddisonWesley, 1998.

Reference Books

1. Ramesh Gopalaswamy , "Managing and global Software Projects", Tata McGraw Hill Tenth Reprint, 2011.
2. Fenton, N.E., and Pfleeger, S.L.. "Software Metrics: A Rigorous and Practical Approach, Revised" Brooks Cole, 1998.
3. Kaplan, R.S., Norton, D.P. "The Balanced Scorecard: Translating Strategy into Action", Harvard Business School Press, 1996.
4. Boehm, B. W. "Software Risk Management: Principles and Practices" in IEEE Software, January 1991, pp32-41.
5. Roger S.Pressman, "Software Engineering- A Practitioner's Approach", 7th Edition ,McGraw Hill, 2010.

Data Mining

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**Data Mining**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (√)**	**PE()**		**OE ()**	
5. Pre-requisite (if any)	Database concepts	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

The purpose of this course is to provide basic concepts of data mining and its applications.

Learning objectives:

1. To study the methodology of engineering legacy databases for data mining to derive business rules for decision support systems.
2. To analyze the data, identify the problems, and choose the relevant models and algorithms to apply.

9. Course Outcomes (COs):

1. Enable students to understand and implement classical algorithms in data mining
2. Students will be able to assess the strengths and weaknesses of the algorithms, identify the application area of algorithms, and apply them.
3. Students would learn data mining techniques as well as methods in integrating and interpreting the data sets and improving effectiveness, efficiency and quality for data analysis.

10. Unit wise detailed content

Unit-1	**Number of lectures = 09**	**Introduction to Data Mining**

Introduction: Basic concepts of Data Mining, Related technologies (Machine Learning, DBMS, OLAP, Statistics),Data Mining Goals, Stages of the Data Mining Process, Data Mining Tasks ,Knowledge Representation Methods, Applications of Data Mining, Major Challenges and Issues in Data Mining Data pre-processing: Data cleaning, Data transformation, Data reduction, Discretization

Unit – 2	**Number of lectures = 09**	**Association Rule Mining**

Association Rule Mining: Introduction and Basic Concepts, Motivation and terminology, Examples of Association rule mining, Basic Algorithms, Parallel and Distributed Algorithms, Comparing Approaches, Incremental Rules, Advanced Association Rule Techniques, Measuring the Quality of Rules

Classifications and Prediction: Basic Concepts, Decision Tree induction, Bayes Classification Methods, Rule Based Classification, Model Evaluation and Selection, Techniques to Improve

Classification Accuracy		
Unit – 3	**Number of lectures = 09**	**Cluster Analysis**
Cluster Analysis: Basic concepts and Methods, Cluster Analysis, Partitioning methods, Hierarchical methods, Density based Methods, Grid Based Methods, Evaluation of Clustering Advanced Cluster Analysis: Probabilistic model based clustering, Clustering High, Dimensional Data, Clustering Graph and Network Data, Clustering with Constraints Outlier Analysis: Basic concepts of Outlier analysis, Types of Outliers, Challenges of Outlier Detection, Outlier Detection Methods, Statistical approaches, Proximity-Based Approaches,		
Unit – 4	**Number of lectures = 09**	**Text mining:**
Text mining: Basic Concepts, Extracting attributes (Keywords), structural approaches (parsing, soft parsing) ,Web Mining: Introduction, Classifying web pages, extracting knowledge from the web ,Overview of Data Mining Software and Applications: Case Study: WEKA		
11. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://elearning.sgtuniversity.ac.in/course-category/		
12. Books Recommended		
Text Books 1. Jiawei Han, Micheline Kamber, Jain Pei, "Data Mining: Concepts and Techniques",Third Edition (The Morgan Kaufmann Series in Data Management System), 2012		
Reference Books		
1. David J. Hand, HeikkiMannila and Padhraic Smyth "Principles of Data Mining"(Adaptive Computation and Machine learing), 2005 2. Margaret H Dunham, "Data Mining: Introductory and Advanced Topics", 2003iv. Soman, K.P., Diwakar Shyam and Ajay V. "Insight into Data Mining: Theory and Practices", PHI, 2009.		

Data Mining Lab

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Data Mining Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core (√)</td><td>PE( )</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td>6. Frequency (use tick marks)</td><td>Even (√)
Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 24</td></tr>
<tr><td colspan="8">8. Course Description: The purpose of this course is to provide basic concepts of data mining and its applications.</td></tr>
<tr><td colspan="8">9. Learning objectives:
1. To study the methodology of engineering legacy databases for data mining to derive business rules for decision support systems.
2. To analyze the data, identify the problems, and choose the relevant models and algorithms to apply.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):
The students will be able to: -
1. Enable students to understand and implement classical algorithms in data mining
2. Students will be able to assess the strengths and weaknesses of the algorithms, identify the application area of algorithms, and apply them.
3. Students would learn data mining techniques as well as methods in integrating and interpreting the data sets and improving effectiveness, efficiency and quality for data analysis.</td></tr>
<tr><td colspan="8">3. List of Experiments</td></tr>
<tr><td colspan="8">1. Introduction to exploratory data analysis
2. Demonstrate the Descriptive Statistics for a sample data like mean, median, variance and correlation etc.
3. Demonstrate Missing value analysis and different plots using sample data.
4. Demonstration of apriori algorithm on various data sets with varying confidence (%) and support (%).
5. Demo on Classification Techniques using sample data Decision Tree, ID3 or CART.
6. Demonstration of Clustering Techniques K-Mean and Hierarchical.
7. Simulation of Page Rank Algorithm and Demonstration on Hubs and Authorities.
8. Demo on Classification Technique using KNN.
9. Demonstration on Document Similarity Techniques and measurements.
10. Design and develop a recommendation engine for the given application.</td></tr>
</table>

Semester 3rd

Distributed Computing

1. Name of the Department- Computer Science & Engineering						
2. Subject Name	**Distributed Computing**	**L**	**T**		**P**	
3.Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (√)**	**PE()**		**OE()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical						
Lectures = 36		**Tutorials =0**	**Practical =0**			

8. Course Description: The course introduces the main principles underlying distributed systems: processes, communication, naming, synchronization, consistency, fault tolerance, and security. Students will be familiar with some of the main paradigms in distributed systems: object-based systems, file systems, web-based and coordination-based systems. On the completion of the unit, students will understand the fundamentals of distributed computing and be able to design and develop distributed systems and applications.

9. Course objectives: The students will learn and understand

1. To provide students with contemporary knowledge in distributed systems
2. To equip students with skills to analyze and design distributed applications.
3. To provide master skills to measure the performance of distributed synchronization algorithms

10. Course Outcomes (COs): On completion of this course, the students will be able to

1. Demonstrate knowledge of the basic elements and concepts related to distributed system technologies;
2. Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.
3. Analyze the various techniques used for clock synchronization and mutual exclusion
4. Demonstrate the concepts of Resource and Process management and synchronization algorithms
5. Demonstrate the concepts of Consistency and Replication Management
6. Apply the knowledge of Distributed File System to analyze various file systems like NFS, AFS and the experience in building large-scale distributed applications.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Introduction to Distributed Systems**

Characterization of Distributed Systems: Issues, Goals, and Types of distributed systems, Distributed System Models, Hardware concepts, Software Concept.
Middleware: Models of Middleware, Services offered by middleware, Client Server model.

Unit – 2	**Number of lectures = 9**	**Communication**

Layered Protocols, Interprocess communication (IPC): MPI, Remote Procedure Call (RPC), Remote Object Invocation, Remote Method Invocation (RMI).
Message Oriented Communication, Stream Oriented Communication, Group Communication.

Unit – 3	**Number of lectures = 9**	**Synchronization**

Clock Synchronization, Logical Clocks, Election Algorithms, Mutual Exclusion, Distributed Mutual Exclusion-Classification of mutual Exclusion Algorithm, Requirements of Mutual Exclusion Algorithms, Performance measure.
Non Token based Algorithms: Lamport Algorithm, Ricart–Agrawala‘s Algorithm, Maekawa‘s Algorithm.
Token Based Algorithms: Suzuki-Kasami‘sBroardcast Algorithms, Singhal‘s Heurastic Algorithm, Raymond‘s Tree based Algorithm, Comparative Performance Analysis

Unit – 4	**Number of lectures = 9**	**Resource and Process Management**

Desirable Features of global Scheduling algorithm, Task assignment approach, Load balancing approach, load sharing approach.
Introduction to process management, process migration, Threads, University of Mumbai, B. E. (Computer Engineering), Rev. 2016 114 Virtualization, Clients, Servers, Code Migration.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal.

13. Books Recommended

Text Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, ―Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education.
2. George Coulouris, Jean Dollimore, Tim Kindberg, , "Distributed Systems: Concepts and Design", 4th Edition, Pearson Education, 2005.

Reference Books:

1. A. S. Tanenbaum and M. V. Steen, "Distributed Systems: Principles and Paradigms", Second Edition, Prentice Hall, 2006.
2. M. L. Liu, ―Distributed Computing Principles and Applications‖, Pearson Addison Wesley, 2004

AI & Soft Computing

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td>2. Subject Name</td><td colspan="2">AI & Soft Computing</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td>3.Course Code</td><td colspan="2"></td><td colspan="2">3</td><td colspan="2">0</td><td>0</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td colspan="2">Core (√)</td><td colspan="2">PE()</td><td>OE()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td colspan="2"></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical</td></tr>
<tr><td colspan="3">Lectures = 36</td><td colspan="2">Tutorials =0</td><td colspan="3">Practical =0</td></tr>
<tr><td colspan="8">8. Course Description: This course enables learning on different graph traversal techniques (BFS & DFS)
along with enhanced search algorithms like A* algorithm. Genetic algorithms are discussed along with Min-Max algorithms.

Expert systems also discussed in detail along with Fuzzy logic in SC.</td></tr>
<tr><td colspan="8">9. Course objectives: The students will learn and understand
1. To conceptualize the basic ideas and techniques of AI and SC.
2. To distinguish various search techniques and to make student understand knowledge representation and planning.
3. To become familiar with basics of Neural Networks and Fuzzy Logic.
4. To familiarize with Hybrid systems and to build expert system.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On completion of this course, the students will be able to
1. Identify the various characteristics of Artificial Intelligence and Soft Computing techniques.
2. Choose an appropriate problem solving method for an agent to find a sequence of actions to reach the goal state.
3. Analyze the strength and weakness of AI approaches to knowledge representation, reasoning and planning.
4. Construct supervised and unsupervised ANN for real world applications.
5. Design fuzzy controller system. 6 Apply Hybrid approach for expert system design.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td colspan="3">Number of lectures = 9</td><td colspan="4">Introduction to Artificial Intelligence(AI) and Soft Computing</td></tr>
<tr><td colspan="8">Intelligent Agents : Agents and Environments ,Rationality, Nature of Environment, Structure of Agent, types of Agent
Soft Computing: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques.</td></tr>
<tr><td>Unit – 2</td><td colspan="3">Number of lectures = 9</td><td colspan="4">Problem Solving</td></tr>
<tr><td colspan="8">Problem Solving Agent, Formulating Problems, Example Problems
Uninformed Search Methods: Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Method: A* Search
Optimization Problems: Hill climbing Search, Simulated annealing, Genetic algorithm</td></tr>
<tr><td>Unit – 3</td><td colspan="3">Number of lectures = 9</td><td colspan="4">Knowledge, Reasoning and Planning</td></tr>
<tr><td colspan="8">Knowledge based agents, First order logic: syntax and Semantic, Knowledge Engineering in FOL
Inference in FOL : Unification, Forward Chaining, Backward Chaining and Resolution.
Planning Agent, Types of Planning: Partial Order, Hierarchical Order, Conditional Order.</td></tr>
<tr><td>Unit – 4</td><td colspan="3">Number of lectures = 9</td><td colspan="4">Fuzzy Logic & Expert System</td></tr>
</table>

Introduction to Fuzzy Set: Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, membership functions, Fuzzy Logic: Fuzzy Logic basics, Fuzzy Rules and Fuzzy Reasoning.
Fuzzy inference systems: Fuzzification of input variables, Defuzzification and fuzzy controllers.
Expert system : Introduction, Characteristics, Architecture, Stages in the development of expert system

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal.

13. Books Recommended

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education.
2. Samir Roy and Chakraborty, —Introduction to soft computing‖, Pearson Edition.
3. S.N.Sivanandam, S.N.Deepa "Principles of Soft Computing" Second Edition, Wiley Publication.
4. S.Rajasekaran and G.A.VijayalakshmiPai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning.
5. N.P.Padhy, —Artificial Intelligence and Intelligent Systems‖, Oxford University Press.

Reference Books:

1. Elaine Rich and Kevin Knight —Artificial Intelligence‖ Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
2. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
3. Zimmermann H.S "Fuzzy Set Theory and its Applications"Kluwer Academic Publishers.
4. Hagan, Demuth, Beale,"Neural Network Design" CENGAGE Learning, India Edition.
5. J.-S.R.Jang "Neuro-Fuzzy and Soft Computing" PHI 2003.
6. JacekM.Zurada "Introduction to Artificial Neural Sytems" Jaico Publishing House.

1. Name of the Department- Computer Science & Engineering						
1. Department		**Computer science & Engineering**				
2. Course Name	**Distributed Computing Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even	Odd (✓)	Either Sem()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 24**			

Course Description:

The course introduces the main principles underlying distributed systems: processes, communication, naming, synchronization, consistency, fault tolerance, and security. Students will be familiar with some of the main paradigms in distributed systems: object-based systems, file systems, web-based and coordination-based systems. On the completion of the unit, students will understand the fundamentals of distributed computing and be able to design and develop distributed systems and applications.

9. Learning objectives:

1. To provide students with contemporary knowledge in distributed systems
2. To equip students with skills to analyze and design distributed applications.
3. To provide master skills to measure the performance of distributed synchronization algorithms.

10. Course Outcomes (COs):

1. Demonstrate knowledge of the basic elements and concepts related to distributed system technologies;
2. Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object based middleware.
3. Analyze the various techniques used for clock synchronization and mutual exclusion
4. Demonstrate the concepts of Resource and Process management and synchronization algorithms
5. Demonstrate the concepts of Consistency and Replication Management
6. Apply the knowledge of Distributed File System to analyze various file systems like NFS, AFS and the experience in building large-scale distributed applications.

11. List of Experiment

1. Client/server using RPC/RMI.
2. Implementation of multi tread application
3. Inter-process communication
4. Group Communication
5. Load Balancing Algorithm.
6. Name Resolution protocol.
7. Election Algorithm.
8. Clock Synchronization algorithms.
9. Mutual Exclusion Algorithm.
10. Deadlock management in Distributed systems
11. Distributed File System
12. CORBA

AI & Soft Computing Lab

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**AI & Soft Computing Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even	Odd (✓)	Either Sem()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 24**			

Course Description:

This course enables learning on different graph traversal techniques (BFS & DFS) along with enhanced search algorithms like A* algorithm. Genetic algorithms are discussed along with Min-Max algorithms.

Expert systems also discussed in detail along with Fuzzy logic in SC.

8. Learning objectives:

1. To conceptualize the basic ideas and techniques of AI and SC.
2. To distinguish various search techniques and to make student understand knowledge representation and planning.
3. To become familiar with basics of Neural Networks and Fuzzy Logic.
4. To familiarize with Hybrid systems and to build expert system.

9. Course Outcomes (COs):

1. To realize the basic techniques to build intelligent systems
2. To create knowledge base and apply appropriate search techniques used in problem solving.
3. Apply the supervised/unsupervised learning algorithm.
4. Design fuzzy controller system.

10. List of Experiment

1. Identify the problem PEAS Description• Problem formulation•
2. Introduce AI programming Language
3. Start Implementation Knowledge Representation and Create• Knowledge Base
4. Implement search algorithms to reach goal state
5. To implement Mc-Culloch Pitts Model for a problem
6. To implement Fuzzy Controller system
7. To implement Basic Supervised / Unsupervised Neural Network learning rules for a problem
8. Case study on Hybrid Systems
9. Case study of an Application

MACHINE LEARNING

1. Name of the Department- Computer Science Engineering						
2. Course Name	**Machine Learning**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

Machine Learning is a method of data analysis that automates analytical model building. Machine Learning is one of the fastest growing fields in the sector of Computer Science Engineering and Information Technology. Nowadays, every student wants to enhance their Machine Learning Course skills, which is proving to be hugely beneficial in increasing the chances of their placements.

9. Learning Objectives:

- Acquire theoretical Knowledge on setting hypothesis for pattern recognition
- Apply suitable machine learning techniques for data handling and to gain knowledge from it.
- Evaluate the performance of algorithms and to provide solution for various real-world applications

10. Course Outcomes (COs):

- Recognize the characteristics of Machine Learning techniques that enable to solve real world problems.
- Recognize the characteristics of machine learning strategies.
- Apply various supervised learning methods to appropriate problems.
- Identify and integrate more than one techniques to enhance the performance of learning.
- Create probabilistic and unsupervised learning models for handling unknown pattern.
- Analyze the co-occurrence of data to find interesting frequent patterns.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	

Introduction To Machine Learning

Introduction, Examples of Various Learning Paradigms, Perspectives and Issues, Version Spaces, Finite and Infinite Hypothesis Spaces, PAC Learning, VC Dimension. Supervised Learning: Decision Trees: ID3, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Neural Networks: Introduction, Perceptron, Multilayer Perceptron, Support vector machines: Linear and Non-Linear, Kernel Functions, K-Nearest Neighbours.

Unit – 2	**Number of lectures = 9**	

Ensemble Learning

Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking. Unsupervised Learning: Introduction to Clustering, Hierarchical: AGNES, DIANA, Partitional: K-means clustering, K-Mode Clustering, Expectation Maximization, Gaussian Mixture Models.

Unit – 3	Number of lectures = 9	

Probabilistic Learning
Bayesian Learning, Bayes Optimal Classifier, Naıve Bayes Classifier, Bayesian Belief Networks. Learning Association Rules: Mining Frequent Patterns -basic concepts –Apriori algorithm, FP-Growth algorithm, Association-based Decision Trees.

Unit – 4	Number of lectures = 9	

Machine Learning in Practice
Design, Analysis and Evaluation of Machine Learning Experiments, Other Issues: Handling imbalanced data sets, Recent Trends in Big Data Analytics.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.
The link to the E-Learning portal.
https://elearning.sgtuniversity.ac.in/course-category/

13. Books Recommended

Text Books

- Ethem Alpaydin,"IntroductiontoMachineLearning",MITPress, Prentice Hall of India, Third Edition2014.
- Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press,2012.
- Tom Mitchell, "Machine Learning", McGraw Hill, 3rdEdition,1997.

14. Reference Books

- CharuC.Aggarwal,"DataClassificationAlgorithmsandApplications",CRCPress,2014.
- Charu C. Aggarwal, "DATA CLUSTERING Algorithms and Applications", CRC Press, 2014.
- Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
- Jiawei Hanand Micheline Kambers andJianPei,"DataMining Concepts andTechniques",3rd edition, Morgan Kaufman Publications, 2012.

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Machine Learning Lab	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core (√)**	**PE( )**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 24**			

8. Course Description

Learning objectives:

- Apply suitable machine learning techniques for data handling and to gain knowledge from it.
- Evaluate the performance of algorithms and to provide solution for various real-world applications

9. Course Outcomes (COs):

- Recognize the characteristics of Machine Learning techniques that enable to solve real world problems.
- Recognize the characteristics of machine learning strategies.
- Apply various supervised learning methods to appropriate problems.
- Develop skills to present scientific findings in the form of figures, data summaries, formal scientific writing, and oral presentations.

10. List of Experiments

1.Implement Decision Tree learning
2.Implement Logistic Regression
3.Implement classification using Multilayer perceptron
4.Implement classification using SVM
5.Implement Adaboost
6.Implement Bagging using Random Forests
7.Implement K-means Clustering to Find Natural Patterns in Data
8.Implement Hierarchical clustering
9.Implement K-mode clustering
10. Implement Association Rule Mining using FP Growth
11.Classification based on association rules
12.Implement Gaussian Mixture Model Using the Expectation Maximization
13.Evaluating ML algorithm with balanced and unbalanced datasets
14.Comparison of Machine Learning algorithms
15.Implement k-nearest neighbours algorithm

11. Brief Description of self-learning / E-learning component

Streaming Data Analytics

1. Name of the Department- Computer Science Engineering						
2. Course Name	**Streaming data analytics**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

Process data in real-time by building fluency in modern data engineering tools, such as Apache Spark, Kafka, Spark Streaming, and Kafka Streaming. The components of data streaming systems and build a real-time analytics application. Students will compile data and run analytics, as well as draw insights from reports generated by the streaming console.

9. Learning Objectives:

- It introduces theoretical foundations, algorithms, methodologies, and Applications of streaming data and also provide practical knowledge for handling and analyzing streaming data.

10. Course Outcomes (COs):

- Recognize the characteristics of data streams that make it useful to solve real-world problems.
- Identify and apply appropriate algorithms for analyzing the data streams for variety of problems.
- Implement different algorithms for analyzing the data streams.
- Identify the metrics and procedures to evaluate a model.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	

Introduction

Characteristics of the data streams, Challenges in mining data streams Requirements and principles for real time processing, Concept drift Incremental learning. Data Streams: Basic Streaming Methods, Counting the Number of Occurrence of the Elements in a Stream, Counting the Number of Distinct Values in a Stream, Bounds of Random Variables, Poisson Processes, Maintaining Simple Statistics from Data Streams, Sliding Windows, Data Synopsis, Change Detection: Tracking Drifting Concepts, Monitoring the Learning Process.

Unit – 2	**Number of lectures = 9**	

Decision Trees

The Very Fast Decision Tree Algorithm (VFDT), The Base Algorithm, Analysis of the VFDT Algorithm, Extensions to the Basic Algorithm: Processing Continuous Attributes, Functional Tree Leaves, Concept Drift. Clustering from Data Streams: Clustering Examples: Basic Concepts, Partitioning Clustering -The Leader Algorithm, Single Pass k-Means, Micro Clustering, Clustering Variables: A Hierarchical Approach.

Unit – 3	Number of lectures = 9	

Frequent Pattern Mining
Mining Frequent Item sets from Data Streams-Landmark Windows, Mining Recent Frequent Item sets, Frequent Item sets at Multiple Time Granularities Sequence Pattern Mining-Reservoir Sampling for Sequential Pattern Mining over data streams, Evaluating Streaming Algorithms: Evaluation Issues, Design of Evaluation Experiments, Evaluation Metrics, Error Estimators using a Single Algorithm and a Single Dataset, Comparative Assessment, The 0-1 loss function, Evaluation Methodology in Non-Stationary Environments, The Page-Hinkley Algorithm.

Unit – 4	Number of lectures = 9	

Complex Event Processing
Introduction to Complex Event Processing, Features of CEP, Need for CEP, CEP Architectural Layers, Scaling CEP, Events, Timing and Causality, Event Patterns, Rules and Constraint, STRAW-EPL, Complex Events and Event Hierarchies.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.
The link to the E-Learning portal.
https://elearning.sgtuniversity.ac.in/course-category/

13. Books Recommended

Text Books

- Joao Gama, "Knowledge Discovery from Data Streams", CRC Press,2010.
- David Luckham, "The Power of Events: An Introduction to Complex Event Processing in Distributed Enterprise Systems", Addison Wesley,2002.

14. Reference Books

- Charu C. Aggarwal, "Data Streams: Models And Algorithms", Kluwer Academic Publishers,2007.

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Streaming Data Analytics Lab	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core (√)**	**PE( )**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 24**			

8. Course Description

Learning objectives:

- It introduces theoretical foundations, algorithms, methodologies, and Applications of streaming data and also provide practical knowledge for handling and analysing streaming data.

9. Course Outcomes (COs):

- Identify and apply appropriate algorithms for analyzing the data streams for variety of problems.
- Implement different algorithms for analyzing the data streams.
- Identify the metrics and procedures to evaluate a model.

10. List of Experiments

1. Exploring one stream processing engine like storm or STREAM etc.
2. Implementation of algorithms for example: VFDT, CVFDT.
3. Implementation of Clustering
4. Implementation of Frequent pattern mining
5. Exploring one CEP engine like ESPER or DROOLS.
6. Exercise with continuous queries Logical operations on single stream
7. Exercise with continuous queries Logical operations on multiple streams
8. Exercise with continuous queries temporal operators on single stream
9. Exercise with continuous queries temporal operators on multiple streams
10. Exercise with complex continuous queries with logical, relational & temporal operators on multiple streams

11. Brief Description of self-learning / E-learning component

Domain Specific Predictive Analytics

1. Name of the Department- Computer Science Engineering						
2. Course Name	**Domain specific predictive analysis**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE()**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

Performing prediction on every domain belonging to industry/firm is measured as effective management. This prediction helps the firm effectively manage human power and other resources, which leads to good productivity. In this chapter, the authors discuss applications where predictive analytics are applied. The applications are as follows: evaluation of customer lifetime value used in retail industry, customer churn management in the telecommunication sector, credit scoring in banking, sentiment analysis on product reviews to understand the customer opinion, clinical decision support systems, news analytics, and social media analytics.

9. Learning Objectives:

- It introduces theoretical foundations, algorithms, methodologies for analyzing data in various domains such Retail, Finance, Risk and Healthcare

10. Course Outcomes (COs):

- Recognize challenges in dealing with data sets in domains such as finance, risk and healthcare.
- Identify real-world applications of machine learning in domains such as finance, risk and healthcare.
- Identify and apply appropriate algorithms for analyzing the data for variety of problems in finance, risk and healthcare.
- Make choices for a model for new machine learning tasks based on reasoned argument

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	

Retail Analytics
Understanding Customer: Profiling and Segmentation, Modelling Churn. Modelling Lifetime Value, Modelling Risk, Market Basket Analysis, Risk Analytics: Risk Management and Operational Hedging: An Overview, Supply Chain Risk Management, A Bayesian Framework for Supply Chain Risk Management, Credit Scoring and Bankruptcy Prediction.

Unit – 2	**Number of lectures = 9**	

Financial Data Analytics
Financial News analytics: Framework, techniques, and metrics, News events impact market sentiment, Relating news analytics to stock returns. Financial Time Series Analytics: Financial Time Series and Their Characteristics, Common Financial Time Series models, Autoregressive models, Markov chain models, Time series models with leading indicators, Long term forecasting.

Unit – 3	Number of lectures = 9	
Introduction Healthcare Analytics An Introduction to Healthcare Data Analytics, Electronic Health Records, Privacy-Preserving Data Publishing Methods in Healthcare, Clinical Decision Support Systems		
Unit – 4	**Number of lectures = 9**	
Healthcare Data Analytics Natural Language Processing and Data Mining for Clinical Text: Core NLP Components, Information Extraction and Named Entity Recognition, Social Media Analytics for Healthcare: Tracking of Infectious Disease Outbreaks, Readmission risk Prediction , Genomic Data Analytics: Microarray Data, Microarray Data Analysis, Genomic Data Analysis for Personalized Medicine, Patient Survival Prediction from Gene Expression Data, Genome Sequence Analysis.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://elearning.sgtuniversity.ac.in/course-category/

13. Books Recommended

Text Books

- Chris Chapman, Elea McDonnell Feit"R for Marketing Research and Analytics", Springer,2015.
- Olivia Parr Rud “Data Mining Cookbook: Modeling Data for Marketing, Risk, and Customer Relationship Management”, Wiley,2001.
- Chandan K. Reddy, Charu C. Aggarwal "Healthcare Data Analytics", CRC Press,2015..

14. Reference Books

- Rene Carmona "Statistical Analysis of Financial Data in R", Springer,2014.
- James B. Ayers “Handbook Of Supply Chain Management” Auerbach Publications,2006.
- PanosKouvelis, Lingxiu Dong, OnurBoyabatli, RongLi "The Handbook of Integrated Risk Management in Global Supply Chains", Wiley,2012.

DEPARTMENT ELECTIVES				
Specialization	**IoT**	**Data Science**	**Cyber Security & Forensics**	**AIML**
DE-XIII	Microcontrollers for IoT Prototyping	Information Visualization	Cyber Attacks Detection and Prevention Systems	Soft Computing Techniques
DE-XIV	Wireless Sensor Networks and IoT	Web Intelligence and Big Data	Cryptosystem	Knowledge Engineering and Intelligent Systems
DE-XV	Signal Processing and Data Analytics	Bigdata Frameworks	Digital Forensics	Deep Learning and its Applications
DE-XVI	Micro Systems & Hybrid Technology	IoT and Cloud Computing	Mobile and Wireless Security	Bio-Inspired Computing
DE-XVII	Cloud and Fog Computing	NoSQL Databases	Malware Analysis	Machine Learning for Signal Processing

IoT

Microcontrollers for IoT Prototyping

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td>2. Course Name</td><td colspan="2">Microcontrollers for IoT Prototyping</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td colspan="2"></td><td>3</td><td>0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE(✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td colspan="2"></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 36</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">This course is aimed to Introduce low power microcontrollers and to develop the skill set of programming low power sensing applications.</td></tr>
<tr><td colspan="8">9. Learning Objectives:

1. Impart the knowledge of various peripheral related to sensing and communication using wired or wireless means.
2. Upgrade the students by introducing them Advanced ARM Cortex microcontrollers
3. Develop the skill set of students to build IoT systems and sensor interfacing.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">The students will be able to:-
1. Design and develop embedded programs for low power microcontrollers for sensor applications.
2. Develop ARM basic and advanced programs.
3. Interface and deploy analog and digital sensors
4. Develop communication system with sensor units
5. Design Develop IoT systems using Wi-Fi CC3200.
6. Program the single board computers to read sensor data and posting in cloud.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td colspan="2">Number of lectures = 9</td><td colspan="5">MSP430 microcontrollers</td></tr>
<tr><td colspan="8">Architecture of the MSP430, Memory, Addressing modes, Reflections on the CPU instruction set. Clock system, Exceptions: Interrupts and resets. Functions and subroutines, Mixing C and assembly language, Interrupts, Interrupt service routines, Issues associated with interrupts, Low power modes of operation.</td></tr>
<tr><td>Unit – 2</td><td colspan="2">Number of lectures = 9</td><td colspan="5">ARM Cortex MX microcontroller</td></tr>
<tr><td colspan="8">ARM Cortex M4: Assembly language basics, Thumb-2 Technology, ARM Instruction set, Cortex M4 architecture, advantages, peripherals, instruction set, floating point operations, Advanced Cortex MX Microcontroller, core, architecture, on-chip wi-fi.</td></tr>
</table>

Unit – 3	Number of lectures = 9	Display and Communication modules
GPIO, LCD display, graphical display, relays, Peripheral programming SPI, I2C, UART, Zigbee controller. **Sensors interfacing:** Sensors interfacing techniques- Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DTH11, single wire thermometer, Frequency counters.		
Unit – 4	**Number of lectures = 9**	**Microcontrollers for IoT**
ESP8266,NodeMCU,TI-CC3200,Access point and station point mode, HTTP, MQTT, transmission and receiving, Intel-Gallileo boards. **Single board computers**: Raspberry pi board, porting Raspbian, sensor interface examples, Python programming for cloud access, sensor systems using Arduino boards. **Cloud interfacing**: Interfacing and data logging with cloud: Thing speak, Things board, Blync platform.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Text Book(s)

1. John H. Davies, "MSP430 Microcontroller Basics", 2011, 2nd ed., Newnes publishing, New York.

2. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2014, 4th ed., Springer, New York.

Reference Book(s)

1. Sergey Y. Yurish,"Digital Sensors and Sensor Systems: Practical Design", 2011, 1st ed., IFSA publishing, New York.

2. Jonathan W Valvano, "Introduction to ARM Cortex –M3 Microcontrollers", 2012, 5th ed., Create Space publishing, New York.

3. Muhammad Ali Mazidi, Shujen Chen, SarmadNaimi, SepehrNaimi, "TI ARM Peripherals Programming and Interfacing: Using C Language", 2015, 2nd ed., Mazidi and Naimi publishing, New York.

Microcontrollers for IoT Prototyping Lab

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Microcontrollers for IoT Prototyping Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE(√)</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 24</td></tr>
<tr><td colspan="8">8. Course Description: This course is aimed to Introduce low power microcontrollers and to develop the skill set of programming low power sensing applications.</td></tr>
<tr><td colspan="8">9 Learning objectives:
1. Impart the knowledge of various peripheral related to sensing and communication using wired or wireless means.
2. Upgrade the students by introducing them Advanced ARM Cortex microcontrollers.
3. Develop the skill set of students to build IoT systems and sensor interfacing.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):
The students will be able to:-
1. Design and develop embedded programs for low power microcontrollers for sensor applications.
2. Develop ARM basic and advanced programs.
3. Interface and deploy analog and digital sensors
4. Develop communication system with sensor units
5. Design Develop IoT systems using Wi-Fi CC3200.
6. Program the single board computers to read sensor data and posting in cloud.</td></tr>
<tr><td colspan="8">11. List of Experiments</td></tr>
<tr><td colspan="8">• Working with MSP430 (CCStudio)
Sub Task 1: Port programming of MSP430 microcontrollers.
Sub Task 2: Analog to Digital Conversion using MSP430 microcontroller.
Sub Task 3: LCD display of characters and numbers.
Sub Task 4: Timer
• Working with ARM (Keil and energia)
Sub Task 1: Peripheral programming of ARM7 board.
Sub Task 2: PWM generation.
Sub Task 3:Configuring CC3200, wifi configuration ,HTTP and MQTT.
• Low power wireless transmission using Zigbee
Sub Task 1 : Interfacing Zigbee controller with MSP 430 microcontroller using SPI/UART.
Sub Task 2: Programming sleep and wake up mode of MSP 430
• IoT systems
Working with Raspberry pi using Python.
Arduino platform
Working with open source clouds.</td></tr>
</table>

Wireless Sensor Networks and IoT

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Wireless Sensor Networks and IoT</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td colspan="2">3</td><td colspan="2">0</td><td>0</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td colspan="2">Core ()</td><td colspan="2">PE(✓)</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="10">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 36</td><td colspan="3">Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="10">8. Course Description</td></tr>
<tr><td colspan="10">This course is aimed to to identify and expose the students to the central elements in the design of communication protocols for the WSNs.</td></tr>
<tr><td colspan="10">9. Learning Objectives:

1. To disseminate the design knowledge in analyzing the specific requirements for applications in WSNs regarding energy supply, memory, processing, and transmission capacity
2. To get the perception of mobile ad hoc networks, design, implementation issues, and solutions based on different algorithms and protocols for power management, sensor data routing and query processing.
3. To associate, hardware platforms and software frameworks used to realize dynamic Wireless sensor network</td></tr>
<tr><td colspan="10">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="10">The students will be able to:-
1. Assess the applicability and limitations of communication protocols for a real time WSN application.
2. Confirms the behavior of mobile ad hoc networks (MANETs)and correlates the infrastructure based networks.
3. Proactive in understating the routing protocols function and their implications on data transmission delay and bandwidth.
4. Able to establish networks with an attempt to reduce issue of broadcast and flooding techniques.
5. Contribute appropriate algorithms to improve existing or to develop new wireless sensor network applications.
6. Familiarize the protocol, design requirements, suitable algorithms, and the state-of-the-art cloud platform to meet the industrial requirement.
7. On a profound level to implement hardware & software for wireless sensor networks in day to day life</td></tr>
<tr><td colspan="10">11. Unit wise detailed content</td></tr>
<tr><td colspan="2">Unit-1</td><td colspan="2">Number of lectures = 9</td><td colspan="6">Network for embedded systems</td></tr>
<tr><td colspan="10">RS232, RS485, SPI, I2C, CAN, LIN, FLEXRAY.
Embedded wireless communication and Protocols: Bluetooth, Zigbee, Wifi, MiWi, Nrf24, Wireless LAN &PAN, UWB</td></tr>
<tr><td colspan="2">Unit – 2</td><td colspan="2">Number of lectures = 9</td><td colspan="6">Wireless sensor network (WSN) & WSN (Medium access control)</td></tr>
</table>

Characteristic and challenges, WSN vs Adhoc Networks, Sensor node architecture, Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations.
Fundamentals of MAC protocols - Low duty cycle protocols and wakeup concepts, Contention Based protocols, Schedule-based protocols - SMAC – BMAC, Traffic-adaptive medium access protocol (TRAMA), The IEEE 802.15.4 MAC protocol.

Unit – 3	**Number of lectures = 9**	Sensor Network Architecture

Data Dissemination, Flooding and Gossiping-Data gathering Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design Principles for WSNs- Gateway Concepts, Need for gateway, WSN and Internet Communication, WSN Tunneling

Unit – 4	**Number of lectures = 9**	IP based WSN & Tiny OS

Circuit switching, packet switching, concept of IPV4, IPV6, 6LOWPAN and IP, IP based WSN, 6LOWPAN based WSN.
Tiny OS:Tiny OS for WSN and IoT, M2M communication, Alljoyn network

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Text Book(s):

1. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks” 2011, 1 st ed., John Wiley & Sons, New Jersey.
2 Jun Zheng, Abbas Jamalipour, “Wireless Sensor Networks: A Networking Perspective”, 2014, 1 st ed., Wiley-IEEE Press, USA.

Reference Book(s)

1. Waltenegus W. Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", 2014, 1 st ed., John Wiley & Sons, New Jersey.
2 Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks", 2011, 1 st ed., John Wiley & Sons, New Jersey.
3 Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", 2009, 1 st ed., John Wiley & Sons, New Jersey.

Signal Processing and Data Analytics

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Signal Processing and Data Analytics	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
This course is aimed to identify and expose the students to the central elements in the design of communication protocols for the WSNs.						

9. Learning Objectives:

1. To introduce the concepts of discrete time signal processing and the characterization of random signals.
2. To present the basic theory of modeling the signals and the methods of estimating the unknowns using prediction filters
3. To provide a comprehensive understanding on applying FFT, DCT, and wavelet techniques for extracting the signal features.
4. To provide an overview of analysing big data using intelligent techniques and an in-depth introduction to two main areas of Machine Learning: supervised and unsupervised.

11. Course Outcomes (COs):

The students will be able to:-

1. Apply FFT, DCT wavelet techniques for extracting the features from the big data
2. Develop algorithms that can be used to analyse the real-world univariate and multivariate time series data. 3. Design an approach to leverage data using the steps in the machine learning process.
4. Understand and apply both supervised and unsupervised classification methods to detect and characterize patterns in real-world data.
5. Estimate the signal parameters and identify the model using ARMA models and prediction filters.
6. Understand the methods of visualization and analysis of big data.

12. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Discrete Random Signal Processing
Random Processes, Ensemble Average, Gaussian Process, Multi variate Gausssian Process, Stationary process, Autocorrelation, Auto Covariance, Ergodicity, White noise, Power Spectrum, Filtering of Random Process		
Unit – 2	**Number of lectures = 9**	Signal Modeling & Feature extraction
ARMA, AR, MA Models. Wiener filter, Linear prediction, Kalman Filter. Feature extraction: FFT, Power spectrum, DCT, filter banks, Wavelet, Wavelet Packets, Cepstrum		
Unit – 3	**Number of lectures = 9**	Time series analysis

Basic analysis, Univariate time series analysis, Multivariate time series analysis, non stationary time series.		
Unit – 4	**Number of lectures = 9**	Machine learning & Big Data Analytics
Machine learning: Supervised learning, generative algorithms, Support Vector machines, Unsupervised learning, K means clustering, Neural network (SOM, ART), Expectation maximization. Big Data Analytics: Introduction Big data analytics, visualization and data exploration, basic and intermediate analysis, linear and logistic regression, decision tree.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Text Book(s)

1. J. G. Proakis, DG. Manolakis and D. Sharma, “Digital signal processing principles, algorithms and applications”, 2012, 4th ed., Person education, USA

2. Sophocles J. Orfanidis, “Inroduction to signal Processing” 2010, 2nd ed., Prentice Hall, New Delhi India.

Reference Books

1. Oppenhiem V. A.V and Schaffer R. W, “Discrete- time signal Processing”, 2014, 3 rd ed., Prentice Hall,. New Delhi, India

2. Thomas A. Runkler, "Data Analytics: Models and Algorithms for Intelligent Data Analysis", 2016, 2 nd ed., Springer Verlag, UK

3. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective" 2012, 1 st ed., MIT Press, USA

Signal Processing and Data Analytics Lab

1. Name of the Department- Computer Science & Engineering							
2. Course Name	Signal Processing and Data Analytics Lab	**L**	**T**	**P**			
3. Course Code		**0**	**0**	**2**			
4. Type of Course (use tick mark)		**Core ()**	**PE(√)**	**OE ()**			
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 24**				

8. Course Description: This course is aimed to identify and expose the students to the central elements in the design of communication protocols for the WSNs.

9. Learning objectives:

1. To introduce the concepts of discrete time signal processing and the characterization of random signals.
2. To present the basic theory of modeling the signals and the methods of estimating the unknowns using prediction filters
3. To provide a comprehensive understanding on applying FFT, DCT, and wavelet techniques for extracting the signal features.
4. To provide an overview of analysing big data using intelligent techniques and an in-depth introduction to two main areas of Machine Learning: supervised and unsupervised.

9. Course Outcomes (COs):

The students will be able to:-

1. Apply FFT, DCT wavelet techniques for extracting the features from the big data
2. Develop algorithms that can be used to analyse the real-world univariate and multivariate time series data.
3. Design an approach to leverage data using the steps in the machine learning process.
4. Understand and apply both supervised and unsupervised classification methods to detect and characterize patterns in real-world data.
5. Estimate the signal parameters and identify the model using ARMA models and prediction filters.
6. Understand the methods of visualization and analysis of big data.

10. List of Experiments

1. Design and implementation of Wiener filter and Kalman filter.
2. Design and implementation of filter banks and wavelets for random process (speech, audio).
3. Design and implementation of Principal Component Analysis (PCA) and Single Value Decomposition (SVD). 4. Design an expert system for simple application (speech recognition, speaker recognition, face recognition). 5. Consider a real time data available in college campus and develop a data analytic system to determine the average, trend and prediction

Micro Systems & Hybrid Technology

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Micro Systems & Hybrid Technology	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

This course is aimed to introduce the fundamental concepts of MEMS based sensors and actuators.

9.Learning Objectives:

1. To acquaint the students with various materials and material properties for Microsystem designing.
2. To provide comprehensive understanding of various micromachining techniques and expose the students to design, simulation and analysis software.
3. Enhancing the basics of thick film and hybrid technologies for sensor development.

10. Course Outcomes (COs):

The students will be able to:-

1. Identify and understand the fundamental concepts and background of MEMS and Microsystems
2. Familiar with the basics of various sensors and actuators.
3. The students were acquainted with various materials for Microsystem designing.
4. Determine and compare the scaling effects in miniaturizing devices.
5. Recognize and interpret various micromachining techniques and design, analysis and applications of various MEMS devices micromachining tools and techniques
6. Acquainted with thick film and hybrid technologies for sensor development.
7. Incorporate simulation and micro-fabrication knowledge for developing various MEMS devices.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Introduction to MEMS and Microsystems

MEMS and Microsystems, Miniaturization, Benefits of Microsystems, Typical MEMS and Microsystems products, Evolution of Micro fabrication and Applications.

Unit – 2	**Number of lectures = 9**	Introduction to Sensors and Actuators

Various domains and classification of transducers: electrostatic, piezoelectric, thermal. Sensing principles: electrostatic, resistive, chemical etc. SAW devices. Micro actuators, Design of Micro accelerometers, Engineering Science for Microsystem design and fabrication.

Unit – 3	**Number of lectures = 9**	Micromachining Technologies

Overview of silicon processes techniques, Photolithography, Ion Implantation, Diffusion, Chemical Vapor Deposition, Physical vapor Deposition, Epitaxy, Etching, Bulk micromachining, Surface Micromachining, LIGA and other techniques.
MEMS and micro systems applications: Details of application in actual systems, introduction to RF- MEMS, MOEMS, future of smart structures and MEMS leading to NEMS. Packaging, test and calibration of MEMS

Unit – 4	**Number of lectures = 9**	Hybrid Technology

Thick-film and hybrid technology in sensor production. Basic materials, components, manufacturing Screen manufacturing, Screen printing, Parameters, Comparison: thick- vs. thin film technology Structure dimensions, Assembly and packaging Surface mount technology (SMT) Active and passive devices (SMD), Connection technologies, Packaging.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Text Book(s)

1. G.K.Ananthasuresh, K J Vinoy, S Gopalakrishnan, KN Bhatt, V K Aatre," Micro and smart systems", 2012, 1st ed., Wiley, New York.

2. Tai-Ran Hsu, “MEMS & Microsystem, Design and Manufacture”, 2017, 1st ed., McGraw Hill India, New Delhi.

Reference Books

1. Mahalick NP, "MEMS", 2017, 1st ed., Tata McGraw Hill, New Delhi

2 Wolfgang Menz, Jürgen Mohr, Oliver Paul, "Microsystem Technology", 2011, 2nd ed., Wiley, New York.

3 Banks H.T. Smith R.C. and Wang Y.Smart, ‘Material Structures – Modeling, Estimation and Control’, 2011, 1st ed., John Wiley & Sons, NewYork.

4 Massood Tabib – Arar, ‘Microactuators – Electrical, Magnetic Thermal, Optical, Mechanical, Chemical and Smart structures’, 2014, 1st ed., Kluwer Academic publishers, New York .

Signal Processing and Data Analytics Lab

1. Name of the Department- Computer Science & Engineering							
2. Course Name	Signal Processing and Data Analytics Lab	**L**	**T**	**P**			
3. Course Code		**0**	**0**	**2**			
4. Type of Course (use tick mark)		**Core ()**	**PE(√)**		**OE ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 24**				

Course Description: This course is aimed to introduce the fundamental concepts of MEMS based sensors and actuators.

8.

Learning objectives:

1 To introduce the fundamental concepts of MEMS based sensors and actuators.
2. To acquaint the students with various materials and material properties for Microsystem designing.
3. To provide comprehensive understanding of various micromachining techniques and expose the students to design, simulation and analysis software.
4. Enhancing the basics of thick film and hybrid technologies for sensor development.

9. Course Outcomes (COs):

The students will be able to:-

1. Identify and understand the fundamental concepts and background of MEMS and Microsystems
2. Familiar with the basics of various sensors and actuators.
3. The students were acquainted with various materials for Microsystem designing.
4. Determine and compare the scaling effects in miniaturizing devices.
5. Recognize and interpret various micromachining techniques and design, analysis and applications of various MEMS devices micromachining tools and techniques
6. Acquainted with thick film and hybrid technologies for sensor development.
7. Incorporate simulation and micro-fabrication knowledge for developing various MEMS devices.

10. List of Experiments

Design and Simulation of MEMS Capacitance based Accelerometer:

In this topic, Students need to design a capacitive accelerometer that has a full scale Measurement range of ± 10 g. The accelerometer may be designed using a closed loop or an open-loop. You need to have reasonable over range protection in your device.

Specification:

Measurement range: ± 10g

Output capacitance: at least tens of fF level

Device simulation results (must take into account parasitic capacitance of your design):

(a) Static analyses: Gap vs. acceleration Capacitance (or differential capacitance) vs. acceleration (identify sensitivity [F/g])

(b) Dynamic analyses: Your device's response on vibration.

2. Piezoresistive barometric pressure sensor: In this topic, Students need to design a piezoresistive pressure sensor that has the measurement range of 0 - 1.1 bar. You need to have a reasonable over range protection in your device.

Specification:

Measurement range: 0 -1.1 bar.

Device simulation results:

(i) Strain in the piezoresistor vs. pressure

(ii) Resistance vs. pressure

(iii) Voltage output vs. pressure for Wheatstone bridge circuit output.

Circuit integration issues:

Temperature compensation circuit design

Cloud and Fog Computing

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Cloud and Fog Computing	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description:

This course is aimed to Introduce cloud computing and enabling technologies

9.Learning Objectives:

1. Explore the need for fog and edge computation
2. Impart the knowledge to log the sensor data and to perform further data analytics

10. Course Outcomes (COs):

At the end of the course student will be able to

1. Deploy their data in the cloud for simple applications
2. Apply the analytics in cloud to extract information
3. Appreciate and deploy fog data processing layers
4. Integrate sensor data to cloud through fog computation layers
5. Understand and implement edge computation
6. Develop edge analytics using python and tensor flow
7. Perform data pushing and processing in commercial clouds

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Cloud Computing basics and enabling technologies

Cloud Computing basics and enabling technologies: Basics of cloud computing-Need for clouds- concepts and models: Roles and boundaries – Cloud characteristics – Cloud delivery models – Cloud deployment models. Broadband Networks and Internet Architecture – Data Center Technology – Virtualization Technology.
Cloud Virtualisation: Server oriented – Virtual Machines (IaaS), Modern Serverless Configurations- Functions/ (PaaS) Lambda functions – App, Biz function, logics, data ingestion (elasticity, scalability – on demand) DB services, Analytics services (SaaS).

Unit – 2	**Number of lectures = 9**	Cloud Application Development in Python

Python for Cloud: Amazon Web Services – Google Cloud – Windows Azure. Python for MapReduce.
Federated Cloud Service Management and IoT: Cloud Service management (federated) –Cloud Life Cycle-service and management-Cloud architectures -Self organizing cloud architectures

Unit – 3	**Number of lectures = 9**	Fog and edge computing

Need for Fog computation, Fog data processing layers – Security and Identity Management – Business process integration – Big data interfaces – Wireless sensors and actuators, Fog in 5G, Architecture Harmonization Between Cloud Radio Access Networks and Fog Networks, Fog applications.
Need for edge computation-Edge computing architectures,Device registration, Remote diagnostics,SW update, Geo

distributed computing-concept of cloud orchestration, Edge Networks (Low bandwidth networks/ Security/ protcols),WAN vs Low bandwidth networks		
Unit – 4	**Number of lectures = 9**	Overview of Edge Data Analytics tools
Thick-film and hybrid technology in sensor production. Basic materials, components, manufacturing Screen manufacturing, Screen printing, Parameters, Comparison: thick- vs. thin film technology Structure dimensions, Assembly and packaging Surface mount technology (SMT) Active and passive devices (SMD), Connection technologies, Packaging.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.		
13. Books Recommended		
Text Books: 1. Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, "Cloud Computing: Concepts, Technology & Architecture", Arcitura Education, 2013 **Reference Books** 1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012. 2. S.-C. Hung et al.: Architecture Harmonization Between Cloud RANs and Fog Networks, IEEE Access: The Journal for rapid open access publishing, Vol.3, pp: 3019 – 3034, 2015.		

Cloud and Fog Computing Lab

1. Name of the Department- Computer Science & Engineering							
2. Course Name	Cloud and Fog ComputingLab	**L**	**T**	**P**			
3. Course Code		**0**	**0**	**2**			
4. Type of Course (use tick mark)		**Core ()**	**PE(√)**		**OE ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 24**				

8. Course Description: This course is aimed to Introduce cloud computing and enabling technologies

9. Learning objectives:

1. Introduce cloud computing and enabling technologies
2. Explore the need for fog and edge computation
3. Impart the knowledge to log the sensor data and to perform further data analytics

10. Course Outcomes (COs):

At the end of the course student will be able to

1. Deploy their data in the cloud for simple applications
2. Apply the analytics in cloud to extract information
3. Appreciate and deploy fog data processing layers
4. Integrate sensor data to cloud through fog computation layers
5. Understand and implement edge computation
6. Develop edge analytics using python and tensor flow
7. Perform data pushing and processing in commercial clouds

11. List of Experiments

Cloud Platforms: Microsoft Azure/IBM Bluemix

Language: Python

1. Pushing documents
2. Pushing Images and Processing
3. Mini Weather Station
4. Image analytics at cloud
5. Python Scikit learn
6. Tensor flow

Data Science

Information Visualization

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Information Visualization	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course is aimed to understand the various types of data, apply and evaluate the principles of data visualization.

9. Learning Objectives:

1. Acquire skills to apply visualization techniques to a problem and its associated dataset.
2. To apply structured approach to create effective visualizations.
3. To learn how to bring valuable insight from the massive dataset using visualization.
4. To learn how to build visualization dashboard to support decision making.
5. To create interactive visualization for better insight using various visualization tools.

10. Course Outcomes (COs):

At the end of the course student will be able to

1. Identify the data types and its associated visualization mechanisms.
2. Apply the various scalar and vector visualization techniques to create suitable visualization for real life applications.
3. Handle and analyse multidimensional data and hierarchical data for visualization.
4. Perform multivariate data analysis and visualization.
5. Apply the visualization guidelines for effective information visualization.
6. Demonstrate the concept of visualization through dashboard creation for various applications.
7. Choose appropriate methods for the given real world problems and produce meaningful visualization.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Introduction to Data Visualization

Overview of data visualization - Data Abstraction - Task Abstraction - Analysis: Four Levels for Validation, Human Visual Perception

Unit – 2	**Number of lectures = 9**	Visualization Techniques

Scalar and point techniques – vector visualization techniques – matrix visualization
Visualization Techniques for Trees, Graphs, and Networks, Multidimensional data

Unit – 3	**Number of lectures = 9**	Visual Analysis of data from various domains

Time-oriented data visualization – Spatial data visualization and case studies
Text data visualization – Multivariate data visualization, and case studies

Unit – 4	Number of lectures = 9	Designing Effective Visualizations
Designing Effective Visualizations: Guidelines for designing successful visualizations, Data visualization dos and don'ts Dashboard Creation and Visual Story Telling: Dashboard Design principles, Effective Dashboard Display Media, Dashboard creation using visualization tools for the use cases: Finance- marketing-insurance-healthcare etc.,		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Reference Books

1.Tamara Munzer, "Visualization Analysis and Design", CRC Press, 2014.

2.Stephen Few, "Now You See It", Analytics Press, 2009.

3. Stephen Few, "Information Dashboard Design: the effective visual communication of data", Oreilly, 2006.

4. Matthew O. Ward, Georges Grinstein, Daniel Keim "Interactive Data Visualization: Foundations, Techniques, and Applications", CRC Press, Second Edition, 2015.

5. Dr.Chun-hauh Chen, W.K.Hardle, A. Unwin, "Handbook of Data Visualization", Springer publication, 2008.

6. Ben Fry, "Visualizing Data", O'Reilly Media, 2008 7. Winston Chang, "R Graphics Cookbook", O'Reilly, 2012

Information Visualization Lab

1. Name of the Department- Computer Science & Engineering							
2. Course Name	Information visualization Lab	**L**	**T**	**P**			
3. Course Code		**0**	**0**	**2**			
4. Type of Course (use tick mark)		**Core ()**	**PE(√)**		**OE ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 24**				

Course Description: This course is aimed to understand the various types of data, apply and evaluate the principles of data visualization.

8.

9. Learning objectives:

1. To Acquire skills to apply visualization techniques to a problem and its associated dataset.
2. To apply structured approach to create effective visualizations.
3. To learn how to bring valuable insight from the massive dataset using visualization.
4. To learn how to build visualization dashboard to support decision making.
5. To create interactive visualization for better insight using various visualization tools.

10. Course Outcomes (COs):

At the end of the course student will be able to

1. Identify the data types and its associated visualization mechanisms.
2. Apply the various scalar and vector visualization techniques to create suitable visualization for real life applications.
3. Handle and analyse multidimensional data and hierarchical data for visualization.
4. Perform multivariate data analysis and visualization.
5. Apply the visualization guidelines for effective information visualization.
6. Demonstrate the concept of visualization through dashboard creation for various applications.
7. Choose appropriate methods for the given real world problems and produce meaningful visualization.

11. List of Experiments

1. Association Rule Mining and Clustering.
2. Visualization on KNN or Naïve Bayes Classification.
3. Financial analysis using Clustering, Histogram and HeatMap
4. Time-series analysis –Stockmarket
5. Visualization of various massive dataset-Finance-Healthcare- Census –Geospatial
6. Market-Basket Data analysis-visualization
7. Text visualization using web analytics
8. Hadoop and R integration in Table au using Hortonworks
9. Google API with maps
10. VisualizationusingD3.js
11. Visualization using Zeppelin

Web Intelligence and Big Data

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Web Intelligence and Big Data	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course is aimed to web-intelligence applications exploiting big data sources

9. Learning Objectives:

The objective of this paper is to build web-intelligence applications exploiting big data sources arising social media using new big-data platforms based on the 'map-reduce' parallel programming paradigm.

10. Course Outcomes (COs):

At the end of the course student will be able to

1. Describe the IoT and Cloud architectures
2. Determine the right sensors and communication protocols to use in a particular IoT system.
3. Deploy Cloud Services using different cloud technologies.
4. Implement cloud computing elements such virtual machines, web apps, mobile services, etc.
5. Establish data migration techniques from IoT devices to the cloud.
6. Implement security features to protect data stored in the cloud.
7. Use visualisation techniques to show data generated from the IoT device.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Introduction**

Introduction: Web Scale AI and Big Data, Web Intelligence, Big Data Look: Indexing- Index creation, Ranking, Page Rank Searching- Enterprise search, Searching structured data, Object Search, Locality Sensitive Hashing and Memory.

Unit – 2	**Number of lectures = 9**	**Listen, Load and Programming**

Listen: Streams, Information and Language, Analyzing Sentiment and Intent
Load: Databases and their Evolution, Big data Technology and Trends.
Programming: Map-Reduce, Map-Reduce applications and its efficiency, Big-Table and HBase

Unit – 3	**Number of lectures = 9**	**Learn and Connect**

Learn: Classification, Clustering, and Mining, Information Extraction
Connect: Reasoning: Logic and its Limits, Dealing with Uncertainty.

Unit – 4	**Number of lectures = 9**	**Predict Data Analysis**

Predict: Forecasting, Neural Models, Deep Learning, and Research Topics.
Data Analysis: Regression and Feature Selection

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Text Book:

1. The Intelligent Web: Search, Smart Algorithms and Big Data published by Oxford University Press, UK, in November 2013, authored by Dr. Gautam Shroff.

References Books:

1. Mining Massive Datasets by J.D. Ullman and A. Rajaraman (Cambridge University Press, UK 2012)
2. Introduction to Information Retrieval by Christopher Manning, Prabhakar Raghavan and Hinrich Schutze (Cambridge University Press, UK 2008).

Bigdata Frameworks

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Bigdata Frameworks	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course is aimed to understand the need of Big Data, challenges and different analytical architectures

1. Learning Objectives:

2.Installation and understanding of Hadoop Architecture and its ecosystems
3.Processing of Big Data with Advanced architectures like Spark.
4.Describe graphs and streaming data in Spark

10. Course Outcomes (COs):

At the end of the course student will be able to
1.Discuss the challenges and their solutions in Big Data
2.Understand and work on Hadoop Framework and eco systems.
3. Explain and Analyse the Big Data using Map-reduce programming in Both Hadoop and Spark framework.
4. Demonstrate spark programming with different programming languages.
5.Demonstrate the graph algorithms and live streaming data in Spark
6. Lab: analyse and implement different frame work tools by taking sample data sets.
7.Project: illustrate and implement the concepts by taking an application problem.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Introduction To Big Data

Data Storage and Analysis - Characteristics of Big Data – Big Data Analytics - Typical Analytical Architecture – Requirement for new analytical architecture – Challenges in Big Data Analytics – Need of big data frameworks

Unit – 2	**Number of lectures = 9**	Hadoop Framework & Ecosystem

Hadoop – Requirement of Hadoop Framework - Design principle of Hadoop –Comparison with other system - Hadoop Components – Hadoop 1 vs Hadoop 2 – Hadoop Daemon's – HDFS Commands – Map Reduce Programming: I/O formats, Map side join, Reduce Side Join, Secondary sorting, Pipelining MapReduce jobs
Hadoop Ecosystem: Introduction to Hadoop ecosystem technologies: Serialization: AVRO, Co-ordination: Zookeeper, Databases: HBase, Hive, Scripting language: Pig, Streaming: Flink, Storm

Unit – 3	**Number of lectures = 9**	Spark Framework

Introduction to GPU Computing, CUDA Programming Model, CUDA API, Simple Matrix, Multiplication in CUDA, CUDA Memory Model, Shared Memory Matrix Multiplication, Additional CUDA API Features.
Data Analysis with Spark Shell: Writing Spark Application - Spark Programming in Scala, Python, R, Java - Application Execution.

Unit – 4	Number of lectures = 9	Spark SQL and GraphX

SQL Context – Importing and Saving data – Data frames – using SQL – GraphX overview – Creating Graph – Graph Algorithms.
Spark Streaming: Overview – Errors and Recovery – Streaming Source – Streaming live data with spark

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Reference Books

1. Mike Frampton, "Mastering Apache Spark", Packt Publishing, 2015.

2. TomWhite,"Hadoop:TheDefinitiveGuide",O'Reilly,4thEdition,2015.

3. NickPentreath,MachineLearningwithSpark,PacktPublishing,2015.

4. Mohammed Guller, Big Data Analytics with Spark, Apress,2015 5. Donald Miner, Adam Shook, "Map Reduce Design Pattern", O'Reilly, 2012

Bigdata Frameworks Lab

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Bigdata Frameworks Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE(√)</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 24</td></tr>
<tr><td colspan="8">8. Course Description: This course is aimed to understand the need of Big Data, challenges and different analytical architectures</td></tr>
<tr><td colspan="8">Learning objectives:
1.Installation and understanding of Hadoop Architecture and its ecosystems
2.Processing of Big Data with Advanced architectures like Spark.
3.Describe graphs and streaming data in Spark</td></tr>
<tr><td colspan="8">9. Course Outcomes (COs):
At the end of the course student will be able to
1.Discuss the challenges and their solutions in Big Data
2.Understand and work on Hadoop Framework and eco systems.
3. Explain and Analyse the Big Data using Map-reduce programming in Both Hadoop and Spark framework.
4. Demonstrate spark programming with different programming languages.
5.Demonstrate the graph algorithms and live streaming data in Spark
6. Lab: analyse and implement different frame work tools by taking sample data sets.
7.Project: illustrate and implement the concepts by taking an application problem.</td></tr>
<tr><td colspan="8">10. List of Experiments</td></tr>
<tr><td colspan="8">1. HDFS Commends Map Reduce Program to show the need of Combiner
2. Map Reduce I/O Formats-Text, key-value Map ReduceI/O Formats – Nline, Multiline
3. Sequence file Input/Output Formats Secondary sorting
4. Distributed Cache & Map Side Join, Reduce side Join Building and Running a Spark Application Word count in Hadoop and Spark Manipulating RDD
5. Inverted Indexing in Spark Sequence alignment problem in Spark Implementation of Matrix algorithms in Spark Spark Sql programming, Building Spark Streaming application</td></tr>
</table>

IoT and Cloud Computing

1. Name of the Department- Computer Science & Engineering						
2. Course Name	IoT and Cloud Computing	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course is aimed to provides an overview of the Internet of Things (IoT) and Cloud Computing concepts, infrastructures and capabilities.

9.Learning Objectives:

This will help students gain the necessary knowledge to construct IoT systems and use cloud services for processing and storage of the data produced by the IoT devices. Emphasis will be placed on the architecture and design of IoT systems, the different technologies (wireless/mobile/sensor) governing system implementation and the migration of the data to the Cloud for processing. This module aims to develop knowledge and critical understanding of the underlying principles of Cloud Computing and IoT systems, and the commercial and business implications of technical advances in this area. Students will gain practical experience in the development of Cloud-based IoT systems and exposure to appropriate hardware and software platforms that underpin such development.

10. Course Outcomes (COs):

At the end of the course student will be able to

1. Describe the IoT and Cloud architectures
2. Determine the right sensors and communication protocols to use in a particular IoT system.
3. Deploy Cloud Services using different cloud technologies.
4. Implement cloud computing elements such virtual machines, web apps, mobile services, etc.
5. Establish data migration techniques from IoT devices to the cloud.
6. Implement security features to protect data stored in the cloud.
7. Use visualisation techniques to show data generated from the IoT device.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Introduction to IoT & Cloud**
Trends of Computing, Introduction to IoT		
Unit – 2	**Number of lectures = 9**	**Internet of Things**
IoT Architectures, IoT Devices and Sensors, IoT communication and protocols.		
Unit – 3	**Number of lectures = 9**	**Cloud Computing**

Cloud Computing Fundamentals, Cloud Computing Architectures, Cloud Types and Services, Virtualization and Resource Management .

Unit – 4	**Number of lectures = 9**	**Application of IoT & Cloud**

IoT and cloud integration, Application development and cloud processing, Security and Privacy for IoT/Cloud Computing.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Reference Books

1. Botta A, De Donato W, Persico V, Pescapé A, "Integration of Cloud computing and Internet of Things: A survey", 2015.

IoT and Cloud Computing Lab

1. Name of the Department- Computer Science & Engineering							
2. Course Name	IoT and Cloud Computing Lab	**L**	**T**	**P**			
3. Course Code		**0**	**0**	**2**			
4. Type of Course (use tick mark)		**Core ()**	**PE(√)**	**OE ()**			
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 24**				

8. This course is aimed to provides an overview of the Internet of Things (IoT) and Cloud Computing concepts, infrastructures and capabilities.

9.Learning Objectives:

This will help students gain the necessary knowledge to construct IoT systems and use cloud services for processing and storage of the data produced by the IoT devices. Emphasis will be placed on the architecture and design of IoT systems, the different technologies (wireless/mobile/sensor) governing system implementation and the migration of the data to the Cloud for processing. This module aims to develop knowledge and critical understanding of the underlying principles of Cloud Computing and IoT systems, and the commercial and business implications of technical advances in this area. Students will gain practical experience in the development of Cloud-based IoT systems and exposure to appropriate hardware and software platforms that underpin such development.

10. Course Outcomes (COs):

At the end of the course student will be able to

1. Describe the IoT and Cloud architectures
2. Determine the right sensors and communication protocols to use in a particular IoT system.
3. Deploy Cloud Services using different cloud technologies.
4. Implement cloud computing elements such virtual machines, web apps, mobile services, etc.
5. Establish data migration techniques from IoT devices to the cloud.
6. Implement security features to protect data stored in the cloud.
7. Use visualisation techniques to show data generated from the IoT device.

11. List of Experiments:

1. Installation of Raspbian OS or Ubuntu ARM OS on a Rasberry Pi Platform
2. Setting the networking parameters for Raspbian OS like Ethernet, WLAN, Bluetooth, etc
3. Enabling Security or SELinux in Raspbian OS or Ubuntu OS
4. Accessing IBM Bluemix from IoT Devices
5. Data dissemination from Sensor nodes (any make)
6. Data visualization using d3.js or any other tool
7. Contiki OS Installation and Simple IoT network configuration usingContiki
8. Border Router using Contiki OS

9. Implementation of CoAP protocol using Contiki OS
10. Energy, power, duty cycle calculation of IoT devices in Contiki OS
11. Simple application deployment in Google Cloud Engine or Juju Framework
12. Simple application deployment with PubNub cloud services.

NOSQL Databases

1. Name of the Department- Computer Science & Engineering						
2. Course Name	NOSQL Databases	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course is aimed to Explore the origins of NoSQL databases and the characteristics that distinguish them from traditional relational database management systems.

9. Learning Objectives:

1. Understand the architectures and common features of the main types of NoSQL databases (key-value stores, document databases, column-family stores, graph databases)
2. Discuss the criteria that decision makers should consider when choosing between relational and non-relational databases and techniques for selecting the NoSQL database that best addresses specific use cases.

10. Course Outcomes (COs):

At the end of the course student will be able to

1.Explain the detailed architecture, Database properties and storage requirements
2.Differentiate and identify right database models for real time applications
3.Outline Keyvalue architecture and characteristics
4.Design Schema and implement CRUD operations, distributed data operations
5.Compare data ware housing schemas and implement various column store internals
6.Choose and implement Advanced columnar data model functions for the real time applications
7.Develop Application with Graph Data model

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	INTRODUCTION TO NOSQL CONCEPTS

Data base revolutions: First generation, second generation, third generation, Managing Trans actions and Data Integrity, ACID and BASE for reliable database transactions, Speeding performance by strategic use of RAM, SSD, and disk, Achieving horizontal scalability with database sharding, Brewers CAP theorem.

Unit – 2	**Number of lectures = 9**	NOSQL DATA ARCHITECTURE PATTERNS

NoSQL Data model: Aggregate Models- Document Data Model- Key-Value Data Model Columnar Data Model, Graph Based Data Model Graph Data Model, NoSQL system ways to handle big data problems, Moving Queries to data, not data to the query, hash rings to distribute the data on clusters, replication to scale reads, Database distributed queries to data nodes.

Unit – 3	**Number of lectures = 9**	KEY VALUE DATA STORES

From array to key value databases, Essential features of key value Databases, Properties of keys, Characteristics of Values, Key-Value Database Data Modeling Terms, Key-Value Architecture and implementation Terms, Designing Structured Values, Limitations of Key Value Databases, Design Patterns for Key-Value Databases, Case Study: Key-Value Databases for Mobile Application Configuration

Unit – 4	Number of lectures = 9	DOCUMENT ORIENTED DATABASE

Document, Collection, Naming, CRUD operation, querying, indexing, Replication, Sharding, Consistency Implementation: Distributed consistency, Eventual Consistency, Capped Collection, Case studies: document oriented database: MongoDB and/or Cassandra

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Reference Books

1. An introduction to Information Retrieval, Christopher D.manning, Prabhakar Raghavan, Hinrich Schutze

2. TheDesignandImplementationofModernColumn-OrientedDatabaseSystems,Daniel Abadi YaleUniversity

3. Next Generation database: NoSQL and big data by GuyHarrison

NOSQL Databases Lab

2. Name of the Department- Computer Science & Engineering							
3. Course Name	NOSQL Databases Lab	**L**	**T**	**P**			
4. Course Code		**0**	**0**	**2**			
5. Type of Course (use tick mark)		**Core ()**	**PE(√)**	**OE ()**			
6. Pre-requisite (if any)		**7. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()	
8. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 24**				

9. Course Description: This course is aimed to Explore the origins of NoSQL databases and the characteristics that distinguish them from traditional relational database management systems.

9. Learning objectives:

1. Understand the architectures and common features of the main types of NoSQL databases (key-value stores, document databases, column-family stores, graph databases)
2. Discuss the criteria that decision makers should consider when choosing between relational and non-relational databases and techniques for selecting the NoSQL database that best addresses specific use cases.

10. Course Outcomes (COs):

At the end of the course student will be able to

1. Explain the detailed architecture, Database properties and storage requirements
2. Differentiate and identify right database models for real time applications
3. Outline Keyvalue architecture and characteristics
4. Design Schema and implement CRUD operations, distributed data operations
5. Compare data ware housing schemas and implement various column store internals
6. Choose and implement Advanced columnar data model functions for the real time applications
7. Develop Application with Graph Data model

11. List of Experiments

ImporttheHubwaydataintoNeo4jandconfigureNeo4j.Then, answer the following questions using the Cypher Query Language:

a) List top 10 stations with most outbound trips (Show station name and number of trips)
b) Listtop10stationswithmostinboundtrips(Show station name and number of trips)
c) List top 5 routes with most trips (Show starting station name, ending station name and number of trips)
d) List the hour number(forexample13means1pm-2pm)and number of trips which end at the station ”B.U. Central”

2. Download a zip code dataset at http://media.mongodb.org/zips.json .Use mongo import to import the zip code dataset into MongoDB. After importing the data, answer the following questions by using aggregation pipelines: (1) Find all the states that have a city called ”BOSTON”.
Find all the states and cities whose names include the string ”BOST”.
Each city has several zip codes. Find the city in each state with the most number of zip codes and rank those cities along with the states using the city populations.
MongoDB can query on spatial information.

3. Create a database that stores road cars. Cars have a manufacturer ,a type. Each car has a maximum

performance and a maximum torque value. Do the following: Test Cassandras replication schema and consistency models.

4. Master Data Management using Neo4j Manage your master data more effectively The world of master data is changing. Data architects and application developers are swapping their relational databases with graph databases to store their master data. This switch enables them to use a data store optimized to discover new insights in existing data,providea360-degree view of master data and answer questions about data relationships in real time.

5. Shopping Mall case study using cassendra, where we have many customers ordering items from themal land we have suppliers who deliver them their ordered items

Cyber Security & Forensics

Cyber Attacks Detection and Prevention Systems

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Cyber Attacks Detection and Prevention Systems	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course is aimed to understand the intrusion detection and prevention technologies, various types of network behavior analysis.

9. Learning Objectives:

1. To understand the honeypots, multiple IDS methods, tools to analyze various types of attacks like wireless attacks and their detection.
2. To understand the the attack source and also provides practical knowledge for dealing with intrusions in real world applications

10. Course Outcomes (COs):

The students will be able to:-

1. To understand the intrusion detection and prevention technologies, various types of network behavior analysis.
2. To understand the honeypots, multiple IDS methods, tools to analyze various types of attacks like wireless attacks and their detection.
3. To understand the the attack source and also provides practical knowledge for dealing with intrusions in real world applications.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Introduction to IDPS

IDPS Technologies, Components and Architecture Implementation Uses of IDPS Technologies, Key Functions, Common Detection Methodologies Signature, Anomaly and Stateful Protocol Analysis, Types of IDPS Technologies 2 Host and Network IDPS: Application, Transport, Network and Hardware Layer attacks, Sniffing Network Traffic, Replay Attacks, Command Injection, Internet Control Message Protocol Redirect, DDoS, Dangers and defenses with Man-in the Middle, Secure Socket Layer attacks, DNS Spoofing, Defense- in-Depth Approach, Port Security, Use Encrypted Protocols

Unit – 2	**Number of lectures = 9**	Network Behaviour Analysis and Honeypots

Components and Architecture Typical, Network Architecture, Sensor Locations.
Honeypots: Honeynets- Gen I, II and III, Honeymole, Detecting the Attack - Intrusion Detection, Network Traffic Capture, Monitoring on the box, Setting up the Realistic Environment.

Unit – 3	**Number of lectures = 9**	Working with SNORT IDS

Introduction to Snort, Snort Alert Modes and Format, Working with Snort Rules, Rule Headers, Rule Options, The Snort Configuration File etc, Plugins, Preprocessors and Output Modules, Using Snort with MySQL.

Unit – 4	**Number of lectures = 9**	Multiple IDPS Technologies

Need for multiple IDPS Technologies, Integrating Different IDPS Technologies -Direct and Indirect, Firewalls, Routers and Honeypots, IPS using IP Trace back - Probabilistic and De- terministic Packet Marking, Marking Wireless IDPS: WLAN Standards, WLAN Components, Threats against WLANs, 802.11 Wireless Infrastruc- ture Attacks, WEP Attacks, Wireless Client Attacks, Bluetooth Attacks, Cellphones, Personal Digital Assistance and Other Hybrid Devices Attack Detection, Jailbreaking.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Text Book(s)

1.Shui Yu, Distributed Denial of Service Attack and Defense, Springer, 2014

2.Bradd Lhotsky, OOSEC Host based Intrusion detection, PACKT Publication, 2013

Reference Books

1.John Hoopes, Virtualization for Security: Including Sandboxing, Disaster Recovery, High Availability, Forensic Analysis, and Honeypotting, Syngress,2009.

2.Karen Scarfone and Peter Mell, Guide to Intrusion Detection and Prevention Systems (IDPS), NIST Special Publication 800-94, 2007

Cyber Attacks Detection and Prevention Systems Lab

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Cyber Attacks Detection and Prevention Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE(√)</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td colspan="2"></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 24</td></tr>
<tr><td colspan="8">8. Course Description: This course os aimed to understand the intrusion detection and prevention technologies, various types of network behavior analysis.</td></tr>
<tr><td colspan="8">9. Learning objectives:
1.To 2.To understand the honeypots, multiple IDS methods, tools to analyze various types of attacks like wireless attacks and their detection.
3.To understand the the attack source and also provides practical knowledge for dealing with intrusions in real world applications</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):
The students will be able to:-
1.To understand the intrusion detection and prevention technologies, various types of network behavior analysis.
2.To understand the honeypots, multiple IDS methods, tools to analyze various types of attacks like wireless attacks and their detection.
3.To understand the the attack source and also provides practical knowledge for dealing with intrusions in real world applications.</td></tr>
<tr><td colspan="8">11. List of Experiments</td></tr>
<tr><td colspan="8">Extract the features based on various color models and apply on image and video retrieval.
2. Network monitoring, packet sniffing with Wire shark and Deep Packet inspection.
3. Protocol and traffic analysis with MRTG and Performance measurement using PRTG for different sensors.
4. Real time environment setup with honeynet and capturing intrusions and Analyzing the benchmark dataset to categorize the various kind of intrusion types.
5. Analysis of SNORT IDS with ACID and Design custom rules for intrusion detection based on attack signatures with SNORT IDS.
6. Comparative study of various IP traceback schemes and Tools available for wireless attack detection and prevention</td></tr>
</table>

Cryptosystem

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Cryptosystem	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course is aimed to provide an in-depth understanding of cryptography theories, algorithms and systems.

9. Learning Objectives:

1. To provide necessary approaches and techniques to develop protection mechanisms in order to secure computer networks

10. Course Outcomes (COs):

The students will be able to:-

1. Analyze and model the Symmetric cryptographic algorithms for information security.
2. Model the Public Key cryptosystems.
3. Apply the Integrity standards for information systems.
4. Identify the authentication schemes for membership authorization.
5. Understand how to apply access control techniques to authenticate the data.
6. Analyze the Cryptanalysis techniques.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Introduction to Wireless Sensor Networks

Introduction, Applications of Wireless Sensor Networks, WSN Standards, IEEE 802.15.4, Zigbee. Network Architectures and Protocol Stack – Network architectures for WSN, classification of WSN, protocol stack for WSN Wireless Transmission Technology and Systems: Wireless Transmission Technology and Systems – Radio Technology, Available Wireless Technologies. Wireless Sensor Technology - Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Operating Environment

Unit – 2	**Number of lectures = 9**	Medium Access Control Protocols for Wireless Sensor Networks

Fundamentals of MAC Protocols, MAC Protocols for WSNs, Contention-Based protocols: Power Aware Multi-Access with Signaling - Data-Gathering MAC, Contention-Free Protocols: Low Energy Adaptive Clustering Hierarchy, B-MAC, S-MAC. Dissemination Protocol for Large Sensor Network.

Unit – 3	**Number of lectures = 9**	Deployment and Configuration

Target tracking, Localization and Positioning, Coverage and Connectivity, Single-hop and Multi hop Localization, Self-Configuring Localization Systems. Routing Protocols and Data Management for Wireless Sensor Networks - Routing Challenges and Design Issues in Wireless Sensor Networks, Routing Strategies in Wireless Sensor Networks, Routing protocols: data centric, hierarchical, location based energy efficient routing etc. Querying, Data Dissemination and Gathering.

Unit – 4	**Number of lectures = 9**	Operating Systems For Wireless Sensor Networks

Operating System Design Issues, TinyOS, Contiki – Task management, Protothreads, Memory and IO management Sensor Network Platforms And Tools: Sensor Node Hardware – Tmote, Micaz, Programming Challenges, Node-level Software Platforms, Node-level Simulators, State-centric Programming.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks, Technology, Protocols and Applications", Wiley, 2007

2. Holger Karl, Andreas Willig, "Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005.

3. Jun Zheng, Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", Wiley, 2009.

4. Ian F. Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks", Wiley, 2010

5. Ibrahiem M. M. El Emary, S. Ramakrishnan, "Wireless Sensor Networks: From Theory to Applications", CRC Press Taylor & Francis Group, 2013

Digital Forensics

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Digital Forensics	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course is aimed to learn about the different digital forensic systems and services

9.Learning Objectives:

1. To learn the basics of digital forensics
2. To learn about file recovery using various tools
3. To learn about processing the crime scene and preserving digital evidence

10. Course Outcomes (COs):

The students will be able to:-

1. Describe what a digital investigation is, the sources of digital evidence, and the limitations of forensics
2. Describe the legal requirements for use of seized data
3. Conduct data collection on backup drives
4. Recover data based on a given search term from an imaged system
5. Capture and interpret network traffic
6. Handle the challenges associated with mobile device forensics
7. Handling forensics challenges in social and cloud computing

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Overview of Computer Forensics Technology

Computer Forensics Fundamental- Types of Computer Forensics Technology
Computer Forensics system and Services: Types of Computer Forensics system Computer Forensics Services

Unit – 2	**Number of lectures = 9**	Computer Forensics: Evidence Capture - Data Recovery and Data Seizure

Data Backup and Recovery Test Disk Suite, Data-Recovery Solution, Hiding and Recovering Hidden Data, Evidence Collection and Data Seizure.
Preserving the Digital Crime scene, Computer Evidence Processing steps, Legal aspects of Collecting and Preserving Computer Forensic Evidence.

Unit – 3	**Number of lectures = 9**	Digital Forensics Tools and Platform

Tools (Encase)- Building software, Installing Interpreters, Working with images and File Sys- tems Forensics

Unit – 4	**Number of lectures = 9**	Network Forensics and Operating System Artifacts

Network Forensic Scenario: Destruction of email, damaging computer evidence and System Testing. Operating System Artifacts: Windows System Artifacts, Linux System Artifacts.
Mobile Forensics: Introduction to mobile forensics, understanding Android, Android forensic setup and predata extraction techniques, data recovery techniques

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Text Books:

1. John R. Vacca, Computer Forensics: Computer Crime Scene Investigation, Second Edition, Charles River Media,2005

2. Cory Altheide, Harlan Carvey, Digital Forensics with Open Source Tools, British Library Cataloguing-in-Publication Data,2011.

3. Sathish Bommisetty, Rohit Tamma, Heather Mahalik, Practical Mobile Forensics, Kindle Edition, 2014

4. Greg Gogolin,Digital Forensics Explained,CRC Press,2013.

Reference Books

1. David Lilburn Watson, Andrew Jones, Digital Forensics Processing and Procedures, Syngress,2013.

2 Bill Nelson, Amelia Philips, Christopher Steuart, Guide to Computer Forensics and Investigations, Fifth Edition, Cengage Learning,2016

Digital Forensics Lab

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Digital Forensics Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE(√)</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 24</td></tr>
<tr><td colspan="8">8. Course Description: This course is aimed to learn about the different digital forensic systems and services</td></tr>
<tr><td colspan="8">9. Learning objectives:
1. To learn the basics of digital forensics
2. To learn about file recovery using various tools
3. To learn about processing the crime scene and preserving digital evidence</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):
The students will be able to:-
1. Describe what a digital investigation is, the sources of digital evidence, and the limitations of forensics
2. Describe the legal requirements for use of seized data
3. Conduct data collection on backup drives
4. Recover data based on a given search term from an imaged system
5. Capture and interpret network traffic
6. Handle the challenges associated with mobile device forensics
7.Handling forensics challenges in social and cloud computing</td></tr>
<tr><td colspan="8">11. List of Experiments</td></tr>
<tr><td colspan="8">1. File Recovery (Deleted, fragmented, hidden)
2. Network Forensics (Determining the type attacks, extracting files from network logs, encrypted files) 8 hours .
3. OS Forensics (Windows and Linux artifacts, memory, registry).
4. OS Forensics (Windows and Linux artifacts, memory, registry).
5. Mobile Forensics(Tools for Android and iOS).
6. Data backup and preservation and password recovery</td></tr>
</table>

Mobile and Wireless Security

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Mobile and Wireless Security	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course is aimed to Identify and analyze various the security issues in wireless mobile communication.

9. Learning Objectives:

1. To learn about securing wireless networks.
2. To learn various issues of application level security in wireless environment and its related solution.

10. Course Outcomes (COs):

The students will be able to:-

1. Identify the requirement of security and various issues at wireless and mobile network.
2. Analyze the threats in wireless environment including device, networks and servers.
3. Distinguish the attacks at various protocols in wireless network and differentiate the solution required for them.
4. Assess the security requirement for mobile adhoc environment, ubiquitous environment
5. Recognize the attacks in various environment and Report consequences of them.
6. Select an appropriate solution for security and Justify and demonstrate the usage of preventive measures and countermeasures.
7. Implement the security solution for various environment in wireless network

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Security Issues in Mobile Communication

Mobile Communication History, Security Wired Vs Wireless, Security Issues in Wireless and Mobile Communications Security of Device, Network, and Server Levels:s Mobile Devices Security Requirements, Mobile Wireless network level Security, Server Level Security. Application Level Security in Wireless Networks - Application of WLANs, Wireless Threats, Security for 2G Wi-Fi Applications,Recent Security Schemes for Wi-Fi Applications

Unit – 2	**Number of lectures = 9**	Application Level Security in Cellular Networks

Generations of Cellular Networks, Security Issues and attacks in cellular networks, GSM,GPRS and UMTS security for applications, 3G security for applications.

Unit – 3	**Number of lectures = 9**	Application Level Security in MANETs

MANETs, applications of MANETs, MANET Features, Security Challenges in MANETs, Security Attacks on MANETs.

Application Level Security in Ubiquitous Networks: Ubiquitous Computing, Need for Novel Security Schemes for UC, Security Challenges for UC

Unit – 4	Number of lectures = 9	Application Level Security in Heterogeneous Wireless Networks

Heterogeneous Wireless network architecture, Heterogeneous network application in disaster management, Security problems and solutions in heterogeneous wireless networks.
Wireless Sensor Network Security: Attacks on wireless sensor networks and counter measures Prevention mechanisms: authenti- cation and traffic protection centralized and passive intruder detection decentralized intrusion detection

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

1. Pallapa Venkataram, Satish Babu, Wireless and Mobile Network Security, First Edition, Tata McGraw Hill, 2010.

2 Hakima Chaouchi, Maryline Laurent-Maknavicius, Wireless and Mobile Network Security Security Basics, Security in On-the-shelf and Emerging Technologies, Wiley, 2009

3 Tara M. Swaminathan and Charles R. Eldon, Wireless Security and Privacy- Best Practices and Design Techniques, Addison Wesley, 2002.

Mobile and Wireless Security Lab

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Mobile and Wireless Security Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE(√)</td><td colspan="2">OE ()</td></tr>
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<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 24</td></tr>
<tr><td colspan="8">8. Course Description: This course is aimed to Identify and analyze various the security issues in wireless mobile communication.</td></tr>
<tr><td colspan="8">9. Learning objectives:
1. To learn about securing wireless networks.
2. Identify and analyze various the security issues in wireless mobile communication.
3. To learn various issues of application level security in wireless environment and its related solution.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):
The students will be able to:-
1. Identify the requirement of security and various issues at wireless and mobile network.
2. Analyze the threats in wireless environment including device, networks and servers.
3.Distinguish the attacks at various protocols in wireless network and differentiate the solution required for them. 4.Assess the security requirement for mobile adhoc environment, ubiquitous environment
5.Recognize the attacks in various environment and Report consequences of them.
6. Select an appropriate solution for security and Justify and demonstrate the usage of preventive measures and countermeasures.
7. Implement the security solution for various environment in wireless network</td></tr>
<tr><td colspan="8">11. List of Experiments</td></tr>
<tr><td colspan="8">1. Design and Implementation of Security algorithm for Wireless networks.
2. Implementation of security protocol for mobile network.</td></tr>
</table>

Malware Analysis

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Malware Analysis	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
This course is aimed to recognize the types of malware through analysis methods						
9. Learning Objectives:						
1. To learn basic and advanced malware analysis techniques 3.To practice the android malware analysis techniques for real world applications						
10. Course Outcomes (COs):						
The students will be able to:- 1.Identify various malwares and understand the behavior of malwares in real world applications. 2.Implement different malware analysis techniques. 3.Analyze the malware behavior in windows and android. 4.Understand the purpose of malware analysis. 5.Identify the various tools for malware analysis.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 9**	Introduction				
Malware Analysis Goals of Malware Analysis, Techniques Static and Dynamic Analysis, Types of Malware Backdoor, Botnet, Downloader, Information Stealing malware, Launcher, Rootkit, Scareware, Worm or Virus. Data Collection Methods: Volatile Data Collection Methodology-Preservation of Volatile Data, Physical Memory Acqui sition on a Live Windows System, Identifying Users Logged into the System, Non-Volatile Data Collection Inspect Prefetch Files, Examine the File System, Remote Registry Analysis, Examine Web Browsing Activities, Examine Cookie Files.						
Unit – 2	**Number of lectures = 9**	Windows Basics				
Introduction to Windows Malware - Windows Basics Relevant to Malware Behavior-File System and Directory structure, Registry, Boot Sequence, Malware payloads.						
Unit – 3	**Number of lectures = 9**	Dynamic Malware Analysis				
Malware activities, Self-Start techniques, Essential setup for executing malware, Executing DLL files, Classifying Malware Based on their Behavior. Basic Static Analysis: Number System Static Analysis with File Attributes and PE Header Packet Identification						
Unit – 4	**Number of lectures = 9**	Advanced Static Analysis Reverse Engineering				
Advanced Static Analysis Reverse Engineering Assembly level computing Standard x86 in structions, Introduction to IDA, OllyDbg, Advanced Malware Analysis Virus, Trojan. Parsing Basic Analysis of an APK.						

Android Malware Analysis: APK File Structure Security Model Android Root Brief Description of Spreading and Dis- tribution Introduction to Android Debugging Tools and Their Usage Dex Structure Parsing Basic Analysis of an APK. Exploits MasterKey VulnerabilityFileNameLength Vulnerability Introduction to Obfuscation DEX code obfuscation

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

1.Cameron H. Malin, Eoghan Casey, James M. Aquilina and Curtis W. Rose, Malware Forensics Field Guide for Windows Systems, Syngress, Elsevier, 2012

2 Christopher C. Elisan , Advanced Malware Analysis, Tata McGraw Hill, 2015

3.Cameron H. Malin, Eoghan Casey, James M. Aquilina and Curtis W. Rose, Malware 3 Cameron H. Malin, Eoghan Casey, James M. Aquilina and Curtis W. Rose, Malware Forensics Field Guide for Linux Systems, Syngress, Elsevier, 2014.

4.Ken Dunham, Saeed Abu-Nimeh, Michael Becher and Seth Fogie, Mobile Malware Attacks and Defense, Syngress, Elsevier, 2009

5 John Aycock, Computer Viruses and Malware, Springer, 2006.

6 ErciFiliol, Computer Viruses: from theory to applications, Springer, 2005

Malware Analysis Lab

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Malware Analysis Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE(√)</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (√)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 24</td></tr>
<tr><td colspan="8">8. Course Description: This course is aimed to recognize the types of malware through analysis methods</td></tr>
<tr><td colspan="8">Learning objectives:
1. To learn basic and advanced malware analysis techniques
2. To practice the android malware analysis techniques for real world applications</td></tr>
<tr><td colspan="8">9. Course Outcomes (COs):
The students will be able to:-
1. Identify various malwares and understand the behavior of malwares in real world applications.
2. Implement different malware analysis techniques.
3. Analyze the malware behavior in windows and android.
4. Understand the purpose of malware analysis.
5. Identify the various tools for malware analysis.</td></tr>
<tr><td colspan="8">10. List of Experiments</td></tr>
<tr><td colspan="8">1. Packet sniffing with Wire shark.
2. Capturing intruders through packet inspection.
3. Analysis of various Malware types and behavior.
4. Basic Static Analysis.
5. Basic Dynamic Analysis.
6. Analyzing windows programs.
7. Android malware analysis .
8. Data encoding and malware countermeasures.
9. Comparative study of various malware analysis tools.
10. Tools available in Antivirus Application</td></tr>
</table>

AIML

Soft Computing Techniques

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Soft Computing Techniques	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

The concepts of Fuzzy logic (FL) will be covered first, followed by Artificial Neural Networks (ANNs) and optimization techniques using Genetic Algorithm (GA). Applications of Soft Computing techniques to solve a number of real life problems will be covered to have hands on practices.

12. Learning Objectives:

1. To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for real-world problems.
2. To provide adequate knowledge of non-traditional technologies and fundamentals of artificial neural networks, backpropagation networks, fuzzy sets, fuzzy logic, genetic algorithms in solving social and engineering problems.
3. o provide comprehensive knowledge of associative memory networks and adaptive resonance theory

10. Course Outcomes (COs):

The student will be able

1. Apply neural networks, bidirectional associative memories and adaptive resonance theory for solving different engineering problems.
2. Identify and describe soft computing techniques and build supervised learning and unsupervised learning networks.
3. Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
4. Apply genetic algorithms to combinatorial optimization problems.
5. Evaluate and compare solutions by various soft computing approaches for a given problem

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Introduction to Soft Computing & Neural Networks

Soft computing vs. hard computing, evolution of soft computing, features and types of soft computing, applications of soft computing, basics of machine learning.

Basic concepts of Neural Networks, Model of Artificial Neuron, Neural Network Architectures, Characteristics of neural networks, Learning Methods, Early neural network architectures, Application domains. Backpropagation network (BPN), Backpropagation Learning, Applications of BPN, Parameter selection, Variations of Backpropagation Algorithms

Unit – 2	**Number of lectures = 9**	Associative Memory Network & Unsupervised learning

Autocorrelators, hetero-correlators: Kosko's discrete Bi-direction associative memory (BAM), Exponential BAM, Application of Character Recognition.

Adaptive Resonance Theory (ART), Classical ART Networks, Simplifies ART Architecture, Features, algorithms and

Illustration of ART1 and ART2 model, Related Applications		
Unit – 3	**Number of lectures = 9**	Fuzzy Sets and Fuzzy Relation
Fuzzy versus Crisp, Crisp Sets, Fuzzy sets, Membership functions, fuzzy set operations, properties of Fuzzy sets, Crisp Relations, Fuzzy relations –Fuzzy Cartesian product, Operations of Fuzzy Relations. Crisp Logic, Predicate Logic, Fuzzy Logic, Fuzzy Quantifiers, Fuzzy Inference, Fuzzy knowledge and rule-based system, fuzzy decision making, Defuzzification, Application of fuzzy logic.		
Unit – 4	**Number of lectures = 9**	Genetic Algorithms
History of Genetic Algorithm, Basic concepts, Creation of offspring, working principles, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, crossover, inversion & deletion, mutation operator, Bitwise operator, Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional method, Hybrid systems, evolutionary computing, Genetic Algorithm based on Backpropagation networks-Implementation and comparison on performance of traditional algorithms with Genetic Algorithms.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.		
13. Books Recommended		
S, Rajasekaran & G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy systems and evolutionary algorithms: Synthesis and Applications", PHI Publication, 2ndEd.2017. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", John Wiley and Sons, 3rded, 2011. S.N. Sivanandam & S.N. Deepa, "Principles of Soft Computing", Wiley Publications, 3rded, 2018		

Soft Computing Techniques Lab

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td colspan="2">2. Course Name</td><td colspan="2">Soft Computing Techniques Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td colspan="2">3. Course Code</td><td colspan="2"></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE(√)</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (√)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 24</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">Learning objectives:
1. To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for real-world problems.
2.To provide adequate knowledge of non-traditional technologies and fundamentals of artificial neural networks, backpropagation networks, fuzzy sets, fuzzy logic, genetic algorithms in solving social and engineering problems.
3. To provide comprehensive knowledge of associative memory networks and adaptive resonance theory</td></tr>
<tr><td colspan="8">9. Course Outcomes (COs):
The student will be able
1.Apply neural networks, bidirectional associative memories and adaptive resonance theory for solving different engineering problems.
2.Identify and describe soft computing techniques and build supervised learning and unsupervised learning networks.
3.Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
4.Apply genetic algorithms to combinatorial optimization problems.
5.Evaluate and compare solutions by various soft computing approaches for a given problem</td></tr>
<tr><td colspan="8">10. List of Experiments</td></tr>
<tr><td colspan="8">1. Create a perceptron with appropriate number of inputs and outputs. Train it using fixed increment learning algorithm until no change in weights is required. Output the final weights
2. Write a program to implement artificial neural network without back propagation
3. Write a program to implement artificial neural network with back propagation.
4. Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.
5. Implement travelling sales person problem (tsp) using genetic algorithms
6. Implement linear regression and multi-regression for a set of data points.
7. Implement crisp partitions for real-life iris dataset</td></tr>
</table>

Knowledge Engineering and Intelligent Systems

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Knowledge Engineering and Intelligent Systems	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course presents Artificial Intelligence methods, techniques and technologies which are applied already in the engineering of distributed systems in order to make them more flexible, adaptable and reconfigurable. It presents first a new paradigm of agent-based software design methodologies, where the analysis and design of distributed systems uses concepts from human societies and organizations (actor, role, responsibility, delegation of tasks) to model, in a flexible way, the interactions within the system and ways to recover from failures. Also we see how smart technologies are being implemented (logical reasoning, planners automatic mechanisms of negotiation and argumentation) to extend the semantic web services technologies towards their fullest potential, to make them more flexible and adaptive.

11. Learning Objectives:

1. To introduce the fundamentals of Knowledge Engineering and Intelligent Systems.
2.To provide deep understanding of Knowledge Engineering and Intelligent Systems .
3.To educate about all aspect of advanced models of KE and its application.

10. Course Outcomes (COs):

The student will be able
1. Demonstrate the knowledge of fundamental elements and concepts related to Intelligent Systems.
2.Demonstrate the fundamental and advanced modules of KE especially with Searching methods, Representation of knowledge and different reasoning techniques.
3.Ability to work with Predicate logic, back propagation with respect to the CNNs model parameters and implementing the models successfully.
4.Apply the higher order logics for handling uncertainty5.Implement an expert system to solve critical problems of medical domain, application of business intelligence and robotics in real life problems.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Knowledge Engineering Concepts

Definition of Knowledge Engineering –Knowledge base Systems –Knowledge base systems Vs Database systems – Rules Vs Triggers –Domain Expert –Expert Systems –Heuristic Search –A*, AO* and Mini-max algorithms - Knowledge representation –Semantic Networks –Frames-Conceptual Dependency –Scripts –Ontology –Semantic Web– Reasoning Methods

Unit – 2	**Number of lectures = 9**	First Order Logic

Role of Logic –Propositional logic –Predicate logic –Syntax –Semantics –Interpretations –Denotation –Satisfaction and models –Pragmatics –Explicit and Implicit Beliefs -Logical Consequence –Expressing Knowledge -Basic and Complex Facts –Terminological facts –Entailment –Abstract Individuals -Other Sorts of Facts –Resolution –The Propositional Case –Predicate Logic –Handling Variables and Quantifiers –First Order Resolution-Answer Extraction –Skolemization –Clause Form –Equality -Dealing with Computational Intractability -The First-Order Case -Herbrand Theorem -The Propositional Case -The Implications -SAT Solvers -Most General Unifiers -Other Refinement

Unit – 3	**Number of lectures = 9**	Knowledge Representation –Using Rules

Procedural Versus Declarative Knowledge -Logic Programming -Forward versus Backward Reasoning –Rule Matching –Rules in Production Systems-Working Memory-Conflict Resolution-Rete's Algorithm –Discriminant Networks -Control Knowledge –Reasoning with Horn Clauses –Computing Selective Linear Definite clause resolution Derivatives –Rule Formation and Search Strategy –Algorithm Design –Specifying Goal order –Committing to Proof methods –Controlling Back Tracking –Negation as Failure –Dynamic Databases.

Unit – 4	**Number of lectures = 9**	Object Oriented Representation using Logic

Object oriented Representation –Objects and Frames –Frame Formalism –Object Driven Programming with Frames –Generic and Individual Frames –Inheritance –Reasoning with Frames –Structured Descriptions –Descriptions –Description Language –Meaning and Entailment –Interpretations –Truth in an Interpretation –Computing Entailments –Simplifying the Knowledge base –Normalization –Structure Matching –Subsumption Computation –Taxonomies and Classification –Inheritance Networks –Handling Defeasible Inheritance

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

1. Ronald Brachman, Hector Levesque, Knowledge Representation and Reasoning, 1st Edition, Morgan Kaufmann, 2004
2.Richard A Frost, "Introduction to Knowledge Based Systems", Macmillan Publishing Co, 1986.
3.John F. Sowa, Knowledge Representation: Logical, Philosophical and Computational Foundations, Brooks Cole Publishing Co., Pacific Grove, CA, 20004.
4. Building Intelligent Systems A Guide to Machine Learning Engineering, Authors: Hulten, Geoff, Apress; 1st ed. edition (2018

Deep Learning and its Applications

Stochastic Models and Applications						
1. Name of the Department- Computer Science & Engineering						
2. Course Name	Deep Learning and its Applications	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(√)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
The course is aimed to understand the theoretical foundations, algorithms and methodologies of Neural Network						
9.Learning Objectives: 1.To design and develop an application using specific deep learning models. 2. To provide the practical knowledge in handling and analysing real world applications.						
10. Course Outcomes (COs):						
Upon completion of the course, the students will be able to 1. Recognize the characteristics of deep learning models that are useful to solve real-world problems. 2. Understand different methodologies to create application using deep nets. 3. Identify and apply appropriate deep learning algorithms for analyzing the data for variety of problems. 4. Implement different deep learning algorithms 5. Design the test procedures to assess the efficacy of the developed model. 6. Combine several models in to gain better result						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 9**	MACHINE LEARNING BASICS				
Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Neural Networks Multilayer Perceptron, Back-propagation algorithm and its variants Stochastic gradient decent, Curse of Dimensionality Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications						
Unit – 2	**Number of lectures = 9**	CONVOLUTIONAL NEURAL NETWORKS				
Architectural Overview,Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures: ResNet, AlexNet - Applications Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet.						
Unit – 3	**Number of lectures = 9**	SEQUENCE MODELLING – RECURRENT AND RECURSIVE NETS				

Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures - BPTT for training RNN, Long Short Term Memory Networks.

Unit – 4	**Number of lectures = 9**	AUTO ENCODERS & DEEP GENERATIVE MODELS

Under complete Auto encoder, Regularized Auto encoder, stochastic Encoders and Decoders, Contractive Encoders.
DEEP GENERATIVE MODELS: Deep Belief networks, Boltzmann Machines,Deep Boltzmann Machine, Generative Adversial Networks.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

Text books:

1. Ian Goodfellow, YoshuaBengio and Aaron Courville, " Deep Learning", MIT Press, 2017. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
2.Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.

Reference Books :

1. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
2. EthemAlpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.
3.Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy "Deep Learning with TensorFlow: Explore neural networks with Python", Packt Publisher, 2017.
4.Antonio Gulli, Sujit Pal "Deep Learning with Keras", Packt Publishers, 2017. Francois Chollet "Deep Learning with Python", Manning Publications, 2017.

Deep Learning and its Applications Lab

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Deep Learning and its Applications Lab	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE(√)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0	**Tutorials = 0**	**Practical = 24**				

8. Course Description: The course is aimed to understand the theoretical foundations, algorithms and methodologies of Neural Network

9. Learning objectives:

1. To design and develop an application using specific deep learning models.
2. To provide the practical knowledge in handling and analysing real world applications

10.Course Outcomes (Cos):

Upon completion of the course, the students will be able to

1. Recognize the characteristics of deep learning models that are useful to solve real-world problems.
2. Understand different methodologies to create application using deep nets.
3. Identify and apply appropriate deep learning algorithms for analyzing the data for variety of problems.
4. Implement different deep learning algorithms
5. Design the test procedures to assess the efficacy of the developed model.
6. Combine several models in to gain better result

11.List of Experiments

1. Train a Deep learning model to classify a given image using pre trained model
2. Object detection using Convolution Neural Network
3. Recommendation system from sales data using Deep Learning
4. Improve the Deep learning model by tuning hyper parameters
5. Perform Sentiment Analysis in network graph using RNN
6. Image generation using GAN

Bio-Inspired Computing

<table>
<tr><td colspan="8">1. Name of the Department- Computer Science & Engineering</td></tr>
<tr><td>2. Course Name</td><td colspan="2">Bio-Inspired Computing</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td colspan="2"></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE(✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td colspan="2"></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 36</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">An introduction to self-adapting methods also called artificial intelligence or machine learning. Schemes for classification, search and optimization based on bio-inspired mechanisms are introduced. This includes evolutionary computation, artificial neural networks and more specialized approaches like e.g. swarm intelligence and artificial immune systems. Further, an overview of alternative traditional methods will also be included.</td></tr>
<tr><td colspan="8">9.Learning Objectives:

1.To understand the fundamentals of evolutionary theory and cellular automata.
2.To learn the artificial neural systems and swarm optimization for feature selection.
3.To learn the genetic algorithm and hybridization with memetic algorithms.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):</td></tr>
<tr><td colspan="8">Upon completion of the course, the students will be able to

1.Understand basic concepts of evolutionary algorithm .
2.Understand the basic features of neural and immune systems and able to build the neural model.
3. Explain how complex and functional high-level phenomena can emerge from low-level interactions.
4.Explain the computational processes derived from neural models.
5.Implement simple bio-inspired algorithms like genetic and Particle Swarm Optimization.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td colspan="2">Number of lectures = 9</td><td colspan="5">INTRODUCTION TO EVOLUTIONARY ALGORITHM</td></tr>
<tr><td colspan="8">Evolutionary algorithm, components of evolutionary algorithm representation (definition of individuals), Evaluation function (Fitness function), Population, parent selection Mechanism, Variation Operators, Survivor Selection Mechanism (Replacement), Initialization, Termination Condition, evolutionary algorithm case study Cellular systems, cellular automata, modeling with cellular systems, other cellular systems, computation with cellular systems, artificial life: analysis and synthesis of cellular systems.</td></tr>
<tr><td>Unit – 2</td><td colspan="2">Number of lectures = 9</td><td colspan="5">NEURAL SYSTEMS</td></tr>
</table>

Biological nervous systems, artificial neural networks, neuron models, architecture, signal encoding ,synaptic plasticity, unsupervised learning, supervised learning, reinforcement learning, evolution of neural networks, hybrid neural systems, case study Rewriting system, synthesis of developmental system, evolutionary rewriting systems, evolutionary developmental programs, biological immune systems, lessons for artificial immune systems, algorithms and applications, shape space, negative selection algorithm

Unit – 3	**Number of lectures = 9**	BEHAVIORAL SYSTEMS

Behavior is cognitive science, behavior in AI, behavior based robotics, biological inspiration for robots, robots as biological models, robot learning, evolution of behavioral systems, learning in behavioral systems, co-evolution of body and control, towards self-reproduction, simulation and Reality.
Representation of Individuals, Mutation, Recombination, Population Models, Parent Selection, Survivor Selection, Example Application: Solving a Job Shop Scheduling Problem

Unit – 4	**Number of lectures = 9**	COLLECTIVE SYSTEMS

Biological self-organization, Particle Swarm Optimization (PSO),ant colony optimization (ACO), swarm robotics, co-evolutionary dynamics, artificial evolution of competing systems, artificial evolution of cooperation, case study Introduction to Local Search, Lamarckianism and the Baldwin Effect, Structure of a Memetic Algorithm, Heuristic or Intelligent Initialization, Hybridization within Variation Operators: Intelligent Crossover and Mutation, Local Search Acting on the output from Variation Operators , Hybridization During the Genotype to Phenotype Mapping, Design Issues for Memetic Algorithms

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

1. D. Floreanoand C. Mattiussi, "Bio-Inspired Artificial Intelligence", MIT Press, 2008.
2. Tao Song, Pan Zheng, Mou Ling Dennis Wong, Xun Wang, “Bio-Inspired Computing Models and Algorithms”, ISBN: 978-981-3143-19-7, world scientific, 2019F.
3. Neumann and C. Witt, “Bioinspired Computation in combinatorial optimization: Algorithms and their computational complexity”, Springer, 2010

Bio-Inspired Computing Lab

1. Name of the Department- Computer Science & Engineering							
2. Course Name	Bio-Inspired Computing Lab	**L**	**T**	**P**			
3. Course Code		**0**	**0**	**2**			
4. Type of Course (use tick mark)		**Core ()**	**PE(√)**	**OE ()**			
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 24**				

8. Course Description: An introduction to self-adapting methods also called artificial intelligence or machine learning. Schemes for classification, search and optimization based on bio-inspired mechanisms are introduced. This includes evolutionary computation, artificial neural networks and more specialized approaches like e.g. swarm intelligence and artificial immune systems. Further, an overview of alternative traditional methods will also be included.

Learning objectives:

1. To understand the fundamentals of evolutionary theory and cellular automata.
2. To learn the artificial neural systems and swarm optimization for feature selection.
3. To learn the genetic algorithm and hybridization with memetic algorithms.

9. Course Outcomes (Cos):

Upon completion of the course, the students will be able to

1. Understand basic concepts of evolutionary algorithm .
2. Understand the basic features of neural and immune systems and able to build the neural model.
3. Explain how complex and functional high-level phenomena can emerge from low-level interactions.
4. Explain the computational processes derived from neural models.
5. Implement simple bio-inspired algorithms like genetic and Particle Swarm Optimization.

10. List of Experiments

1. Python Review
2. Measuring (uncertainty based) information
3. L-System
4. Cellular Automata & Boolean Networks
5. Evolutionary Algorithms
6. Ant Clustering Algorithm

Machine Learning for Signal Processing

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Machine learning for signal processing	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE(✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 36		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course aims at introducing the students to the fundamentals of machine learning (ML) techniques useful for various signal processing applications. It will discuss various mathematical methods involved in ML, thereby enabling the students to design their own models and optimize them efficiently. The lectures will focus on mathematical principles, and there will be coding based assignments for implementation. Prior exposure to ML is not required. The course will be focused on applications in signal processing and communication, and the theory will be tailored towards that end.

9.Learning Objectives:

1. To introduce the students with machine learning fundamentals for solving signal processing based applications.
2. To implement various mathematical methods involved in Machine Learning
3. To design their own models for the specific applications and optimize them efficiently

10. Course Outcomes (COs):

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

1. Understand the mathematical methods for implementing signal processing and machine learning techniques
2. Perform the optimization techniques for various Machine Learning models
3. Develop methods of data representations for signal processing in machine learning environment
4. Apply Machine Learning models for linear systems
5. Classify Machine Learning models for Non-linear systems
6. Apply basic machine learning models and prediction techniques on signals
7. Apply machine learning models in speech and image processing applications

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	Mathematical Foundations
Introduction -Notion of a signal-Basic digital representation of data (text, speech, image, video)-Complex Exponential functions-Shannon Information Theory, Convolution, Correlation and Covariance Functions-Wavelets-Fourier Transform -DCT and Wavelets, Gaussian Processes		
Unit – 2	**Number of lectures = 9**	Optimization Techniques

Gradient ascent/descent-Basics of convex optimization-Constrained optimization, Convex sets, Hyperplanes/ Half-spaces, Lagrange multipliers, projected gradients-Bio-Inspired Algorithms, Dictionary based representations -Eigen representations –Karhunen Loeve Theorem -Principal Component Analysis-Properties-Independent Component Analysis (ICA)-ICA for representations and Denoising -Non-negative matrix factorization

Unit – 3	**Number of lectures = 9**	Linear Gaussian Systems and Signal Processing

Delta and Related Functions-Linear Time Invariant Systems –LTI Signal Processing –Exploiting Statistical Stability for linear-Gaussian DSP-Kalman Filters.
Running Window filters-Recursive filters-Global Non-linear Filter –Hidden Markov Modelling –Homomorphic Signal Processing

Unit – 4	**Number of lectures = 9**	Statistical Machine Learning

Statistical Machine Learning techniques -implementation for signal processing applications: Binary Classification -Linear classifiers –Perceptron's-–SVM-Linear, Kernel SVM -Multiclass Problem -K-means -Nearest Neighbors -Linear regression -Regularization, Machine Learning for Audio Classification -Time Series Analysis, LSTMs and CNNs. Machine Learning for Image Processing -Transfer Learning, Attention models, Attribute-based learning

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

13. Books Recommended

1. Max A. Little, Machine Learning for Signal Processing: Data Science, Algorithms, and Computational Statistics, Oxford Publisher, 2019.
2. Paolo Prandoni,Martin Vetterli, Signal Processing for Communications (Communication and Information Sciences), CRC Press, 2008.
3. Stephen Boyd, LievenVandenberghe, Convex Optimization,Cambridge University Press, 2004

Machine Learning for Signal Processing Lab

1. Name of the Department- Computer Science & Engineering						
2. Course Name	Machine Learning for Signal Processing Lab	**L**	**T**	**P**		
3. Course Code		**0**	**0**	**2**		
4. Type of Course (use tick mark)		**Core ()**	**PE(√)**	**OE ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 24**			

8. Course Description: This course aims at introducing the students to the fundamentals of machine learning (ML) techniques useful for various signal processing applications. It will discuss various mathematical methods involved in ML, thereby enabling the students to design their own models and optimize them efficiently. The lectures will focus on mathematical principles, and there will be coding based assignments for implementation. Prior exposure to ML is not required. The course will be focused on applications in signal processing and communication, and the theory will be tailored towards that end.

Learning objectives:

1. To introduce the students with machine learning fundamentals for solving signal processing based applications.
2. To implement various mathematical methods involved in Machine Learning
3. To design their own models for the specific applications and optimize them efficiently

9. Course Outcomes (Cos):

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

1. Understand the mathematical methods for implementing signal processing and machine learning techniques
2. Perform the optimization techniques for various Machine Learning models
3. Develop methods of data representations for signal processing in machine learning environment
4. Apply Machine Learning models for linear systems
5. Classify Machine Learning models for Non-linear systems
6. Apply basic machine learning models and prediction techniques on signals
7. Apply machine learning models in speech and image processing applications

10. List of Experiments

1. Implement Decision Tree learning
2. Implement Logistic Regression
3. Implement classification using Multilayer perceptron
4. Implement classification using SVM
5. Implement Adaboost
6. Implement Bagging using Random Forests
7. Implement k-nearest Neighbors algorithm
8. Implement K-means, K-Modes Clustering to Find Natural Patterns in Data
9. Implement Hierarchical clustering

10. Implement Gaussian Mixture Model Using the Expectation Maximization
11. Implement Principle Component Analysis for Dimensionality Reduction
12. Evaluating ML algorithm with balanced and unbalanced datasets Comparison of Machine Learning algorithms