SIES (Nerul) College of Arts, Science and Commerce (Autonomous)
(Affiliated to University of Mumbai)
RE-ACCREDITED GRADE "A" BY NAAC (3rd CYCLE)
BOARD OF STUDIES
SYLLABUS FOR
M.Sc. Computer Science
(WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025)

Sr. No	Heading	Particulars
1	Title of the Programme	M.Sc. (Computer Science)
2	Minimum Percentage for admission	40%
3	Semesters	III & IV
4	Level	PG II
5	Pattern	02 years & 04 semesters CBGS
6	To be implemented from	From Academic year 2024-25 in a progressive manner

Date: 29th June, 2024.

Signature:

Dr. Koel Roychoudhury
AC Chairperson

Dr. Sheeja Ravi
Head of the Department

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BOARD OF STUDIES
SYLLABUS For M.Sc. Computer Science
(WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025)

OBJECTIVES OF THE PROGRAMME:
- To be fundamentally strong at core subject of Computer Science.
- To apply programming and computational skills for industrial solutions.
- Broad understanding of latest technological trends.
- To identify opportunities for establishing an enterprise for immediate Employment.
- Able to understand and apply fundamental research concepts.

PROGRAMME OUTCOMES:
- An ability to apply the skills acquired in post-graduation to get better career prospects.
- An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computational systems.
- An ability to apply the knowledge for higher research in a specialized area of Computer Science.
- Ability to understand and apply the core concepts of Computer Science.
- Ability to provide socially acceptable technical solutions in various domains of specializations.

Level	Semester	Major		RM	OE	VSC, SEC	IKS, AEC/ VEC	OJT/ FP	RP	Cum. Cr. / Sem.
		Mandatory	Elective (Through NPTEL)							
III		Data Visualization Techniques (4 Credits)	TO BE DONE THROUGH NPTEL Wireless Networking OR Cyber security and risk assessment (04 Credits)	-	-	-	-	-	04	22
		Adv. Computer Networking (4 Credits)								
		Cryptology (4 Credits)								
		Advanced Cloud Computing (2 Credits)								
Total of III		14	04	-	-	-	-	-	04	22

Level	Semester	Major		RM	OE	VSC, SEC	IKS, AEC/ VEC	OJT/ FP	RP	Cum. Cr. / Sem.
		Mandatory	Elective (Through NPTEL)							
IV		Deep Learning (4-Credits)	TO BE DONE THROUGH NPTEL Web 3 Tech OR System Network Architecture (04 Credits)	-	-	-	-	-	06	22
		Fund. Of Robotics and Applications (4 Credits)								
		Natural Language Processing (4 Credits)								
Total of IV		12	04	-	-	-	-	-	06	22

SCHEME OF MODULES

No. of Courses	Course Code	Course Name	Credits
Semester IV			
1	**Major**		
1	M24CS4MJ01	Deep Learning	3
2	M24CS4MJP01	Deep Learning Practical	1
3	M24CS4MJ02	Fundamentals of Robotics and Applications	3
4	M24CS4MJP02	Fundamentals of Robotics and Applications Practical	1
5	M24CS4MJ03	Natural Language Processing	3
6	M24CS4MJP03	Natural Language Processing Practical	1
2	**Electives(E) (Any one)(To Be Done Thorough NPTEL)**		
1	M24CS4E01	Web 3 Tech	4
2	M24CS4E02	System Network Architecture	4
3	**Research Project**		
1	M24CS4RP01	Research Project	6
Total Credits			22

SCHEME OF MODULES

Sr. No.	Course Code	Course Name	Credits
Semester III			
Sr. No.	Course Code	Course Name	Credits
1	**Major**		
1	M24CS3MJ01	Data Visualization Techniques	3
2	M24CS3MJP01	Data Visualization Techniques Practical	1
3	M24CS3MJ02	Adv. Computer Networking	3
4	M24CS3MJP02	Adv. Computer Networking Practical	1
5	M24CS3MJ03	Cryptology	3
6	M24CS3MJP03	Cryptology Practical	1
7	M24CS3MJ04	Advanced Cloud Computing	1
8	M24CS3MJP04	Advanced Cloud Computing Practical	1
2	**Electives(E) (Any one)(To Be Done Thorough NPTEL)**		
1	M24CS3E01	Wireless Networking	4
2	M24CS3E02	Cyber security and risk assessment	4
3	**Research Project**		
1	M24CS3RP01	Research Project	4
Total Credits			**22**

<div align="center">**Data Visualization Techniques**</div>

Course Code : M24CS3MJ01   **Course Credit : 3**

1 credit - 15 lectures   **1 lecture is 60 minutes**

Course Objectives:

- To Understand the fundamentals of Visualization.
- Knowledge on working with different Data Collection Structures.
- Designing and Developing practical Data Visualization can be performed using Tableau.

Course Outcome: -

- Familiarity with working with data analysis tools.
- Ability to perform data wrangling for practical purposes.
- Ability to solve real-world data analysis problems with thorough, detailed examples.
- Ability to use Tableau to handle data from various sources and perform analysis of data.

Unit	Syllabus	No. of lectures
1.	**Statistical Methods:** Mean, Mode, Median, Standard deviation, Regression. **Preparing and Storing Data:** Series: Creating a Series with index, creating a Series from a Dictionary, Creating a Series from a Scalar Value, Vectorized Operations and Label Alignment with Series, Name Attribute. Accessing Data from a Series with a Position, Exploring and Analysing a Series, Operations on a Series. **Data Frames**: Creating a Data Frame from a Dict of Series or Dicts, Creating Data Frames from a Dict of Ndarrays, Creating Data Frames from a Structured or Record Array, Creating Data Frames from a List of Dicts, Creating Data Frames from a Dict of Tuples, Selecting, Adding, and Deleting Data Frame Columns, Assigning New Columns in Method Chains, Row Selection, Row Addition, Row Deletion, Exploring and Analysing a Data Frame, Indexing and Selecting Data Frames, Transposing a Data Frame, Data Frame Interoperability with Numpy Functions. Visualizing Data: Data visualization in Business Intelligence, Data visualization techniques. Data visualization libraries in Python.	15
2.	**Data Cleaning, Data Wrangling and Basics of Tableau**: **Data Gathering and Cleaning**: Cleaning Data, Checking for Missing Values, Handling the Missing Values, Reading and Cleaning CSV Data, Merging and Integrating Data, Reading Data from the JSON Format, HTML Format, XML Format. **Data Transformation Removing Duplicates**: Replacing Values, Renaming Axis Indexes **Hierarchical Indexing**: Reordering and Sorting Levels Summary' Statistics by Level Indexing with a DataFrame's columns. Combining and Merging Datasets Database-Style, DataFrame Joins Merging on Index Concatenating Along with an Axis Combining Data with Overlap	15

	Reshaping and Pivoting: Reshaping with Hierarchical Indexing Pivoting "Long" to "Wide" Format Pivoting "Wide" to "Long" Format **Statistical Analysis, Data Aggregation**: Data Grouping, Iterating Through Groups, Aggregations, Transformations, Filtration. **Tableau**: Introduction, connecting to data, Visualizing Data using Tableau, Graphs, charts, and reports **Connecting to Data**: Connecting various data sources, Managing data source metadata, Extract Data, Filtering data. Moving beyond basic visualization. **Calculations**: Introduction to Calculation, Row-level Calculations, Aggregate calculations, parameters, Leveraging level of Detail Calculations. **Telling Data Story with Dashboards**: Designing Dashboards in tableau, Designing for different displays and devices.	
3.	**Data Visualization and Introduction to Power BI**: **Trend Visualization**: Trend Models, Analysing Trend Models. Clustering, Distributions, and Forecasting, Different Charts and Visualization. **Dynamic Dashboards**: Sheet Swapping, Automatically Showing and hiding controls. **Exploring Mapping and Advanced Geospatial Features**: Rendering maps with Tableau. Using Geospatial Data Creating custom territories. Structuring Messy Data to Work Well in Tableau: Structuring data for Tableau. Taming data with Tableau Prep: Cleaning, Transforming, Filtering, and Calculating data.Sharing Data story. **Introduction to Power BI:** Overview of Power BI Desktop, Importing data into Power BI Desktop.	15

REFERENCES:

TEXTBOOKS:
1. Dr. Ossama Embarak, Data Analysis and Visualization Using Python, Apress, 2018
2. Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly, 2nd Edition, 2018.
3. Learning Tableau 2020, Create effective data visualizations, build interactive visual analytics, and transform your organization. Joshua Milligan, Fourth Edition, Packt, 2020.

ADDITIONAL REFERENCES:
1. Jake VanderPlas, "Python Data Science Handbook: Essential Tools for Working with Data",O'Reilly, 2017
2. Visual Data Storytelling with Tableau, Linda Ryan, Pearson Addison Wesley Data &Analytics Series, 2018
3. Visual Analytics with Tableau, Alexander Loth, Wiley, 2019

Data Visualization Techniques Practical

Course Code : M24CS3MJP01   **Credit : 01**

1 Credit – 2 lectures   **1 lecture – 60 minutes**

Note: Practical can be implemented using Python / R studio/ Tableau

Sr. No	List of Practicals
1	Create one dimensional data using series and perform various operations on it.
2	Create Two-dimensional data with the help of data frames and perform different operations on it.
3	Write a code to read data from the different file formats like JSON, HTML, XML, and CSV files and check for missing data and outlier values and handle them.
4	Perform Reshaping of the hierarchical data and pivoting data frame data.
5	Connecting and extracting with various data resources in tableau.
6	Performing calculations and creating parameters in Tableau.
7	Designing Tableau Dashboards for different displays and devices.
8	Create a Trend model using data, Analyse-it and use it for forecasting.
9	Creating Geospatial feature maps in Tableau using Geospatial Data.
10	Create various reports in Tableau Dashboard
11	Create different types of graphs in tableau.
12	Create row-level calculations in tableau.
13	Create Dashboard and Storytelling using tableau.

COURSE CODE: M24CS3MJ03   **COURSE CREDIT: 03**

credit - 15 lectures   **1 lecture is 60 minutes**

Course Objectives:

- To develop the foundation for the study of cryptography and its use in security.
- To understand the role of cryptography in communication over an insecure channel.
- To analyze and compare symmetric-key encryption and public-key encryption schemes based on different security models

Course Outcomes:

- Insights related to cryptography and cryptanalysis.
- Analyze and use methods for cryptography. Implement some of the prominent techniques for public-key cryptosystems and digital signature schemes.
- Understand the notions of public-key encryption and digital signatures and sketch their formal security definitions.

UNIT	Syllabus	No. of lectures
01	Classic Cryptography Techniques: Cryptosystems and Basic Cryptographic Tools: Introduction, Secret-key Cryptosystems, Public-key Cryptosystems, Block and Stream Ciphers, Hybrid Cryptography, Hybrid Cryptography, Message Integrity, Message Authentication Codes, Signature Schemes, Nonrepudiation, Certificates, Hash Functions, Cryptographic Protocols, Security Classical Cryptography: Introduction to Some Simple Cryptosystems, Shift Cipher, Substitution Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Permutation Cipher, Stream Ciphers, Cryptanalysis, Cryptanalysis of the Affine Cipher, Cryptanalysis of the Substitution Cipher, Cryptanalysis of the Vigenere Cipher, Cryptanalysis of the Hill Cipher, Cryptanalysis of the LFSR Stream Cipher. Perfect Secrecy: Introduction, Perfect Secrecy, Entropy, Properties of Entropy, Spurious Keys, and Unicity Distance	15
02	Advanced Encryption, Integrity, and Authentication: Block Ciphers and Stream Ciphers: Substitution-Permutation Networks, Linear Cryptanalysis, Differential Cryptanalysis, Data Encryption Standard, Advanced Encryption Standard, Modes of Operation, Stream Ciphers Hash Functions and Message Authentication: Hash Functions and Data Integrity, Security of Hash Functions, Iterated Hash Functions, Sponge Construction, Message Authentication Codes, Unconditionally Secure MACs RSA Cryptosystem and Factoring: Public-key Cryptography, Number Theory-	15

		Euclidean Algorithm, Chinese Remainder Theorem, Other Useful Facts, RSA Cryptosystem, Primality Testing, Square Roots Modulo n, Factoring Algorithms, Rabin Cryptosystem, Semantic Security of RSA	
03		Public-Key Cryptography and Identity Verification: Public-Key Cryptography and Discrete Logarithms: Introduction, ElGamal Cryptosystem, Shanks' Algorithm, Pollard Rho Discrete Logarithm Algorithm, Finite Fields, Elliptic Curves, Discrete Logarithm Algorithms in Practice, Security of ElGamal Systems Signature Schemes: Introduction to RSA Signature Scheme, Security Requirements, ElGamal Signature Scheme, Variants of the ElGamal Signature Scheme, Full Domain Hash, Certificates, Signing and Encrypting Identification Schemes and Entity Authentication: Passwords and Secure Identification Schemes, Challenge-and-Response in the Secret-key Setting, Challenge-and-Response in the Public-key Setting, Schnorr Identification Scheme, Feige-Fiat-Shamir Identification Scheme	15

TEXTBOOKS:
1. Cryptography Theory and Practice Douglas R. Stinson, , Fourth Edition, CRC Press, 2019
2. Applied Cryptanalysis, Breaking Ciphers in Real World, John Wiley, 2015

REFERENCE BOOKS:
1. Implementing Cryptography, Shannon W. Bray, John Wiley, 2020
2. Algorithmic Cryptanalysis, Antoine Joux, CRC Press, 2017
3. Modern Cryptography: Applied Mathematics for- Encryption and Information Security, William Easttom, Springer, 2021

Cryptology Practical

COURSE CODE: M24CS3MJP03   **COURSE CREDIT: 01**

1 credit - 2 lectures   **1 lecture is 60 minutes**

Note: The practical can be performed in C/C++/Java/Python

Sr. No.	List of Practicals
1	Program to implement password salting and hashing to create secure passwords.
2	Program to implement Substitution Cipher
3	Program to implement Vigenère Cipher
4	Program to implement Affine cipher
5	Program to demonstrate cryptanalysis (e.g., breaking Caesar or Vigener Cipher)
6	Program to implement AES algorithm for file encryption and decryption
7	Program to implement various block cipher modes
8	Program to implement Steganography for hiding messages inside the image file.
9	Program to implement HMAC for signing messages.
10	Program to implement Sending Secure Messages Over IP Networks
11	Program to implement RSA encryption/decryption
12	Program to implement El-Gamal Cryptosystem
13	Program to implement Elliptic Curve Cryptography

Advanced Computer Networking

COURSE CODE: M24CS3MJ02 **COURSE CREDIT: 03**

1 credit - 15 lectures **1 lecture is 60 minutes**

Course Objective:
- Identify important requirements to design and support a data center
- Determine a data center environment's requirements including systems and network architecture as well as services.
- Design a data center infrastructure integrating features that address security, performance, and availability.
- Evaluate options for server farms, network designs, high availability, load balancing, data center services, and trends that might affect data center designs.

Course Outcome:
- Learners will be able to know basic concepts of Server and Data-Centric Networking
- Learners will be able to know about the infrastructure of Data Centers.
- Learners will be able to know about the security measures of Data Centers.
- Learners will be able to know about network designing and virtualization.

Unit	SYLLABUS	No Of lectures
I	Virtualization History and Definitions Data Center: Essential Definition, Data Center Evolution, thernet Protocol, The Humble Beginnings of Network Virtualization,Resource Sharing Control and Management Plane, Concepts from the Routing World, Overlapping Addresses in a Data Center. Virtual Routing and Forwarding:Defining and Configuring VRFs, VRFs and Routing Protocols, VRFs and the Management Plane VRF-Awareness, VRF Resource Allocation Control, Use Case: Data Center Network Segmentation.	15
II	ACE Virtual Contexts: Application Networking Services: The Use of Load Balancers, Load-Balancing Concepts, Security Policies, Suboptimal Traffic, Application Environment Independency, ACE Virtual Contexts, Application Control Engine Physical Connections, Connecting an ACE Appliance, Bridged Design, One-Armed Design. Managing and Configuring ACE: Virtual Contexts, Allowing Management Traffic to a Virtual Context, Allowing Load Balancing Traffic Through a Virtual Context, Controlling	15

	Management Access to Virtual Contexts, ACE Virtual Context Additional Characteristics, Sharing VLANs Among Contexts, Virtual Context Fault Tolerance, Instant Switches, MPLS Basic Concepts.	
III	Virtualization in Server Technologies : Server virtualization: Operational Policies, Configuration, External IPMI Management Configuration, Management IP Address, The Virtual Data Center and Cloud Computing, The Virtual Data Center. Automation and Standardization:Cloud Implementation Example, Journey to the Cloud, Networking in the Clouds, Software-Defined Networks, OpenStack, Network Overlays.	15

TEXTBOOKS:
1. Data Center Virtualization Fundamentals by Gustavo Alessandro Andrade Santana,Cisco Press, 2018
2. Storage Networks Explained Wiley Publishing, 2019

REFERENCE BOOKS:
1. Information Storage and Management Wiley Publishing, 2016
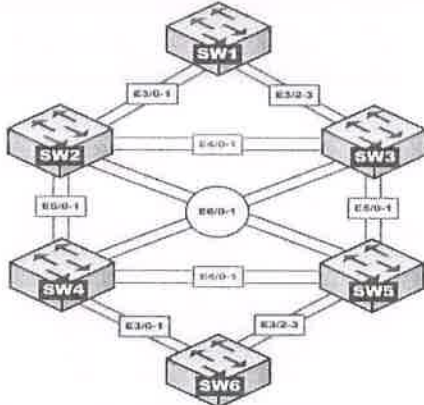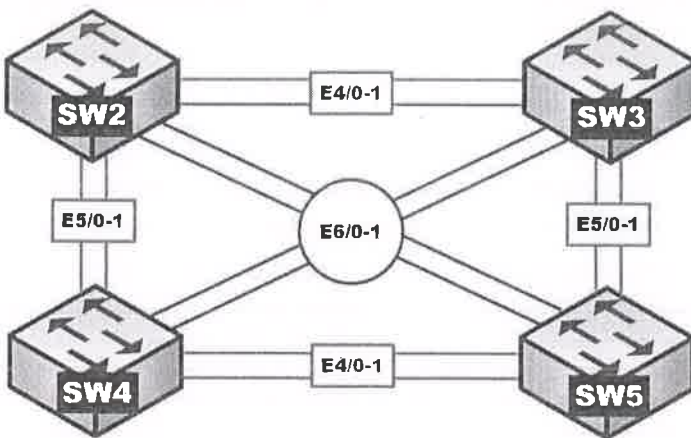
Sr. No	List of Practicals
01	Installation of Vmware Esxi Citrix Xen Microsoft Hyper-V
02	Create and manage the inter connectivity of Virtual Machine on Vmware Esxi Citrix Xen Microsoft Hyper-V
03	Configuring Trunks between switches and VTP Pruning Suggested Topology
04	Configuring EtherChannels Suggested Topology
05	Configure Secure DMVPN Tunnels Implement a DMVPN Phase 1 Hub-to-Spoke Topology Implement a DMVPN Phase 3 Spoke-to-Spoke Topology

06	Implement BGP Path Manipulation Implement BGP Communities
07	Control Routing Updates Path Control Using PBR
08	Implement Route Redistribution Between Multiple Protocols
09	Configure Route Redistribution Within the Same Interior Gateway Protocol
10	Implement GLBP (Load Balance Protocol (GLBP) Configuration Process and Commands
11	Implement VRRP (Configure VRRP commands (Virtual Router Redundancy Protocol))
12	Implement HSRP (How to Configure HSRP with L3 Switching)
13	Implement MPLS (Configure a Basic MPLS VPN Network)

Advanced Cloud Computing

COURSE CODE: M24CS3MJ04   **COURSE CREDIT: 01**

1 credit - 15 lectures   **1 lecture is 60 minutes**

Course Objectives:
- Learners will be able to develop and launch applications in the cloud environment
- Explore various frameworks and APIs that are used for developing cloud-based applications

Unit No	Syllabus	No. of lectures
01	Application Development : Web application vs Cloud,Cloud platforms in Industry – Google AppEngine, Microsoft Azure, Openshift, CloudFoundry, Storing objects in the Cloud, Session management, Amazon Simple Queue Service (SQS), RabbitMQ Managing the data in the Cloud: Securing data in the cloud, ACL, OAuth, OpenID, XACML, securing data for transport in the cloud, scalability of applications and cloud Services. Basics of DevOps: Introduction to DevOps, Continuous Integration and Continous Deployment(CICD) Containerization with Docker, Orchestration (Kubernetes and Terraform) Case study on Amazon EC2/Microsoft Azure/Google Cloud Platform	15

Textbooks:
1. Kevin L. Jackson. Scott Goessling, Architecting Cloud Computing Solutions,Packt Publishing 2018
2. Shailendra Singh, Cloud Computing: Focuses on the Latest Developments in Cloud Computing, Oxford University Press; First edition, June 2018

References:
1. Enterprise Cloud Computing Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010
2. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S Thamarai Selvi, Tata McGraw Hill Education Private Limited, 2013

Advanced Cloud Computing Practical

COURSE CODE : M24CS3MJP04   **COURSE CREDIT: 01**

1 credit - 2 lectures

1 lecture is 60 minutes

Sr.No.	List of Practicals
1	Study and implementation of Infrastructure as a Service
2	Study and implementation of Storage as a Service
3	Study and implementation of identity management
4	Study Cloud Security management
5	Write a program for web feed.
6	Study and implementation of Single-Sing-On.
7	User Management in Cloud
8	Installing and configuring the required platform for Google App Engine
9	Hosting a website on google app engine
10	Creating an application in Dropbox to store data securely. Develop a source code using Dropbox API for updating and retrieving files.
11	Installing and Configuring Dockers in localhost and running multiple images on a Docker Platform.
12	Developing an ASP.NET based web application on the Azure platform
13	Installing Cloud Foundry in localhost and exploring CF commands.

Course Code: M24CS3RP01   **Credits: 4**

1 credit - 15 lectures   **1 lecture is 60 minutes**

Course Objectives:

The syllabus is aimed to achieve the following objectives:

- To facilitate substantial data collection for the proposed research work
- To carry out research following ethical aspects of research activities.
- To compile and communicate the findings/conclusions / results obtained in the science community through various means of communication.
- To enable students to put together a research paper that can be published or presented at conferences.

Learning Outcome:

The learners will be able to:

- Carry out a substantial research-based project
- Capacity development to analyze data and process research findings
- Use research findings to advance education theory and practice.
- Focus on quality review of the research papers and may be published in peer reviewed journals or may be presented in conferences / seminars.

Following are the areas from which students can select the topic of research project:

I.   Interdisciplinary Collaboration
II.   Applied real-world problems
III.   Innovation
IV.   Ethical Issues
V.   Open-Source
VI.   Community Engagement
VII.   Sustainable Solutions

Evaluation

I.   Internal evaluation will be of 60 marks and external evaluation will be of 90 marks.
II.   Students will be allowed to work individually or in groups (maximum number of 02 students in each group).
III.   The pattern of evaluation will be as follows:

Internal Assessment

Sr. No.	Parameter	Marks
1	Continuous Assessment of day-to-day work	08
2	Record keeping	08
3	Design of System	08
4	Outline of the study and possible future plans	08
5	Research Potential of the work	08
6	Troubleshooting Skills	08

External Assessment

Sr. No.	Parameter	Marks
1	Documentation (Abstract, Review of Literature, etc.)	20
2	Quality / Significance	10
3	Working (Methodology, Implementation)	10
4	Presentation	10
5	Viva	10

Project Report Format

A Student should submit project implementation report with following details:

- Cover Page
- Title Page
- Certificate
- Declaration by Student(s)
- Self-attested copy of Plagiarism Report.
- Abstract
- Table of Contents
- List of Figures
- List of Tables
- List of Abbreviations
- Chapters
- References
- Appendices

Chapters – The main text will be divided into several chapters and each chapter may further be divided into sections and subsections. The following are suggested chapters and what they could contain.

a) Introduction
 - brief statement of the problem,
 - importance/novelty of the problem,
 - related literature
 - scope of the project
 - brief statements on what subsequent chapters contain.

b) Approach Used
        This could be in one or more chapters. It should give the details of the approaches used

by the student for arriving at results. The approach could be theoretical, computational, experimental, or a combination of these. The description should be detailed enough to enable someone else with the author's background to use the same approach and get the same results. Detailed part of the description, parameter values used, etc can be be presented in Appendices.

c) Results and Discussion

This chapter include the specific details of data generated and results obtained, in graphical and/or tabular form. Based on the analysis and interpretation of data and results, major findings should be pointed out unambiguously. It should be noted that the findings are to be summarized according to the significance to the stated objectives and should complement the latter. Detailed aspects can be presented in Appendices.

d) Conclusions and Recommendations

Conclusions are to be drawn with reference to the previously stated objectives of the project. This should highlight the major results. Recommendations should be given for any further changes or work that would better accomplish the project objectives or can extend them.

Note: It is very important to draw the figures and prepare the tables yourself. If any figure or table or data or result or opinion is not yours

Deep Learning

COURSE CODE : M24CS4MJ01

COURSE CREDIT: 03

1 credit - 15 lectures

1 lecture is 60 minutes

Course objective:

- Understand the context and use of neural networks and deep learning
- Understand the tools and libraries for deep learning
- Have a working knowledge of neural networks and deep learning
- Explore the parameters for neural networks
- Identify emerging applications of deep learning

Course Outcome:

- Knowledge of implementing neural network architectures for deep learning.
- Skill to implement regularization and optimization of neural network
- Ability to implement advanced networks like CNN, RNN and GAN
- Implement deep learning for advanced applications like object identification, speech, and Language

Unit No	Syllabus	No. of lectures
1.	Neural Network for Deep Learning: Optimization and Neural Network: Review of Neural Network fundamentals, the problem of Learning, Implementing single Neuron-Linear and Logistic Regression, Deep Learning: Fundamentals, Deep Learning Applications, Popular open-source libraries for deep learning Feed-Forward Networks: Networks architecture and Matrix notation, Overfitting, Multiclass Classification with Feed-Forward Neural Networks, Estimating Memory requirement of Models.	15
2.	Convolutional and Recurrent Networks for Deep Learning: Regularization: Complex Network and Overfitting, Regularization and related concepts, Hyperparameter tuning Convolutional Neural Networks:Kernels and Filters, Write a program for object detection using pre-trained models to use object detection. Building Blocks of CNN, Inception Network, Transfer Learning Recurrent Neural Network: Notation and Idea of recurrent neural networks, RNN Topologies, backpropagation through time, vanishing and exploding gradients Deep Learning for AI Games: AI Game Playing, Reinforcement learning, Maximizing	15

		future rewards, Q-learning, The deep Q-network as a Q-function, Balancing exploration with exploitation, Experience replay, or the value of experience.	
3.		Advanced Concepts for Deep Learning: Autoencoders: Introduction, Network Design, Regularization in Autoencoders, Denoising autoencoders, Feed-Forward Autoencoders, spare and Contractive autoencoders Unsupervised Feature Learning: Hopfield networks and Boltzmann machines, restricted Boltzmann machine, Deep belief networks Generative Adversarial Networks (GANs): Introduction, training algorithms, Conditional GANs, applications, Deep convolutional generative adversarial networks Deep Learning for Object Localization and classification: Intersect Over Union (IoU), Sliding Window Approach, Region-Based CNN (R-CNN) Deep Learning for Language Modelling and Speech Recognition.	15

TEXTBOOKS:
1. Python Deep Learning, Valentino Zocca, Packt Publication, 2017
2. Applied Deep Learning, with TensorFlow 2, Umberto Michelucci, Apress, 2022
3. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress, 2017
REFERENCE BOOKS:
1. Advanced Deep Learning with Keras, Rowel Atienza, Packt Publication, 2018
2. Python Deep Learning Cookbook, Indra den Bakker, Packt Publication, 2017
3. Deep Learning with Keras, Antonio Gulli, Packt Publication, 2017

Deep Learning Practical

COURSE CODE : M24CS4MJP01   **COURSE CREDIT: 01**

1 credit - 15 lectures   **1 lecture is 60 minutes**

Note: Following practical can be performed using python

Sr. No	List of Practicals
1	Implement Feed-forward Neural Network and train the network with different optimizers and compare the results.
2	Write a Program to implement regularization to prevent the model from overfitting
3	Implement deep learning for recognizing classes for datasets like CIFAR-10 images for previously unseen images and assign them to one of the 10 classes.
4	Implement deep learning for the Prediction of the autoencoder from the test data (e.g. MNIST data set)
5	Implement Convolutional Neural Network for Digit Recognition on the MNIST Dataset
6	Write a program to implement Transfer Learning on the suitable dataset (e.g. classify the cats versus dogs dataset from Kaggle).
7	Write a program for the Implementation of a Generative Adversarial Network for generating synthetic shapes (like digits)
8	Write a program to implement a simple form of a recurrent neural network. E.g. (4-to-1 RNN) to show that the quantity of rain on a certain day also depends on the values of the previous day
9	Write a program to implement a simple form of a recurrent neural network. LSTM for sentiment analysis on datasets like UMICH SI650 for similar.
10	Write a program for object detection from the image/video.
11	Write a program to recognised hand gesture to operate music activity.
12	Write a program to use of Convolutional Neural Network.
13	Write a program for object detection using pre-trained models to use object detection.

Natural Language Processing

COURSE CODE: M24CS4MJ03   **COURSE CREDIT: 03**

1credit - 15 lectures   **1 lecture is 60 minutes**

Course Objectives:
- To Understand the importance and concepts of Natural Language Processing (NLP)
- To Apply algorithms available for the processing of linguistic information and computational properties of natural languages.
- To gain Knowledge on various morphological, syntactic, and semantic NLP tasks.
- To introduce various NLP software libraries and data sets publicly available.
- To Design and develop practical NLP based applications

Course Outcomes:
- The ability to describe the concepts of morphology, syntax, semantics, discourse & pragmatics of natural language
- Discover various linguistic and statistical features relevant to the basic NLP task, namely, spelling correction, morphological analysis, parts-of speech tagging, parsing, and semantic analysis
- Assess and Evaluate NLP based systems
- Ability to choose appropriate solutions for solving typical NLP subproblems (tokenizing, tagging, parsing)
- Analyse NLP problems to decompose them inadequate independent components and develop real-life applications.

Sr. No	Syllabus	No. of lectures
01	Introduction to Natural Language Processing (NLP) and Language Modelling Introduction to NLP: Introduction and applications, NLP phases, Difficulty of NLP including ambiguity; Spelling error and Noisy Channel Model; Concepts of Parts-of speech and Formal Grammar of English. Language Modelling: N-gram and Neural Language Models Language Modelling with N-gram, Simple N-gram models, smoothing (basic techniques), Evaluating language models; Neural Network basics, Training; Neural Language Model, Case study: application of neural language model in NLP system development Python Libraries for NLP: Using Python libraries/packages such as NaturalLanguage Toolkit (NLTK), spaCy, genism	15
02	Morphology & Parsing in NLP Computational morphology & Parts-of-speech Tagging: basic concepts; Tagset; Lemmatization, Early approaches: Rule-based and TBL; POS tagging using HMM, Introduction to POS Tagging using Neural Model. Parsing Basic concepts: top-down and bottom-up parsing, treebank; Syntactic parsing: CKY parsing; Statistical Parsing basics: Probabilistic Context-Free Grammar (PCFG); Probabilistic CKY Parsing of PCFGs	15
03	Semantics and Word Embedding Semantics Vector Semantics: Words and Vector; Measuring Similarity; Semantics with dense vectors; SVD and Latent Semantic Analysis Embeddings from prediction: Skip-gram and Continuous Bag of words; Concept of Word Sense; Introduction to WordNet. NLP Applications and Case Studies Intelligent Work Processors: Machine Translation; User Interfaces; man-machine Interfaces: Natural language Querying Tutoring and Authoring Systems. Speech Recognition Commercial use of NLP: NLP in customer Service, Sentiment Analysis, Emotion Mining, Handling Frauds and SMS, Bots, LSTM & BERT models, Conversations	15

Text book:

Speech and Language Processing, Jurafsky Dan and Martin James H., 3rd Edition, Pearson, 2018.

Natural Language Processing with Python, Steven Bird, Ewan Klein, and Edward Loper, 2nd Edition, O'Reilly, 2016.

Reference book:

Practical Natural Language Processing with Python, Mathangi Sri, Apress, 2021

Handbook of Computational Linguistics and Natural Language Processing, Martin Whitehead, Clanrye International, 2020

Handbook of Natural Language Processing, Nitin Indurkhya and Fred J. Damerau, Pearson; 2nd edition, 2008

Foundations of Statistical Natural Language Processing, Manning Christopher and Heinrich, Schutze, MIT Press, 1997

Natural Language Processing Practicals

COURSE CODE   : M24CS4MJP02   COURSE CREDIT: 01

1 credit - 2 lectures   **1 lecture is 60 minutes**

Note: - The following set of practicals can be performed using any Python Libraries for NLP such as NLTK, spaCy, genism:
Link:-https://www.python.org/downloads/

Sr. No.	List of Practicals
1	Write a program to implement sentence segmentation and word tokenization
2	Write a program to Implement stemming
3	Write a program to Implement lemmatization
4	Write a program to Implement a tri-gram model
5	Write a program to Implement PoS tagging using HMM & Neural Model
6	Write a program to Implement syntactic parsing of a given text
7	Write a program to Implement dependency parsing of a given text
8	Write a program to Implement Named Entity Recognition (NER)
9	Write a program to Implement Text Summarization for the given sample text
	CASE STUDIES
10	Consider a scenario of applying NLP in Customer Service. Design and develop an application that demonstrates NLP operations for working with tasks and data like voice calls, chats, Ticket Data, Email Data. Process the data to understand the voice of the Customer (intent mining, Top words, word cloud, classify topics). Identify issues, replace patterns and gain insight into sales chats.
11	Consider a scenario of Online Review and demonstrate the concept of sentiment analysis and emotion mining by applying various approaches like lexicon-based approach and rule-based approaches.
12	Apply NLP in Banking, Financial Services, and Insurance. Design Application to detect frauds and work with SMS data.
13	Demonstrate the use of NLP in designing Virtual Assistants. Apply LSTM, build conversational Bots

Fundamentals of Robotics and Applications

COURSE CODE : M24CS4MJ02   **COURSE CREDIT: 03**

1 credit - 15 lectures   **1 lecture is 60 minutes**

Course Objective:

- Leverage the features of the Raspberry Pi OS
- Discover how to configure a Raspberry Pi to build an AI-enabled robot
- Interface motors and sensors with a Raspberry Pi
- Code robot to develop engaging and intelligent robot behaviour
- Explore AI behaviour such as speech recognition and visual processing

Course Outcome:

- Knowledge about the fundamentals of Robotics and its applications
- Ability to use Raspberry Pi for programming Robotics
- Ability to apply robotics in speech and vision problems

Unit No.	SYLLABUS	No Of Lectures
1	**Introduction to Robotics** Introduction to Robotics: What is a robot? Examples of Advanced and impressive robots, Robots in the home, Robots in industry Robotics in Action: Exploring Robot Building Blocks - Code and Electronics Technical requirements, Introducing the Raspberry Pi - Starting with Raspbian Technical requirements, Raspberry Pi controller on a robot.	15
2	**Building Robot Basics** Technical requirements: Robot chassis kit with wheels and motors, a motor controller, Powering the robot, Test fitting the robot, Assembling the base. Robot Programming: Programming technique, adding line sensors to our robot, creating line-sensing behaviour, and Programming RGB Strips in robot. Servo Motors: Use and control of servo motors, pan, and tilt mechanism. Distance sensors, Introduction to distance sensors and their usage. Connecting distance sensors to robot and their testing. Creating a smart object avoidance behaviour. Creating a menu to select different robot behaviours, Distance and speed measuring sensors—encoders and odometry.	15
3	Robotics setup: Setting up a Raspberry Pi Camera on the robot (software and hardware), Check the robot vision on a phone or laptop, Mask images with RGB strips. Robotics for Vision and Voice Applications: Colors, masking, and filtering – chasing colored objects, Detecting faces with Haar cascades, Finding objects in an image, Voice Communication with a robot.	15

Textbooks:

Danny Staple, Robotics Programming, Packt Publishing, 2nd edition, Feb 2021

Reference Books:

Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley, 3rd Edition, 2019

D. K. Pratihar, FUNDAMENTALS OF ROBOTICS, Narosa Publication, 2016

Lentin Joseph, Learning Robotics Using Python, Packt Publishing Ltd., May 2015

Fundamentals of Robotics and Applications Practical

COURSE CODE : M24CS4MJP02   **COURSE CREDIT: 01**

1 credit - 15 lectures

1 lecture is 60 minutes.

Note: Following practical can be performed using Python and simulators, Raspberry Pi, and other hardware devices

Sr. No	List of Practicals
1	Making a Raspberry Pi headless, and reaching it from the network using WiFi and SSH.
2	Using sftp upload files from PC.
3	Write Python code to test motors.
4	Write a script to follow a predetermined path.
5	Develop Python code for testing the sensors.
6	Add the sensors to the Robot object and develop the line-following behaviour code.
7	Using the light strip develop and debug the line follower robot.
8	Add pan and tilt service to the robot object and test it.
9	Pan/tilt face tracking with a Raspberry Pi and OpenCV.
10	Create an obstacle avoidance behaviour for robot and test it.
11	Detect faces with Haar cascades.
12	Use the robot to display its camera as a web app on a phone or desktop, and then use the camera to drive smart color and face-tracking behaviours.
13	Use a Raspberry Pi to run the Mycroft environment and connect it to a speaker/microphone combination

Research Project

Course Code: M24CS4RP01   **Credits: 6**

1 credit - 15 lectures   **1 lecture is 60 minutes**

Course Objectives:

The syllabus is aimed to achieve the following objectives:

- To facilitate substantial data collection for the proposed research work
- To carry out research following ethical aspects of research activities.
- To compile and communicate the findings/conclusions / results obtained in the science community through various means of communication.
- To enable students to put together a research paper that can be published or presented at conference.

Learning Outcome:

The learners will be able to:

- Carry out a substantial research-based project
- Capacity development to analyze data and process research findings
- Use research findings to advance education theory and practice.
- Focus on quality review of the research papers and may be published in peer reviewed journals or may be presented in conferences / seminars.

Following are the areas from which students can select the topic of research project :

I.	Interdisciplinary Collaboration
II.	Applied real-world problems
III.	Innovation
IV.	Ethical Issues
V.	Open-Source
VI.	Community Engagement
VII.	Sustainable Solutions

Evaluation

I.   Internal evaluation will be of 60 marks and external evaluation will be of 90 marks.

II.   Students will be allowed to work individually or in groups (maximum number of 02 students in each group).

III.   The pattern of evaluation will be as follows:

Internal Assessment

Sr. No.	Parameter	Marks
1	Continuous Assessment of day-to-day work	10
2	Record keeping	10
3	Design of System	10
4	Outline of the study and possible future plans	10
5	Research Potential of the work	10
6	Troubleshooting Skills	10

External Assessment

Sr. No.	Parameter	Marks
1	Documentation (Abstract, Review of Literature, etc.)	30
2	Quality / Significance	15
3	Working (Methodology, Implementation)	15
4	Presentation	15
5	Viva	15

Project Report Format

A Student should submit project implementation report with following details:
- Cover Page
- Title Page
- Certificate
- Declaration by Student(s)
- Self-attested copy of Plagiarism Report.
- Abstract
- Table of Contents
- List of Figures
- List of Tables
- List of Abbreviations
- Chapters
- References
- Appendices

Chapters – The main text will be divided into several chapters and each chapter may further be divided into sections and subsections. The following are suggested chapters and what they could contain.

a) Introduction
 - brief statement of the problem,
 - importance/novelty of the problem,
 - related literature
 - scope of the project
 - brief statements on what subsequent chapters contain.

b) Approach Used

This could be in one or more chapters. It should give the details of the approaches used by the student for arriving at results. The approach could be theoretical, computational, experimental, or a combination of these. The description should be detailed enough to enable someone else with the author's background to use the same approach and get the same results. Detailed part of the description, parameter values used, etc can be presented in Appendices.

c) Results and Discussion

This chapter include the specific details of data generated and results obtained, in graphical and/or tabular form. Based on the analysis and interpretation of data and results, major findings should be pointed out unambiguously. It should be noted that the findings are to be summarized according to the significance to the stated objectives and should complement the latter. Detailed aspects can be presented in Appendices.

d) Conclusions and Recommendations

Conclusions are to be drawn with reference to the previously stated objectives of the project. This should highlight the major results. Recommendations should be given for any further changes or work that would better accomplish the project objectives or can extend them.

Note: It is very important to draw the figures and prepare the tables yourself. If any figure or table or data or result or opinion is not yours, cite relevant reference.