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(Permanent Affiliation by Andhra University & Approved by AICTE
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IV Year Course structure – CSE

Semester -I

CODE	SUBJECT NAME	Category	Periods				Sessional Marks	Semester end Exam marks	Total Marks	Credits
			L	T	P	Total				
CSE 411	Open Elective -III	OE	3	0	0	3	40	60	100	3
CSE 412	Professional Elective -IV	PE	3	1	0	4	40	60	100	3
CSE 413	Professional Elective -V	PE	3	1	0	4	40	60	100	3
CSE 414	Principles of Management & Financial Accounting	HS	3	0	0	3	40	60	100	3
CSE 415	Data Analytics	PC	2	1	0	3	40	60	100	3
CSE 416	Cryptography & Network Security Lab	PC	0	0	3	3	50	50	100	1.5
CSE 417	Data Analytics Lab	PC	0	0	3	3	50	50	100	1.5
CSE 418	Project -I	PR	0	0	3	3	100	0	100	2
CSE 419	Summer Internship-Industry-2	PR	0	0	0	0	100	0	100	2
Total				1	9	24	500	400	900	22

IV Year Course structure – CSE

Semester -II

CODE	SUBJECT NAME	Category	Periods				Sessional Marks	Semester end Exam marks	Total Marks	Credits
			L	T	P	Total				
CSE 421	Open Elective -IV*	OE	3	0	0	3	40	60	100	3
CSE 422	Project Phase 2& Internship In Industry	PR	0	0	9	9	100	100	200	8
Total			3	0	9	12	140	160	300	11

								Total Credits		**160**

Note: Open Elective-V can be considered as MOOCs Course as NPTEL certification or any emerging courses certification

Open Elective IV	Professional Elective IV	Professional Elective V
CSE 411 (A) - Introduction to Deep Learning	CSE 412 (A) – Computer Vision	CSE 413 (A) – Internet of Things
CSE 411 (B) – Fundamentals of Internet of Things	CSE 412 (B) - Bioinformatics	CSE 413 (B) – Soft Computing
CSE 411 (C) – Data Visualization and Analytics using Open Source Tools	CSE 412 (C) - High Performance Computing	CSE 413 (C) – Social Network Analysis
	CSE 412 (D) – Principles of Programming Languages	CSE 413 (D) – Cloud Computing

Introduction to Deep Learning (Open Elective)	
Code: 411(A)	**Credits: 3**
Instruction: 3 Periods/week	**Sessional Marks: 40**
End Exam: 3 Hours	**End Exam Marks: 60**

Prerequisites:

1. Basic programming skills
2. Understanding of Machine learning concepts
3. Knowledge on mathematical concept such as Linear algebra, Calculus & Probability

Course Objectives:

1. Gain a solid understanding of the fundamental principles and components of neural networks
2. Compare and contrast different optimization methods for training deep neural networks, such as AdaGrad, RMSProp, and Adam.
3. Utilize the concepts and techniques learned to implement and train CNNs for handwritten digits and letters classification.
4. Describe the back propagation through time (BPTT) algorithm and its application in training RNNs.
5. Comprehend the benefits of Word embedding and its role in representing words using Word2Vec.

Course Outcomes (CO):

By the end of the course, the student will be able to:	
1	Define the concept of a neural network and articulate its fundamental components.
2	Evaluate the challenges and techniques associated with training deep neural networks using various optimization methods and regularization techniques.
3	Apply their knowledge of convolutional neural networks (CNNs) to analyze and classify handwritten digits and letters
4	Analyze the architecture and functioning of recurrent neural networks (RNNs) and its variants
5	Apply different language models and word embedding techniques using Word2Vec.

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3		3			3	3	3		2	3
2	3	3	3	3		3			3	3	3		2	3
3	3	3	3	3		3			3	3	3		2	3
4	3	3	3	3		3			3	3	3		2	3
5	3	3	3	3		3			3	3	3		2	3

SYLLABUS

Unit 1: Introduction to Neural Networks: 10 Periods

What is Neural network, How Neural network works, Activation functions, Gradient Descent, Stochastic Gradient Descent, Neural network models- Perceptron, multilayer perceptron, Back propagation, Overfitting and Underfitting, Applications

Learning Outcomes: At the end of this Unit the student will be able to:

- Explain the functioning of a neural network, including the flow of information and the role of activation functions.
- Compare and contrast gradient descent and stochastic gradient descent algorithms used in neural network optimization.

Unit 2: Introduction to Deep Learning: 10 Periods

Perspectives and Issues of Deep Learning, Difficulty of training DNNs, Greedy layer wise training, Optimization for training DNNs, Newer optimization methods for neural networks (AdaGrad, RMSProp, Adam), Second order methods for training, Regularization methods (dropout, drop connect, batch normalization)

Learning Outcomes: At the end of this Unit the student will be able to:

- Compare and contrast different optimization methods for training deep neural networks, such as AdaGrad, RMSProp, and Adam.
- Analyze the difficulties encountered in training deep neural networks and apply appropriate strategies to mitigate them.

Unit 3: Convolution Neural Networks: 10 Periods

Introduction to CNNs – convolution, pooling, Deep CNNs, Different deep CNN architectures – LeNet, AlexNet, VGG, PlacesNet, Training a CNNs: weights initialization, batch normalization, hyperparameter optimization, Understanding and visualizing CNNs, MNIST example using CNN. Handwritten digits and letters classification using CNN

Learning Outcomes: At the end of this Unit the student will be able to:

- Utilize the concepts and techniques learned to implement and train CNNs for handwritten digits and letters classification..
- Evaluate and compare different deep CNN architectures (LeNet, AlexNet, VGG, PlacesNet) in terms of their performance and suitability for specific tasks.

Unit 4: Recurrent neural networks (RNNs): 10 Periods

What are the Recurrent Neural networks?, Understanding a Recurrent Neuron, Sequence modeling using RNNs, Back propagation through time(BPTT), Long Short Term Memory (LSTM), Bidirectional LSTMs, Bidirectional RNNs, Gated RNN Architecture, Implementation of RNN in Keras, Sequence to sequence models for building chatbots,

Learning Outcomes: At the end of this Unit the student will be able to:

- Explain the concept of a recurrent neuron and its role in sequence modeling using RNNs.
- Describe the Back propagation through time (BPTT) algorithm and its application in training RNNs.

Unit V: 10 Periods

Introduction to Language Models: Introduction, Different Language Models- N-gram Models, skip-gram Model, Neural language Model,.

Word Embedding from word2Vect: Introduction, Benefits of Word embedding, Word representation using Word2Vec, Learning word vectors, Loading all dependencies, Define word2vect model, Training and analyzing the model

Learning Outcomes: At the end of this Unit the student will be able to:

- Identify and explain the different language models, including N-gram Models, skip-gram Model, and Neural language Model.
- Comprehend the benefits of Word embedding and its role in representing words using Word2Vec.

Textbooks:

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Dive into Deep Learning, 2021
3. Learning Deep Learning by Magnus Ekmen, Edison Wisley publishers;2022

Reference Books:

1. Chollet, Francois, Deep learning with Python, New York: Manning Publications;2018
2. Richard wilson, Mastering Deep Learning Fundamentals with Python, 2019

Fundamentals of Internet of Things (Open Elective)	
Code: 411(B)	**Credits: 3**
Instruction: 3 Periods/week	Sessional Marks: 40
End Exam: 3 Hours	End Exam Marks: 60

Pre-requisites:

- Basic understanding of computer science and programming concepts.
- Familiarity with networking concepts: Understanding the basics of networking, including TCP/IP, routing, and protocols such as HTTP.

Course Objectives:

The course should enable the students to:

1. Explore the enabling technologies that support IoT implementations, such as microcontrollers, sensors, and communication protocols.
2. Gain practical knowledge and skills in programming and working with microcontrollers like Arduino UNO, ESP8266, and Raspberry Pi.
3. Apply data analytics techniques to process and derive insights from IoT-generated data.
4. Explore IoT security concepts, including security considerations in the perception layer, networks, reference architecture, and secure communication.
5. Analyze case studies of IoT applications in different domains, such as Smart City, Smart Water, Smart Agriculture, Smart Energy, Smart Healthcare, Smart Transportation, Smart Retail, and Smart Waste Management.

Course Outcomes (CO):

By the end of the course, the student will be able to:	
CO1	Demonstrate a comprehensive understanding of IoT principles by applying critical analysis to identify the characteristics of IoT systems, evaluate deployment challenges, and propose appropriate mitigation strategies.
CO2	Apply knowledge of IoT sensors and protocols to effectively design and implement IoT solutions, considering sensor functionalities, selection criteria, and appropriate protocol choices for different aspects of IoT systems.
CO3	Demonstrate proficiency in data analytics for IoT by effectively applying analytics techniques and utilizing relevant tools and technologies to optimize IoT applications.
CO4	Develop proficiency in utilizing cloud platforms for IoT applications, demonstrating the ability to effectively collect, store, and process data using a cloud-based approach.
CO5	Demonstrate proficiency in implementing security measures in perception layers, networks, and communication channels of IoT systems.

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	1	-	-	-	-	3	2	1	-	2	3
2	3	3	3	1	-	-	-	-	3	2	1	-	2	3
3	3	3	3	1	-	1	-	-	3	2	1	-	2	3
4	3	3	3	1	-	1	-	-	3	2	1	-	2	3
5	3	3	3	1	-	1	-	-	3	2	1	-	2	3

SYLLABUS

UNIT I: **10 Periods**

Introduction to loT - loT definition - Characteristics - Things in loT - loT Complete Architectural Stack - loT enabling Technologies - loT Challenges - loT Levels IoT Physical Devices –Micro Controllers : Arduino UNO: Introduction to Arduino, Installation, Fundamentals of Arduino Programming. ESP8266: Introduction, Installation, Python Programming with ESP8266 using sensors. Raspberry Pi: Introduction, Hardware and Software Layout, Configuration, Basic Raspberry Pi Programming with Python

Learning Outcomes: At the end of this Unit the student will be able to:

1. Analyze the characteristics and components of IoT systems to identify their unique features and functionalities.
2. Evaluate the challenges associated with IoT deployment and propose strategies to mitigate potential issues..

UNIT-II: **10 Periods**

Sensors and Hardware for loT - Accelerometer, Proximity Sensor, lR sensor, Gas Sensor, Temperature Sensor, Chemical Sensor, Motion Detection Sensor. Protocols for loT - infrastructure protocol IPV4/V6|RPL), Identification (URLs), Transport (WiFi, LiFi, BLE), Discovery, Data Protocols, Device Management Protocols. - A Case Study with MQTT/CoAP usage.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Analyze the functionalities and applications of different sensors used in IoT systems, such as accelerometers, temperature sensors, chemical sensors, and motion detection sensors.
2. Evaluate and select appropriate protocols for different aspects of IoT systems, including infrastructure protocols (IPv4/IPv6, RPL), identification protocols (URLs), transport protocols (WiFi, LiFi, BLE), discovery protocols, data protocols, and device management protocols.

UNIT-III: **10 Periods**

Data and Analytics for IoT-An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Apply data analytics techniques to extract valuable insights from IoT-generated data and optimize IoT applications.
2. Assess and utilize various data analytics tools and technologies, including machine learning, big data analytics, edge streaming analytics, and network analytics, in the context of IoT.

UNIT-IV: **10 Periods**

IoT Cloud Platform: Data Collection, Storage and Computing Using a Cloud Platform for IoT Applications/Services, Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively (Pachube/COSM), Nimbits.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Analyze and compare different cloud service models and their applicability to IoT, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).
2. Explore the implementation of IoT cloud-based services using specific platforms such as Xively (formerly known as Pachube/COSM) and Nimbits.

UNIT-V: **10 Periods**

IOT security: Baseline of IOT security, security in perception layer, security in networks and reference architecture, IOT security and secure communication. Case studies with architectural analysis: Smart home, Smart city, Smart grid, Smart traffic, Smart agriculture.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Explain the foundational concepts and importance of IoT security, including the baseline principles and best practices.
2. Evaluate and implement security measures in the perception layer of IoT systems to safeguard IoT devices, data, and communications.

Text books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint);2017 .
2. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)",1St Edition, VPT, 2014.
3. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017.

References:

1. Bahga A, Madisetti V. Internet of Things: A hands-on approach; 2014.
2. Hang Song, "Internet of Everything: Key technologies, Practical applications and Security of IOT", Copyright © 2023 by World Scientific Publishing Co. Pte. Ltd

Data Visualization and Analytics using Open Source Tools	
Code:411(C)	**Credits: 3**
Instruction:**3 Periods/week**	Sessional Marks: 40
EndExam:3 Hours	End Exam Marks:60

Pre-requisites:

- A Strong Mathematical Background in Probability and statistics.
- Proficiency with Algorithms.
- Critical Thinking & Problem Solving Skills.
- Programming Skills in C, Python, R, etc.

Course Objectives:

The course should enable the students to:

1. Understand the difference between data and information and identify different types of data.
2. Differentiate between inferential and descriptive statistics and use inferential statistics to draw meaningful inferences from data.
3. Recognize the importance of data wrangling and the need for data cleanup.
4. Understand how to customize Matplotlib plots, including working with axes, legends, and subplots.
5. Introduce the basics of Seaborn and learn how to use it in conjunction with Matplotlib to enhance visualizations
6. Demonstrate the construction of a dashboard incorporating tables and charts for business applications in Tableau.

Course Outcomes:

By the end of the course, the student will be able to:	
CO-1	Understand the fundamentals of statistics to apply the sequential steps to preprocess the data.
CO-2	Apply various functions using Numpy and pandas on data/information.
CO-3	Apply data wrangling tools to format, handle outliers, remove duplicates, and normalize and standardize data.
CO-4	Apply various functions of Matplotlib and Seaborn on the complex data.
CO-5	Develop advanced data visualization techniques using plots and Creating Dashboards using Tableau.

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	2	3	-	-	-	-	-	-	3	-	-	3	2
2	2	2	3	2	2	-	-	-	-	-	-	-	3	2
3	2	2	2	3	-	3	-	-	3	-	-	-	2	-
4	2	2	3	3	-	3	-	-	3	-	-	-	2	-
5	2	2	-	3	-	2	2	-	-	3	-	3	2	-

SYLLABUS

UNIT-1 **10 Periods**

Introduction to Data: Types of Data, Data pre-processing, Similarity and Dissimilarity measures

Inferential statistics: Difference between inferential statistics and descriptive statistics, Inferential Statistics- Drawing Inferences from Data, Random Variables, Normal Probability Distribution, Sampling, Sample Statistics and Sampling Distributions.

Learning Outcomes: At the end of this Unit the student will be able to:

- Gain a comprehensive understanding of different types of data, including categorical, numerical, ordinal, and interval/ratio data.
- Learn the distinction between descriptive statistics and inferential statistics.

UNIT-II: **10 Periods**

NumPy: Creating ndarray, data types, array attributes, indexing, slicing.

Pandas: Series, data frame, how to read write CSV and Excel files, indexing, adding columns, aggregations, handling missing data, group by and merging.

Learning Outcomes: At the end of this Unit the student will be able to:

Develop proficiency in using NumPy and Pandas libraries for efficient data manipulation and analysis.

UNIT-III: **10 Periods**

Data Wrangling: Introduction, Need of data cleanup, data clean up basics.

Tasks of Data Wrangling: Data wrangling tools with – formatting, outliers, duplicates, Normalizing and standardizing data. Importance of analytics and visualization in the era of data abundance.

Learning Outcomes: At the end of this Unit the student will be able to:

- Gain an understanding of the fundamentals of data wrangling, including the need for data cleanup.
- Learn about the benefits of using analytics techniques to extract insights and patterns from complex datasets.

UNIT-IV: **10 Periods**

Matplotlib: Working with axes, working with legends, line plot, scatter plot, bar plot, box plot, histogram, pie chart and subplots.

Introduction to seaborn: Explore seaborn, customizing seaborn plots, colour palette, multiple plots.

Learning Outcomes: At the end of this Unit the student will be able to:

- Develop a strong command over the Matplotlib library and its core functionalities.
- Introduced to the Seaborn library and its capabilities for advanced data visualization.

UNIT-V: **10 Periods**

Data visualization: Crosstab, scatter plot, box plot, tree map/heat map, bump chart, histograms, motion charts, waterfall charts, waffle charts, geospatial data using choropleth maps. Building dashboard with tables and charts for any business applications using Tableau.

Learning Outcomes: At the end of this Unit the student will be able to:

- Develop a strong understanding of various data visualization techniques.
- Acquire the skills needed to build interactive and visually appealing dashboards using Tableau or similar tools.

Text books:

1. Introduction to Data mining by Vipin Kumar, Pang-Ning Tan, Michael Steinback, Anuj Karpatne;2018.
2. Ashutosh Nandeshwar, Tableau Data Visualization Cookbook, 1e, Packt Publishing.
3. Introduction to statistics by PkGiri and Banerjee, Acaemic publishers.
4. Python for Data Analysis by Wes McKinney, 2nd Edition, O'REILLY.

Reference books:

1. Python Data Science Handbook Essential Tools for Working with Data, Jake VanderPlas, 2nd Edition, O'REILLY.
2. Fabio Nelli, Python Data Analytics, First edition.
3. Data Wrangling with Python: Tips and Tools to Make Your Life Easier, Jacqueline Kazil and Katharine Jarmul, O'Reilly.
4. Interactive Data Visualization: Foundations, Techniques, and Applications, Ward, Grinstein Keim, Natick A. K. Peters Ltd.

Computer Vision (Professional Elective)	
Code: 412(A)	**Credits: 3**
Instruction: **3 Periods+1 Tutorial /week**	Sessional Marks: 40
End Exam: 3 Hours	End Exam Marks: 60

Pre-requisites: Basics of Computer graphics and Image processing

Course Objectives:

The course should enable the students to:

1. Understand the basics of image formation, including geometric primitives and transformations, and how they contribute to the creation of digital images.
2. Explore image sensor technology, including sensor materials and configurations, and understand the functioning of sensor photodiode cells.
3. Apply the principles of image classification and deep learning models to train models using Tensor Flow and Keras.
4. Utilize content-based image retrieval methods to retrieve images based on their visual content
5. Compare and contrast various visual feature extraction methods.
6. Evaluate the performance of object detection models using appropriate metrics.

Course Outcomes (CO):

By the end of the course, the student will be able to:	
CO-1	Develop a comprehensive understanding of image formation, image sensor technology, and 3D depth processing
CO-2	Demonstrate the understanding of image pre-processing techniques and their ability to analyze and manipulate images effectively.
CO-3	Analyze and evaluate image features
CO-4	Apply various techniques and algorithms to retrieve and analyze images
CO-5	Apply the principles of video classification to understand and classify videos using various techniques.

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3	3	-	-	-	-	-	-	-	3	3
2	3	3	3	3	3	3	-	-	-	2	-	-	3	3
3	3	3	-	3	3	3	-	-	-	-	-	-	3	3
4	3	3	3	3	3	3	-	-	3	2	-	-	3	3
5	3	3	-	3	3	3	-	-	-	-	-	-	3	3

SYLLABUS

UNIT-I: **10 Periods**

Introduction to Image formation and sensor technology:
Image Formation – geometric primitives and transformations, photometric image formation, digital camera, 3D depth processing
Image sensor Technology-Sensor materials, sensor photodiode cells, sensor configurations
Learning Outcomes: At the end of this Unit the student will be able to:

1. Apply image formation principles and techniques, including the mathematical models and physical processes involved in capturing and representing images.
2. Design image sensor configurations based on the understanding of sensor materials and their properties

UNIT-II: **10 Periods**

Introduction to Image Pre-Processing – perspectives on image processing, vision pipelines, Image processing taxonomy, preparing images for feature extraction, colorimetry, spatial filtering, edge detectors

Learning Outcomes: At the end of this Unit the student will be able to:

1. Analyze different perspectives on image processing and apply image processing taxonomy to categorize various techniques.
2. Evaluate colorimetry methods and their impact on image processing.

UNIT-III: **10 Periods**

Image Classification: Training the model in Tensor Flow(MNIST), Training the model in Keras(MNIST),The deep learning models- VGG-16,AlexNet,DenseNet

Learning Outcomes: At the end of this Unit the student will be able to:

1. Apply the principles of image classification and deep learning models to train models using Tensor Flow and Keras.
2. Evaluate the accuracy and effectiveness of trained models in image classification tasks.

UNIT-IV: **10 Periods**

Image Retrieval: Understanding Visual features, Content based Image Retrieval,
Object Detection: Detecting objects in an image, Exploring the datasets, Localizing algorithms and Detecting the objects,
Semantic segmentation: Predicting Pixels, The fully convolutional networks, the SegNet architecture

Learning Outcomes: At the end of this Unit the student will be able to:

1. Analyze different content-based image retrieval techniques.
2. Evaluate the performance of object detection models using appropriate metrics.
3. Compare SegNet with other semantic segmentation architectures.

UNIT-V: **10 Periods**

Video Classification: Understanding and classifying videos-exploring video classification datsets, splitiing videos into frames,approaches for classifying videos.

Extending image based approaches to videos-Segmenting videos, captioning videos, generating videos

Learning Outcomes: At the end of this Unit the student will be able to:

1. Analyze video classification datasets and split videos into frames
2. Apply different approaches to classify videos based on their content.

Textbooks:

1. Szeliski R., "Computer Vision: Algorithms and Applications", Springer,2nd Edition; 2022.(Unit-1 & 2)

2. Dr. Stephen Moore, "Deep Learning for Computer Vision", PACKT Publications;2018. (Unit-3,4 &5)

Reference books:

1. Shapiro L. G. and Stockman G., "Computer Vision", Prentice Hall, 2001.
2. Forsyth D. A. and Ponce J., "Computer Vision – A Modern Approach", Second Edition, Pearson Education, 2012.
3. Davies E. R., "Machine Vision: Theory, Algorithms, Practicalities", Morgan Kaufmann, 2004.
4. Jain R., Kasturi R. and Shunck B. G., "Machine Vision", McGraw Hill, 1995.

Bioinformatics (Professional Elective)	
Code: CSE412(B)	**Credits: 3**
Instruction: **3 Periods+1 Tutorial /week**	Sessional Marks: 40
End Exam: 3 Hours	End Exam Marks: 60

Pre-requisites:

- Basic biological concepts with programming skills.

Course Objectives:

The course should enable the students to:

1. Understand the concept of a database in bioinformatics and its importance in storing and retrieving biological data.
2. Learn dynamic programming algorithms for pairwise sequence alignment, including global alignment (Needleman-Wunsch) and local alignment (Smith-Waterman).
3. Explore scoring matrices (PAM, BLOSUM, and Dayhoff) for similarity searches and understand their construction methods. Understand the concept of database searching for similar sequences in bioinformatics.
4. Learn sequence similarity search methods, including FASTA and BLAST.
5. Develop skills in building a training set and utilizing HMM for CpG island prediction and gene finding.
6. Apply RNA structure analysis methods to predict and analyze RNA secondary structures.

Course Outcomes (CO):

By the end of the course, the student will be able to:	
CO-1	Understand the fundamentals of bioinformatics and the principles of pairwise sequence alignment.
CO-2	Demonstrate proficiency in performing multiple sequence alignment using various algorithms and tools, and understand the concepts and principles behind sequence alignment.
CO-3	Develop proficiency in using various database search methods and tools commonly employed in bioinformatics research.
CO-4	Develop a strong understanding of Markov Chains and Hidden Markov Models (HMM) and their applications in bioinformatics
CO-5	Understand the RNA structure analysis, including the terminology of RNA secondary structure.

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	-	-	-	-	-	-	-	-	-	-	2	3
2	3	3	3	3	-	-	-	-	-	-	-	-	2	3
3	-	3	-	3	3	-	-	-	3	-	-	-	2	3
4	3	3	-	3	3	-	-	-	-	-	-	-	2	3
5	3	3	-	-	-	-	-	-	-	-	-	-	2	3

SYLLABUS

UNIT-I: **10 Periods**

Introduction to Bioinformatics: What is a Data Base, Types of Databases, Biological Databases, Pitfalls of Biological Databases, Information Retrieval from Biological Databases, Definition of sequence alignment, Methods - Dot matrix sequence comparison.

Pairwise sequence alignment: Dynamic programming algorithm for sequence alignment – Global Alignment: NeedlemanWunsch, Local Alignment: Smith-Waterman, Gap penalty, Assessing the significance of an alignment

Learning Outcomes: At the end of this Unit the student will be able to:

- Learn techniques and strategies for information retrieval from biological databases, including search algorithms and query design.
- have a solid foundation in bioinformatics, including an understanding of databases, sequence alignment methods, and the ability to retrieve information from biological databases and analyze sequence alignments.

UNIT-II: **10 Periods**

Multiple sequence alignment: Dynamic programming, progressive methods, Iterative methods, MSA using CLUSTAL W,PILEUP and CLUSTAL X, purpose and applications of multiple sequence alignment

Scoring Matrices: Similarity searches - PAM and BLOSUM matrix, Dayhoff mutation matrix, construction of PAM and BLOSUM matrix, Differences between PAM & BLOSUM

Learning Outcomes: At the end of this Unit the student will be able to:

- Equipped with the knowledge and skills to perform multiple sequence alignment using different methods.
- Have a solid understanding of scoring matrices and their role in similarity searches, enabling them to apply appropriate matrices in bioinformatics analyses and interpret their results accurately.

UNIT-III: **10 Periods**

Database search methods: Database searching for similar sequences. Sequence similarity search, FASTA sequence database similarity search, BLAST sequence database similarity search, other methods of comparing database of sequences and patterns.

Learning Outcomes: At the end of this Unit the student will be able to:

- Effectively utilize database search methods to identify similar sequences and patterns in biological databases.
- understand the underlying principles of algorithms such as FASTA and BLAST and have the skills to interpret and evaluate the results of similarity searches

UNIT-IV: **10 Periods**

Markov Chains and HMM: Frequent words in DNA, Consensus word analysis, Transaction and emission matrix, Development of training set, CpG island prediction using HMM, Application of HMM in gene finding, and Multiple sequence alignment by HMM method.

Learning Outcomes: At the end of this Unit the student will be able to:

- Utilize these concepts and techniques to analyze DNA sequences, predict CpG islands, identify gene structures, and perform multiple sequence alignment
- Critically evaluate the results and outcomes of HMM-based analyses, contributing to their proficiency in bioinformatics research and analysis.

UNIT-V: **10 Periods**

RNA Structure Analysis: Terminology of RNA secondary structure, inferring structure by comparative sequence analysis, RNA secondary structure prediction, Nussinov folding algorithm, energy minimization and Zuker folding algorithm

Learning Outcomes: At the end of this Unit the student will be able to:

- Apply computational approaches such as the Nussinov and Zuker algorithms to predict RNA secondary structures accurately.
- Developing critical thinking and problem-solving skills in applying RNA structure analysis techniques to specific biological questions or research projects.

Textbooks:

1. "David W.Mount, David Mount" ,Bioinformatics: Sequence and Genome Analysis
2. "Pierre Baldi and Søren Brunak", Bioinformatics: the Machine Learning Approach –Publisher: MIT Press.
3. "D.W. Mount", Bioinformatics: Genome and Sequence Analysis: (2001) Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
4. "Ian Korf, Mark &Josaph", BLAST, Oreilly Publisher, 2003
5. "R. Durbin, S. Eddy, A. Krogh and G. Mitchison", Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids. Cambridge University Press.
6. "A.D. Baxevanis& B.F.F. Oulette", Bioinformatics – A practical guide to the Analysis of Genes and Proteins,2002, Willey International publishers.
7. "M.J. Bishop and C.J. Rawlings (editors)", DNA and Protein Sequence Analysis---A Practical Approach IRL Press at Oxford University Press, ISBN 0 19 963464 7 (Pbk)

Reference books:

1. "Hooman H Rashidi, Lukas K Buehler", Bioinformatics Basics -2000.
2. "Per Jambeck, Cynthia Gibas", Developing Bioinformatics Computer Skills. Computers – 2001.
3. "Stephen Misener, Stephen A Krawetz", Bioinformatics Methods and Protocols: Methods and Protocols. edited by - Science – 1999.

High Performance Computing (Professional Elective)	
Code: 412(C)	**Credits: 3**
Instruction: 3 Periods+1 Tutorial /week	Sessional Marks: 40
End Exam: 3 Hours	End Exam Marks: 60

Pre-requisites:

- Knowledge of IT Fundamentals
- Knowledge of basic programming and CSA
- Knowledge of OS Concepts
- Knowledge of Mathematics for Computing

Course Objectives:

The course should enable the students to:

1. Develop a comprehensive understanding of parallel computing principles and concepts related to high performance computing.
2. Gain practical experience in hands-on programming models in various high performance computing architectures.
3. Understand the concepts of job scheduling, synchronization with respect to different parallel architectures.
4. Analyzing the performance of parallel programing and overcoming the bottlenecks associated with.
5. Apply HPC techniques and tools to solve real-world computational problems from various domains.

Course Outcomes (CO):

By the end of the course, the student will be able to:	
CO-1	Acquire the knowledge of HPC concepts.
CO-2	Gain proficiency in parallel programming and gaining hands-on experience of various computing architectures.
CO-3	Understanding the system architecture of HPC
CO-4	Interpret the performance analysis and optimization skills of the parallel programs.
CO-5	Apply HPC techniques to solve real-world problems.

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	2	2	2	-	-	-	-	-	1	-	-	2	2
2	2	2	3	2	-	-	-	-	-	1	-	-	2	2
3	2	2	2	2	3	-	-	-	-	1	-	-	2	2
4	2	3	2	2	-	-	-	-	-	1	-	-	2	2
5	2	3	2	2	-	-	-	-	-	1	-	-	2	2

SYLLABUS

UNIT-I: **10 Periods**

Introduction to Parallel Processing Concepts

Levels of parallelism (instruction, transaction, task, thread, memory, function) - Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation etc) - Architectures: N-wide superscalar architectures, multi-core, multi-threaded programming

Learning Outcomes: At the end of this Unit the student will be able to:

- Gain a deep understanding of parallel processing concepts.
- Demonstrate the knowledge of HPC models and architectures.

UNIT-II: **10 Periods**

Title: **Introduction to Parallel Programming with CUDA**

Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in high performance computing architectures: (Examples: IBM CELL BE, Nvidia Tesla GPU, Intel Larrabee Microarchitecture and Intel Nehalem microarchitecture) -Memory hierarchy and transaction specific memory design - Thread Organization

Learning Outcomes: At the end of this Unit the student will be able to:

- Acquire the skills to write, debug and optimize parallel programs using appropriate models and languages such as CUDA.
- Learn how the shared memory will be organized using parallel programming.

UNIT-III: **10 Periods**

Title: **Design Issues in Parallel Computing**

Fundamental Design Issues in Parallel Computing - Synchronization - Scheduling - Job Allocation - Job Partitioning - Dependency Analysis - Mapping Parallel Algorithms onto Parallel Architectures - Performance Analysis of Parallel Algorithms

Learning Outcomes: At the end of this Unit the student will be able to:

- Assess basic patterns for problem decomposition.
- Understand underlying hardware and systems configurations.

UNIT-IV: **10 Periods**

Title: **Limitations Facing Parallel Computing**

Fundamental Limitations Facing Parallel Computing - Bandwidth Limitations - Latency Limitations - Latency Hiding/Tolerating Techniques and their limitations

Learning Outcomes: At the end of this Unit the student will be able to:

- Learn about troubleshooting in parallel computing.
- Understand the techniques to measure, assess and analyze the performance of HPC applications.

UNIT-V: **10 Periods**

Title: **Power-Aware Computing and Communication**

Power-Aware Computing and Communication - Power-aware Processing Techniques - Power-aware Memory Design - Power-aware Interconnect Design - Software Power Management

Advanced Topics - Petascale Computing - Optics in Parallel Computing - Quantum Computers - Recent developments in Nanotechnology and its impact on HPC

Learning Outcomes: At the end of this Unit the student will be able to:

- Understand the role of administration, workload and resource management in HPC software.
- Understand the mechanisms to solve real-world problems.

Text Books:

1. "GPU Gems 3", Hubert Nguyen, August 2007, Addison-Wesley Professional
2. "The Art of Multiprocessor Programming", Maurice Herlihy,Nir Shavit, Revised Reprint. 1st Edition - May 22, 2012.
3. Peter S. Pacheco, "An Introduction to Parallel Programming", Morgan Kaufmann Publishers is an imprint of Elsevier, 2011.

Reference Books:

1. "Introduction to High Performance Computing for Scientists and Engineers" by Georg Hager and Gerhard Wellein, © 2011 by Taylor and Francis Group, LLC CRC Press is an imprint of Taylor & Francis Group, an Informa business.

Web References:

http://www.e-tahtam.com/~turgaybilgin/2013-2014-guz/ParalelProgramlama/ParallelProg.pdf

Principles of Programming Languages
(Professional Elective)

Code: CSE412(D)	**Credits: 3**
Instruction: 3 Periods+1 Tutorial /week	**Sessional Marks: 40**
End Exam: 3 Hours	**End Exam Marks: 60**

Pre-requisites: Basic Programming knowledge

Course Objectives:

The course should enable the students to:

1. Analyze and compare various programming languages based on their paradigms, expressive power, and suitability for different problem domains.
2. Gain proficiency in implementing programs using different programming paradigms, such as procedural, object-oriented, logic-based, and functional programming.
3. Evaluate the trade-offs and best practices related to concurrency, exception handling, and event handling in software design and implementation.
4. Understand the principles and techniques of logic programming, including predicate calculus, logical operators, and rules of inference.
5. Apply functional programming principles to enhance the robustness, modularity, and maintainability of software applications.

Course Outcomes (CO):

By the end of the course, the student will be able to:	
CO-1	Analyze the characteristics and features of programming languages.
CO-2	Implementing different programming paradigms by enhancing problem solving and critical thinking skills.
CO-3	Design and implement robust and responsive software systems by understanding concurrency, exception handling and event handling concepts.
CO-4	Design and implement logic-based solutions for the complex problems.
CO-5	Apply functional programming concepts using Haskell and Scala to develop real world applications

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	2	2	-	2	-	1	-	1	1	-	1	2	2
2	2	3	3	2	2	-	1	-	1	1	-	1	2	2
3	2	3	2	3	2	-	1	-	1	1	-	1	2	2
4	2	3	2	3	3	-	1	-	1	1	-	1	2	2
5	2	3	2	3	3	-	1	-	1	1	-	1	2	2

SYLLABUS

UNIT-I: **10 Periods**

History and Need of Various types of Programming Languages(PL), Types of PL, Characteristics of PL, Syntax, Semantics, Pragmatics Analysis

Learning Outcomes: At the end of this Unit the student will be able to:

- Understand the historical development of programming languages and the factors that led to their evolution.
- Analyze the syntax of programming languages, including the rules and structure governing their expressions, statements, and declarations.

UNIT-II: **10 Periods**

Procedure based languages: General features, Data types, Abstract Data Types (ADT), Structuring, Syntax, Semantics, RAM model of computation, Example: C language

Object based languages: Concepts of objects, Class vs ADT, control structures, methods, General features-inheritance, polymorphism, derived classes & information hiding, Example: C++ and Java, Difference with C.

Learning Outcomes: At the end of this Unit the student will be able to:

- Understand the general features and characteristics of (ADTs) and their role in structuring programs.
- Analyze and evaluate the advantages and disadvantages of object-based languages in terms of code reusability, modularity, and maintainability.

UNIT-III: **10 Periods**

Concurrency: Introduction to Subprogram-Level Concurrency, Semaphores, Monitors , Message Passing, Ada Support for Concurrency, Java Threads ,C# Threads ,Concurrency in Functional Languages, Statement-Level Concurrency.

Exception Handling : Introduction ,Exception Handling in C++ ,Exception Handling in Java, Exception Handling in Python and Ruby.

Event Handling: Introduction, Event Handling with Java ,Event Handling in C# .

Learning Outcomes: At the end of this Unit the student will be able to:

- Demonstrate knowledge of multithreading and thread management in programming languages such as Ada, Java and C#.
- Design and implement exception handling and event handling mechanisms to enhance the robustness and reliability of software programs.

UNIT-IV: **10 Periods**

Logic programming: Predicate calculus- Logical operators, Propositional forms, Rules of inference, Logical equivalence, Quantification, Well formed formula, Disproof's.

Prolog- Syntax, Lists, Operators and arithmetic, Control, i/o, data structures.

Functional Programming: Lambda calculus- Lambda expressions, Variables, Substitutions, Arithmetic, Conditionals, Recursion, Lambda reduction, Type assignment, Polymorphism, Lambda calculus and computability;

Lisp- Control constructs, List processing, Files and i/o, Generic functions, Objects, Exceptions.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Demonstrate proficiency in designing and developing programs using Prolog's logic programming paradigm.
2. Develop programs using functional programming principles and techniques in both lambda calculus and Lisp.

UNIT-V: **10 Periods**

Functional programming with Haskell: Functions and types, Functional composition, Numbers, Lists, Tuples.

Functional programming with Scala: Basic Types and operations, Classes and Objects, Functional Objects, Functions and Closure, Composition and Inheritance.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Apply functional programming principles and techniques to design and implement programs in Haskell and Scala.
2. Gain hands-on experience in designing and implementing functional programs using Haskell and Scala.

Text Books:

1. Robert W. Sebesta, "Concepts of Programming Languages" , Pearson Education;2019
2. Martin Odersky, Lex Spoon, Bill Venners, Frank Sommers – "Programming in Scala" -Artima Press;2021
3. Bird. R,"Thinking Functionally with Haskell", Cambridge University Press;2014

References:

Herbert Schildt. "Java-The Complete Reference" ,11th edition, TMC;2018.

Internet of Things (Professional Elective)	
Code: 413(A)	**Credits: 3**
Instruction: 3 Periods+1 Tutorial /week	Sessional Marks: 40
End Exam: 3 Hours	End Exam Marks: 60

Pre-requisites:

- Basic understanding of computer science and programming concepts.
- Familiarity with networking concepts: Understanding the basics of networking, including TCP/IP, routing, and protocols such as HTTP.

Course Objectives:

The course should enable the students to:

1. Explore the enabling technologies that support IoT implementations, such as microcontrollers, sensors, and communication protocols.
2. Gain practical knowledge and skills in programming and working with microcontrollers like Arduino UNO, ESP8266, and Raspberry Pi.
3. Apply data analytics techniques to process and derive insights from IoT-generated data.
4. Explore IoT security concepts, including security considerations in the perception layer, networks, reference architecture, and secure communication.
5. Analyze case studies of IoT applications in different domains, such as Smart City, Smart Water, Smart Agriculture, Smart Energy, Smart Healthcare, Smart Transportation, Smart Retail, and Smart Waste Management.

Course Outcomes (CO):

By the end of the course, the student will be able to:	
CO1	Demonstrate a comprehensive understanding of IoT principles by applying critical analysis to identify the characteristics of IoT systems, evaluate deployment challenges, and propose appropriate mitigation strategies.
CO2	Apply knowledge of IoT sensors and protocols to effectively design and implement IoT solutions, considering sensor functionalities, selection criteria, and appropriate protocol choices for different aspects of IoT systems.
CO3	Demonstrate proficiency in data analytics for IoT by effectively applying analytics techniques and utilizing relevant tools and technologies to optimize IoT applications.
CO4	Develop proficiency in utilizing cloud platforms for IoT applications, demonstrating the ability to effectively collect, store, and process data using a cloud-based approach.
CO5	Demonstrate proficiency in implementing security measures in perception layers, networks, and communication channels of IoT systems.

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	1	-	-	-	-	3	2	1	-	2	3
2	3	3	3	1	-	-	-	-	3	2	1	-	2	3
3	3	3	3	1	-	1	-	-	3	2	1	-	2	3
4	3	3	3	1	-	1	-	-	3	2	1	-	2	3
5	3	3	3	1	-	1	-	-	3	2	1	-	2	3

SYLLABUS

UNIT I: **10 Periods**

Introduction to loT - loT definition - Characteristics - Things in loT - loT Complete Architectural Stack - loT enabling Technologies - loT Challenges - loT Levels IoT Physical Devices –Micro Controllers : Arduino UNO: Introduction to Arduino, Installation, Fundamentals of Arduino Programming. ESP8266: Introduction, Installation, Python Programming with ESP8266 using sensors. Raspberry Pi: Introduction, Hardware and Software Layout, Configuration, Basic Raspberry Pi Programming with Python

Learning Outcomes: At the end of this Unit the student will be able to:

1. Analyze the characteristics and components of IoT systems to identify their unique features and functionalities.
2. Evaluate the challenges associated with IoT deployment and propose strategies to mitigate potential issues..

UNIT-II: **10 Periods**

Sensors and Hardware for loT - Accelerometer, Proximity Sensor, lR sensor, Gas Sensor, Temperature Sensor, Chemical Sensor, Motion Detection Sensor. Protocols for loT - infrastructure protocol IPV4/V6|RPL), Identification (URLs), Transport (WiFi, LiFi, BLE), Discovery, Data Protocols, Device Management Protocols. - A Case Study with MQTT/CoAP usage.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Analyze the functionalities and applications of different sensors used in IoT systems, such as accelerometers, temperature sensors, chemical sensors, and motion detection sensors.
2. Evaluate and select appropriate protocols for different aspects of IoT systems, including infrastructure protocols (IPv4/IPv6, RPL), identification protocols (URLs), transport protocols (WiFi, LiFi, BLE), discovery protocols, data protocols, and device management protocols.

UNIT-III: **10 Periods**

Data and Analytics for IoT-An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Apply data analytics techniques to extract valuable insights from IoT-generated data and optimize IoT applications.
2. Assess and utilize various data analytics tools and technologies, including machine learning, big data analytics, edge streaming analytics, and network analytics, in the context of IoT.

UNIT-IV: **10 Periods**

IoT Cloud Platform: Data Collection, Storage and Computing Using a Cloud Platform for IoT Applications/Services, Everything as a service and Cloud Service Models, IOT cloud-based services using the Xively (Pachube/COSM), Nimbits.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Analyze and compare different cloud service models and their applicability to IoT, including IaaS, PaaS, and SaaS.
2. Explore the implementation of IoT cloud-based services using specific platforms such as Xively (formerly known as Pachube/COSM) and Nimbits.

UNIT-V: **10 Periods**

IOT security: Baseline of IOT security, security in perception layer, security in networks and reference architecture, IOT security and secure communication. Case studies with architectural analysis: loT applications - Smart City - Smart Water - Smart Agriculture - Smart Energy - Smart Healthcare - Smart Transportation - Smart Retail -Smart waste management.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Explain the foundational concepts and importance of IoT security, including the baseline principles and best practices.
2. Evaluate and implement security measures in the perception layer of IoT systems to safeguard IoT devices, data, and communications.

Text books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,IoT
2. Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743) .
3. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)",1St Edition, VPT, 2014. (ISBN: 978-8173719547)
4. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224)

References:

1. Bahga A, Madisetti V. Internet of Things: A hands-on approach; 2014.
2. Hang Song, "Internet of Everything: Key technologies, Practical applications and Security of IOT", Copyright © 2023 by World Scientific Publishing Co. Pte. Ltd

Soft Computing **(Professional Elective)**	
Code: 413(B)	**Credits: 3**
Instruction: 3 Periods+1 Tutorial /week	Sessional Marks: 40
End Exam: 3 Hours	End Exam Marks: 60

Prerequisites:

- Basic knowledge on Liner algebra, Calculus and Probability
- Basic programming skills

Course Objectives:

The course would aim to make the student understand the basic idea of problem solving through the principles of soft computing, which would be seen as a well-balanced integration of fuzzy logic, evolutionary computing, and neural information processing.

- To introduce the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience.
- To familiarize with genetic algorithms.
- To become familiar with neural networks that can learn from available examples and generalize to form appropriate rules for inference systems.

Course Outcomes (CO):

By the end of the course, the student will be able to:	
CO-1	Understand the fundamental concepts of Fuzzy set Theory
CO-2	Discuss Fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
CO-3	Understand the concept of Genetic Algorithm and its basic operations and then to apply in engineering applications
CO-4	Apply fuzzy computing with Neural Networks models to various real-time problems
CO-5	Understand the foundations of Evolutionary computing with fuzzy logic

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	3	2	1	1	1	-	-	-	-	3	2
2	3	3	3	3	2	1	1	1	-	-	-	-	3	2
3	3	3	3	3	3	1	1	1	-	-	-	-	3	2
4	3	3	3	3	3	1	1	1	-	-	-	-	3	2
5	3	3	3	3	3	1	1	1	-	-	-	-	3	2

SYLLABUS

UNIT-I: **10 Periods**

Fuzzy Logic: Fuzzy Set Theory: Basic Definition and Terminology, Set Theoretic Operations, MF Formulation and Parameterization, MF of two dimensions, Fuzzy Union, Intersection and Complement.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Understand the basics of fuzzy logic
2. Illustrate the operations on fuzzy logic

UNIT-II: **10 Periods**

Fuzzy Rules and Fuzzy Reasoning: Extension Principles and Fuzzy Relations, Fuzzy IF THEN Rules, Fuzzy Reasoning. Fuzzy Inference System Introduction, Mamdani Fuzzy models, Other Variants, Sugeno Fuzzy Models, Tekamoto Fuzzy Models

Learning Outcomes: At the end of this Unit the student will be able to:

1. Explore different types of fuzzy models
2. Apply fuzzy models to real world applications

UNIT-III:

10 Periods

Genetic Algorithms: Fundamentals of Genetic Algorithms: Basic Concepts Creation, Offspring's Encoding, Fitness functions, Reproduction, Genetic Modelling: Inheritance Operators, Cross over, Inversion and detection, Mutation operator, Bitwise operators.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Understand the importance of genetic algorithms
2. Explore the applications of genetic algorithms

UNIT-IV: **10 Periods**

Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference Systems – Architecture – Hybrid Learning Algorithm – Learning Methods that Cross-fertilize ANFIS and RBFN – Coactive Neuro Fuzzy Modeling.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Understand the architecture of neuro-fuzzy systems
2. Understand the framework of neuron functions

UNIT-V: **10 Periods**

Evolutionary Computing: Introduction to Evolutionary Computing- Differential Evolution- Ant Colony Optimization and its applications, Fuzzy-Evolutionary Algorithms.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Understand different optimization techniques.
2. Understand the Different Fuzzy-Evolutionary Algorithms

TEXT BOOKS

J.S.R. Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing" PHI/Pearson Education, New Delhi 2004.

REFERENCES

1. S.Rajasekaran, G.A.Vijayalakshmi Pai,"Neural Networks, Fuzzy Systems, and Evolutionary Algorithms Synthesis and Applications", 2nd Edition, PHI Learning Pvt Ltd;2018.
2. T. J. Ross, "Fuzzy Logic with Engineering Applications." TMH, New York, 1997.
3. D. E. Goldberg, Genetic Algorithms in Search Optimization and Machine Learning,Addison Wesley, 3rd Ed.
4. B. Kosko, Neural Network and fuzzy systems, Prentice Hall of India, 2006

SOCIAL NETWORK ANALYSIS	
Code: 413(C)	**Credits : 3**
Instruction **:** 3 Periods+1 Tutorial /week	Sessional Marks : 40
End Exam : 3 Hours	End Exam Marks : 60

Prerequisites:

- Familiarity with data analysis techniques
- Familiarity with basic concepts in graph theory
- Knowledge of concepts such as graph theory, statistics, probability, and linear algebra

Course Objectives:

1. Understand the internal components of social networks
2. Study the behavior patterns, interactions, and dynamics of users within social networks.
3. Explore and evaluate the security and privacy concerns associated with real-world social networking sites.
4. Develop strategies and techniques to mitigate security and privacy risks in social networks.

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

CO1	Describe the internal components of the social network.
CO2	Develop the Model and visualize the social network.
CO3	Investigate the behavior of the users in the social network.
CO4	Analyze the opinion of the users connected to social network.
CO5	Interpret security and privacy issues in real social networking sites

CO-PO Mapping:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	3	3	3	-	-	-	-	3	-	-	-	1	-
3	3	3	3	-	-	-	-	-	3	-	-	-	1	2
4	-	3	3	-	-	-	-	-	3	-	-	-	1	2
5	-	-	-	-	3	-	-	-	-	-	-	-	-	2

SYLLABUS

UNIT-I **10 Periods**

Introduction to WEB: Introduction to Web - Limitations of current Web – Development of Semantic Web -Emergence of the Social Web – Statistical Properties of Social Networks -Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks.

Learning Outcomes:

1. Understand the limitations of the current Web and recognize the need for advancements in web technologies
2. Examine the characteristics and dynamics of discussion networks within online platforms, including forums, social media, and messaging apps.

UNIT-II **10 Periods**

Modeling And Visualization: Visualizing Online Social Networks - A Taxonomy of 26 Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams - Visualizing Social Networks with Matrix-Based Representations- Node-Link Diagrams - Hybrid Representations - Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships.

Learning Outcomes:

1. Identify and categorize different types of visualizations used for representing online social networks.
2. Implement node-link diagrams to represent and explore social networks visually.

UNIT-III **10 Periods**

Mining Communities: Aggregating and reasoning with social network data- Advanced Representations - Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks.

Learning Outcomes:

1. Demonstrate the ability to detect communities in social networks using appropriate algorithms and methods.
2. Analyze and interpret the results of community mining algorithms, understanding their strengths and limitations.

UNIT-IV **10 Periods**

Text and Opinion Mining: Text Mining in Social Networks -Opinion extraction – Sentiment classification and clustering - Temporal sentiment analysis - Irony detection in opinion mining - Wish analysis - Product review mining – Review Classification – Tracking sentiments towards topics over time.

Learning Outcomes:

1. Apply text mining techniques to extract and analyze product reviews from social network data, including sentiment analysis and feature extraction.
2. Classify reviews based on their content and sentiment, developing models to automatically categorize reviews into predefined classes or categories.

UNIT-V **10 Periods**

Privacy in online social networks: Trust in online environment - Trust models based on subjective logic - Trust network analysis - Trust transitivity analysis - Combining trust and reputation - Trust derivation based on trust comparisons - Attack spectrum and countermeasures. Tools:Gephi, Palladio, NodeXL

Learning Outcomes:

1. Explain the principles and foundations of subjective logic and its application in modeling trust relationships within online systems.
2. Apply subjective logic-based trust models to assess and quantify trust in online interactions and transactions.

Text Books:

1. Peter Mika, "Social Networks and the Semantic Web", 1st Edition, Springer, 2007.
2. BorkoFurht, "Handbook of Social Network Technologies and Applications", 1st edition,Springer, 2010

References:

1. GuandongXu, Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", 1st Edition, Springer, 2011.
2. Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis",Springer, 2010.
3. Ajith Abraham, Aboul Ella Hassanien, VáclavSnáel, "Computational Social NetworkAnalysis: Trends, Tools and Research Advances", Springer, 2009.

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc16_cs07/preview
2. https://gephi.org/
3. https://sites.google.com/a/umn.edu/social-network-analysis/home

CLOUD COMPUTING (Professional Elective)	
Code: 413 (D)	**Credits: 3**
Instruction: 3 Periods+1 Tutorial /week	Sessional Marks: 40
End Exam: 3 Hours	End Exam Marks: 60

Prerequisites:

- To undertake this course student must have basic knowledge of Data Communications,Operating systems and Networking Technologies

Course Objectives:

The course should enable the students to:

- To understand the fundamentals and essentials of cloud computing.
- To provide students a sound foundation of the cloud computing so that they are able to start using and adopting cloud computing services and tools in their real-life scenarios.
- To explore some important cloud computing driven commercial systems such as Google Apps, Microsoft Azure and Amazon Web Services and other businesses cloud applications.

Course Outcomes (CO):

By the end of the course, the student will be able to:	
CO-1	To be familiar with the basics, challenges, need of cloud computing.
CO-2	Describe different cloud services & cloud virtualization.
CO-3	Analyzing different cloud security fundamentals and risks.
CO-4	Explore various cloud platforms and its services.
CO-5	Knowledge on software development, exposure on various cloud applications and its migration.

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	1	1	-	-	-	-	-	-	-	-	-	1	1
2	2	3	2	2	2	-	-	-	-	-	2	1	2	1
3	3	3	2	2	1	1	1	-	1	-	2	1	2	1
4	2	3	3	2	1	-	1	-	1	-	2	1	2	1
5	2	3	2	2	1	1	1	-	1	-	2	1	2	1

Syllabus

Unit I: **10 Periods**

Defining Cloud Computing: Defining Cloud Computing, Cloud Type- The NIST model, The Cloud Cube Model, Deployment models, Service models, Characteristics of Cloud Computing-Paradigm shift, Benefits of cloud computing, Disadvantages of cloud computing, Assessing the Role of Open Standards.
Cloud Architecture: Cloud Computing Stack- Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Explain the cloud computing model and discuss the advantages and disadvantages of cloud.
2. Connect to the cloud equipped with knowledge on protocols and cloud platforms

UNIT-II **10 Periods**

Understanding Services and Application by Type: Defining IaaS- Workloads, Pods, Aggregation and silos, PaaS, SaaS- SaaS characteristics, and IDaaS- What is an identity, IDaas interoperability.

Understanding Abstraction and Virtualization: Virtualization Technologies, Load Balancing and Virtualization, Understanding Hypervisors.
Capacity Planning: Capacity Planning, Defining Baseline and Metrics, Network Capacity

Learning Outcomes: At the end of this Unit the student will be able to:

1. Explore different cloud services and its applications
2. Explore cloud virtualization methods and capacity planning

UNIT-III **10 Periods**

Cloud Computing Software Security Fundamentals: Cloud Security Services, Relevant Cloud Security Design Principles, NIST 33 Security Principles, Secure Cloud Software Testing- Testing for Security Quality Assurance, Cloud Penetration Testing.
Cloud Computing Risk Issues: The CIA Triad, Privacy and Compliance Risks, Common Threats and Vulnerabilities, Cloud Access Control Issues, Cloud Service Provider Risks.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Explain the cloud security services and differentiate testing mechanisms.
2. Explore the cloud risk issues.

UNIT-IV **10 Periods**

Using Platforms: Using Google Web Services, Using Amazon Web Services, Using Microsoft Cloud Services.
Learning Outcomes: At the end of this Unit the student will be able to:

1. Use various cloud platforms
2. Explain platform as service

UNIT-V **10 Periods**

Understanding Services and Applications: Introducing Service Oriented Architecture, Managing and Monitoring SOA.

Moving Applications to the cloud: Applications in the cloud- Functionality Mapping, Application Attributes. Cloud service Attributes, System Abstraction.

Learning Outcomes: At the end of this Unit the student will be able to:

1. Implement the cloud storage services for application development.
2. Able to determine when to move the application from local to the cloud.

Textbooks:

1. "Cloud Computing Bible", Barrie Sosinsky, WileyIndiaPvt.Ltd,2013. (Unit-1: Chapter-1 &3, Unit-2: Chapter-4, 5 & 6, Unit-4: Chapter- 8,9 & 10, Unit-5: Chapter- 13 & 14)
2. "Cloud Security A Comprehensive Guide to Secure Cloud Computing", Ronald L.Krutz Russell Dean Vines, Wiley Publishing, Inc (Unit-3:Chapter-3 &4)

Reference books:

1. Buyya R., Broberg J., GoscinskiA., "Cloud Computing: Principles and Paradigms", John Wiley&SonsInc.,
2. AnthonyT.Velte, TobyJ.Velte, RobertElsenpeter. "CloudComputing-A Practical Approach", 1stEdition, McGrawHill.
3. Cloud computing for dummies-Judith Hurwitz, Robin Bloor, Marcia Kaufman, FernHalper, Wiley Publishing, Inc, 2010.

Principles of Management And Financial Accounting	
CSE 414	**Credits : 3**
Instruction **:** 3 Periods & 1 Tut/Week	Sessional Marks : 40
End Exam : 3 Hours	End Exam Marks : 60

Course Objectives: The course should enable students to

- To familiarize the students with the concepts of Management.
- To gain basic understanding of authority and manage organizations effectively
- To help the students to understand the concept Human Resource Management
- To understand the concepts of costs and its evaluation.
- To understand the basics of Final Accounting and determine the profitable status and financial position of the firm.

Course Outcomes:

By the end of the course, the student will be able to:	
1.	**Understand** the concepts of Management
2.	**Develop** skills to help the team and organization face its toughest challenges
3.	**Develop** the understanding of the concept of human resource management and to understand its relevance in organizations.
4.	**Understand** different types of cost and **Apply** the concepts of Break-Even Analysis in **evaluating** project economically
5.	**Apply** the basic concepts of accounting, finance

Mapping of Course Outcomes with Program Outcomes:

Mapping		PO												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO	1	-	-	-	-	-	-	-	-	1	-	2	2	1	
	2	-	-	-	-	-	-	-	-	3	-	2	2	1	
	3	-	-	-	-	-	-	-	-	1	-	2	2	1	
	4	-	-	-	-	-	-	-	-	1	-	3	2	1	1
	5	-	-	-	-	-	-	-	-	1	-	3	2	1	1

SYLLABUS

UNIT 1: Introduction To Management **9L+3T Periods**

Definition and importance of Management. Management Functions or the Process of Management, Roles of a Manager, Levels of Management, Managerial Skills. Scientific Management and Administrative Management

Learning Outcomes: At the end of this unit, student will be able to

1) Identify the levels and roles of a manager

2) Understand the basic principles of management.

UNIT 2: Leadership **6L+3T Periods**

Definition – Difference between a Leader and a Manager. Characteristics of Leadership, Functions of a Leader. Approaches to Leadership, Leadership style in Indian Organizations.

Learning Outcomes: At the end of this unit, student will be able to

1) Know how to lead through character rather than through coping.

2) Understand the role as a team player.

UNIT 3: Human Resource Management **9L+3T Periods**

Definition of Human Resource Management, Roles of a Personnel Manager, Qualities of Personnel Manager, Functions of Human Resource Management – Planning, Organizing, Staffing, Motivating, Controlling

Learning Outcomes: At the end of this unit, student will be able to

1) Understand the functioning of HR management.

2) Understand how to build and maintain the culture of the organization.

UNIT 4: Cost Analysis And Break-Even Analysis **9L+3T Periods**

Definition of Cost, the Concept and Nature of Cost, Break-Even-Analysis Introduction, Key terms used in Break-Even-Analysis, Graphical Representation-its assumptions, application and Limitations. (Simple problems)

Learning Outcomes: At the end of this unit, student will be able to

1) Understand the concept and apply the cost-volume-profit analysis for business decisions.

2) Know how much minimum is to be produced of sold to escape from suffering from the loss.

UNIT 5: Introduction To Financial Accounting **12L+3T Periods**

Final Accounts- Trading Account, Statement of Profit and Loss and Balance Sheet (with simple adjustments)

Learning Outcomes: At the end of this unit, student will be able to

1) Calculate profit and loss of the organization

2) Understand its financial position.

TEXTBOOK:

1) Principles of Management, P.C.Tripathi and P.N.Reddy, Tata McGraw-Hill
2) S.C. Sharma and Banga T. R., Industrial Organization & Engineering Economics, khanna Publications, Delhi-6, 2006
3) Managerial Economics and Financial Analysis, A.R. AryaSri, TMH Publications, new Delhi, 2014

REFERENCES:

Industrial Engineering and Management, O.P.Khanna, Dhanpat Rai Publications (P) Ltd., New Delhi-2, 2017-18

DATA ANALYTICS (Professional Core)	
Code: 415	**Credits: 3**
Instruction: 2 Periods + 1 Tutorial /week	Sessional Marks: 40
End Exam: 3 Hours	End Exam Marks: 60

Prerequisites:

- Basic knowledge of statistics, probability, algebra and calculus.
- Familiarity with programming concepts and experience in a programming language (preferably Python).
- Familiarity with data formats such as CSV and text files.

Course Objective:

1. Understand and apply a range of statistical techniques
2. Utilize various 2D and 3D plots, charts, and graphs to visually represent and communicate data effectively.
3. Apply probability concepts to analyze and interpret data probabilistically.
4. Present statistical findings, data visualizations, and interpretations in a clear and concise manner.

Course Outcome's:

CO 1	Apply statistical techniques to analyze various types of data and draw meaningful insights.
CO 2	Design and create visually appealing and informative data visualizations using a variety of 2D and 3D plots.
CO 3	Demonstrate a comprehensive understanding of various probability distributions for both discrete and continuous variables.
CO 4	Apply appropriate regression methods, evaluate model fitting and goodness of fit, and utilize advanced techniques for data analysis and interpretation.
CO 5	Interpret and analyze receiver operating characteristic (ROC) curves and precision-recall curves for evaluating classification models.

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	1	-	-	-	-	-	-	-	-	-	-	1	1
2	2	3	2	2	2	-	-	-	-	-	2	1	2	1
3	3	3	2	2	1	1	-	-	1	-	2	1	2	1
4	2	3	3	2	1	-	-	-	1	-	2	1	2	1
5	2	3	2	2	1	1	1	-	1	-	2	1	2	1

SYLLABUS

Unit-1: Introduction to Data 10 Periods

Types of Data, Data pre-processing, Similarity and Dissimilarity measures.

Inferential Statistics: Difference between inferential statistics and descriptive statistics, Inferential Statistics- Drawing Inferences from Data, Random Variables(Discrete, Continuous), Building a Data frame in Python: And Computing Some Statistical Functions, Importing a .txt or .csv File, Loading Data into Python, Creating Random Data in Python, Exploring Mathematics in Python, Statistical Analysis in Python.

Learning Outcome: At the end of this Unit the student will be able to

1. Understand Various Data Types, Inferential & Descriptive Statistics.
2. Implement the few fundamental principles of data analytics using Python programming.

Unit-2: Data visualization using 2D & 3D plots: 10 Periods

Importance of Visualization, Crosstab, Scatter plot, Correlograms, Histograms and Bar Graphs, Heatmaps, box plot, Motion charts, geospatial data using choropleth map.

Learning Outcome: At the end of this Unit the student will be able to

1. Significance of visualizing data to gain insights, communicate findings effectively, and support decision-making processes.
2. Gain proficiency in creating and interpreting various types of visualizations, including crosstabs, scatter plots, correlograms, histograms, bar graphs, heatmaps, box plots, motion charts, and choropleth maps.

Unit-3: Distribution and Analysis: 10 Periods

Discrete: Bernoulli distribution, Binomial distribution, Poisson distribution**.**

Continuous –Uniform distribution, Exponential and Gaussian distribution.

Learning Outcome: At the end of this Unit the student will be able to

1. Understand and analyze various Discrete & Continuous probability distributions.
2. Ability to apply these distributions in real-world scenarios, interpret the results, and make informed statistical inferences based on the characteristics of the distributions.

Unit-4: Analytical Models 10 Periods

Principles of Regression, Linear, Multiple Linear Regression, Fitting Evaluation & Goodness of Fitting, Polynomial Regression, Regularization, Lasso. Logistic Regression, Principal Components Analysis, Cluster Analysis, K-Means Clustering Algorithm.

Learning Outcome: At the end of this Unit the student will be able to

1. Learn these techniques to model relationships between variables, evaluate model fit, interpret coefficients, and make predictions.
2. Understand cluster analysis and the K-means clustering algorithm to identify natural groupings within datasets and evaluate clustering results.

Unit-5: Estimation and Hypothesis testing **10 Periods**

Maximum Likelihood Estimation, Maximum A Posterior Estimation, Minimum Mean Square Estimation. Confidence interval, Bootstrapping, Hypothesis Testing: p-Value Test, Z- Test and T-Test, Neiman-Pearson Test, ROC and Precision-Recall Curve.

Learning Outcome: At the end of this Unit the student will be able to

1. Understand the steps involved in hypothesis testing, including formulating hypotheses, calculating test statistics, and making decisions.
2. Evaluating the performance of classification models using ROC curves and precision-recall curves.

Text books:

1. Introduction to Probability for Data Science by Stanley H.Chan, Purdue University;2021
2. Statistics for Engineers, An Introduction with Examples from Practice, Hartmut Schiefer, Felix Schiefer, Springer Fachmedien Wiesbaden;2021.

Reference books:

- Probability & Statistics for Engineers & Scientists (9th Edn.), Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, Prentice Hall Inc.
- The Elements of Statistical Learning, Data Mining, Inference, and Prediction (2nd Edn.), Trevor Hastie Robert Tibshirani Jerome Friedman, Springer, 2014.
- Fundamentals of Mathematical Statistics by S.C.Gupta and V.K. Kapoor. https://onlinecourses.nptel.ac.in/noc22_ma40/course.

CRYPTOGRAPHY & NETWORK SECURITY LAB	
Code: 416	**Credits : 1.5**
Instruction : 3 periods/Week	Sessional Marks : 50
End Exam : 3 Hours	End Exam Marks : 50

Prerequisites:

- Basic knowledge of Computer Networks
- Exposure to network routing and secure communication techniques

Course Objectives:

1. Introducing different tools related to Network Security.
2. Introducing new cryptographic techniques for safeguarding the network traffic and also web applications.

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Understand the process of capturing Network traffic using tools(Wireshark, Tcpdump)
2.	Implement Cryptographic algorithms in C/C++/Java/Python
3.	Demonstrate Buffer Over Flow attacks, Intrusion Detection Systems and Honeypots.
4	Demonstrate SQL Injection Vulnerability attacks and IP Tables.
5.	Set up an Open Web Application Security Project(OWASP) using a tool.

Mapping of course outcomes with program outcomes:

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	1	2	-	3	-	-	3	2	-	-	3	2	3
2	2	1	2	-	3	-	-	3	2	-	-	3	1	3
3	2	1	3	3	3	-	-	3	3	-	-	3	2	3
4	3	2	3	3	3	-	-	3	2	-	2	3	2	3
5	2	2	3	3	3	-	-	3	3	-	2	3	2	3

SYLLABUS

LIST OF EXPERIMENTS:

1. Working with Sniffers for monitoring network communication using
   a)Wireshark b) Tcpdump
2. Implementation and Performance evaluation of DES Key generation for single round and RSA.
3. Using IP TABLES on Linux and setting the filtering rules.
4. Using open SSL for web server - browser communication.
5. Setup a Honey pot and monitor the honey pot on network using KF Sensor.
6. Prevention of buffer overflow and format string attacks.
7. Using NMAP for ports monitoring
8. Testing a website for SQL Injection Vulnerability using SQLMAP.
9. Demonstrate Intrusion Detection Systems using Snort.
10. Case Study: Conduct a Black-box investigation (OWASP Pen Testing) on a web application and address the vulnerabilities.

Text Books :

1)The Complete Reference Network Security By Robert Bragg,Mark Rhodes-Ousley,Keith Strassberg, 1st Edition,Mc Graw Hill India (2004) Publication

2) The Unofficial Guide to Ethical Hacking by by Ankit Fadia ,Second edition (2006),Laxmi Publications.

3) Network Security Tools Writing, Hacking, and Modifying Security Tools by Nitesh Dhanjani, Justin Clarke, 2013 Edition, Publisher: O'Reilly Media.

4) Linux and UNIX Security Portable Reference Book by Nitesh Dhanjani,1st Edition, McGraw-Hill.

Reference Books:

1)Network Security Tools Writing, Hacking, and Modifying Security Tools By Nitesh Dhanjani, Justin Clarke,2nd Edition, Publisher: O'Reilly Media

Web Resources:

1) https://www.udemy.com/courses/it-and-software/network-and-security/
2) https://online.stanford.edu/course/network-security
3) https://owasp.org/www-project-web-security-testing-guide/assets/archive/OWASP_Testing_Guide_v4.pdf

DATA ANALYTICS LAB	
Code: 417	**Credits :1.5**
Instruction**:**3 Periods	Internal Marks: 50
End Exam: 3 Hours	End Exam Marks: 50

Prerequisites:

- A Strong Mathematical Background in Probability and statistics.
- Proficiency with Algorithms.
- Critical Thinking & Problem Solving Skills.
- Programming Skills in C, Python, R, etc.

Course Objectives:

1. To develop hands-on skills in applying various data analytics techniques and tools.
2. Train the students to gain the knowledge of computational statistical approaches and their application to a variety of datasets.
3. Practical way of Understanding of cluster Analysis.

Course Outcomes:

By the end of the course, the student will be able to:	
1.	Develop proficiency in using Python IDEs and Jupyter Notebooks for data preprocessing and analysis tasks.
2.	Demonstrate proficiency in using NumPy, Pandas, Matplotlib and Seaborn libraries for efficient numerical operations and array manipulation.
3.	Apply statistical analysis to gain insights and identify the patterns on the given dataset
4.	Apply supervised and unsupervised techniques on the given dataset

Mapping of Course Outcomes with Program Outcomes:

CO	PO												PSO	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3	3	-	-	-	3	3	-	-	-	3
2	3	3	3	3	3	-	-	-	3	3	-	-	-	3
3	3	3	3	3	3	-	-	-	3	3	-	-	-	3
4	3	3	3	3	3	-	-	-	3	3	-	-	-	3

List of Experiments

1. **Python Numpy (Recap)**

   Getting familiarity with Python IDE, Notebooks, Data Structures & Numpy.

2. **Pandas**

a) Create a Series object from a list, a NumPy array, or a Python dictionary. Apply most ofthe NumPy functions on the Series object. Create a DataFrame object and Apply arithmetic operations.

b) Create a dataset of sales data for different products and analyze the total sales and average sales for each product.

3. Perform data pre-processing operations on a Dataset.
4. Perform Statistical analysis (Mean, Median, Mode and Standard deviation) on a Dataset.
5. Perform Visualization using Box Plot, Correlogram, and Heatmap.
6. Visualize geospatial data using choropleth map.
7. Perform Simple Linear Regression and Multiple Linear Regression.
8. Perform dimensionality reduction operation using PCA on a Dataset.
9. Perform K-Means clustering operation and visualize the clusters.

Note: ***Students can prepare or choose a dataset suitable for the experiment from open Datasets.***

1. https://archive.ics.uci.edu/datasets
2. https://www.kaggle.com/datasets

Text Books:

1. Applied Univariate, Bivariate, and Multivariate Statistics Using Python, Daniel J. Denis, Wiley, First Edition.

Reference Books:

1. Applied Multivariate Statistical Analysis, Richard. A. Johnson and Dean.W. Wichern, Pearson Prentice Hall, 6th Edition, 2007.
2. An Introduction to Multivariate Statistical Analysis, T.W. Anderson, Wiley, 3rd Edition,2003.

Web Resource:

- http://www.cse.msu.edu/~ptan/dmbook/software/
- https://www.westga.edu/academics/research/vrc/univariate-bivariate-analyses.php.
- https://cse.iitkgp.ac.in/~dsamanta/courses/da/index.html#syllabus