CENTRAL UNIVERSITY OF KERALA

School of Physical Sciences

DEPARTMENT OF COMPUTER SCIENCE

M.Sc. (Computer Science)

Specialization: Intelligent Systems

Programme Structure

Multidisciplinary, Internship embedded, value-added/experiential/skill-oriented courses with multiple entry/exit options as per NEP 2020

(Applicable for 2025 batch onwards)

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	DEPARTMENT OF COMPUTER SCIENCE M.Sc. COMPUTER SCIENCE – COURSE STRUCTURE (2025)									
Course Category	**Course Code**	**Course Title**	**Marks**			**Teaching hours/week**			**Credits**	**Exam Hours**
			CA	**ESA**	**Total**	**L**	**T**	**P**		
SEMESTER I										
DSC1	25CSCPG1DSC01	Computational Mathematics	60	40	100	2	1	0	3	3
DSC2	25CSCPG1DSC02	Advanced Data Structures and Algorithms	60	40	100	3	0	0	3	3
DSC3	25CSCPG1DSC03	Operating Systems	60	40	100	3	0	0	3	3
DSC4	25CSCPG1DSC04	Object Oriented Programming	60	40	100	3	0	0	3	3
DSC5	25CSCPG1DSC05	Computational Intelligent Systems	60	40	100	3	0	0	3	3
OPE	XXXXXPG1OPEXX	Open Elective 1	30	20	50	2	0	0	2	2
DSC Pr.1	25CSCPG1DSC06	Object Oriented Programming Lab	30	20	50	0	0	4	2	3
DSC Pr.2	25CSCPG1DSC07	Data Structures Lab	30	20	50	0	0	4	2	3
		Total	**390**	**260**	**650**	**16**	**1**	**8**	**21**	
SEMESTER II										
DSC6	25CSCPG2DSC01	Cryptography and Network Security	60	40	100	2	1	0	3	3
DSC7	25CSCPG2DSC02	Image Processing	60	40	100	2	1	0	3	3
DSC8	25CSCPG2DSC03	Data Mining	60	40	100	3	0	0	3	3
DSC9	25CSCPG2DSC04	Artificial Intelligence and Machine Learning	60	40	100	3	0	0	3	3
DSE1	25CSCPG2DSE01	Data Analysis using R Programming	60	40	100	3	0	0	3	3
	25CSCPG2DSE02	Digital Speech Processing								
	25CSCPG2DSE03	Web Intelligence								
OPE1	XXXXXPG2OPEXX	Open Elective 2	60	40	100	3	0	0	3	3
DSC Pr.3	25CSCPG2DSC05	Artificial Intelligence and Machine Learning Lab	30	20	50	0	0	4	2	3
DSC Pr.4	25CSCPG2DSC06	Network and Information Security Lab	30	20	50	0	0	4	2	3
		Total	**420**	**280**	**700**	**16**	**2**	**8**	**22**	
* Internship to be done during vacation after second semester and viva voce examination during third semester										
SEMESTER III										
DSC10	25CSCPG3DSC01	Big Data Analytics	60	40	100	3	0	0	3	3
DSC11	25CSCPG3DSC02	Pattern Recognition	60	40	100	2	1	0	3	3
INT	25CSCPG3INT01	Internship*	60	40	100	0	0	6	3	-
DSE2	25CSCPG3DSE01	Deep Learning	60	40	100	3	0	0	3	3
	25CSCPG3DSE02	High Performance Computing								
	25CSCPG3DSE03	C# .NET Framework and Unity								
MOOC	XXXXXXXXXX	MOOC Elective	60	40	100	3	0	0	3	3
OPE2	XXXXXPG2OPEXX	Open Elective 3	60	40	100	3	0	0	3	3
DSC Pr.5	25CSCPG3DSC03	Full Stack Development Lab	30	20	50	0	0	4	2	3
DSC Pr.6	25CSCPG3DSC04	Data Analytics Lab	30	20	50	0	0	4	2	3
		Total	**420**	**280**	**700**	**14**	**1**	**14**	**22**	

Course Category	Course Code	Course Tile	Marks			Teaching hours/week			Credits	Exam Hours
			CA	ESA	Total	L	T	P		
SEMESTER IV										
DSC12	25CSCPG4DSC01	Generative AI	60	40	100	2	1	0	3	3
Dissertation	25CSCPG4DIS01	Dissertation	60	40	100	3	0	0	6	-
DSE3	25CSCPG4DSE01	Web Mining and Social Networking	60	40	100	3	0	0	3	3
	25CSCPG4DSE02	Natural Language Processing								
	25CSCPG4DSE03	Computer Graphics								
DSE4	25CSCPG4DSE04	Cyber Security	60	40	100	0	0	12	3	3
	25CSCPG4DSE05	Blockchain Technology								
	25CSCPG4DSE06	Cloud Computing Security								
		Total	**240**	**160**	**400**	**8**	**1**	**12**	**15**	

LIST OF OPEN ELECTIVE COURSES

	Category	Course Code	Title of the Paper	Marks			Teaching hours/week			Credits	Exam Hours
				CA	ESA	Total	L	T	P		
Semester 1	Open Electives	25CSCPG1OPE01	Enjoyable programming	30	20	50	2	0	0	2	2
		25CSCPG1OPE02	C Programming								
		25CSCPG1OPE03	MATLAB								
		25CSCPG1OPE04	R Programming								
		25CSCPG1OPE05	Internet of Things								
		25CSCPG1OPE06	Fundamentals of Generative AI								
Semester 2 Or Semester 3	Open Electives	25CSCPG2OPE01	C++ Programming	60	40	100	3	0	0	3	3
		25CSCPG2OPE02	Python Programming								
		25CSCPG2OPE03	Data Analytics with Python								
		25CSCPG2OPE04	Machine Learning								
		25CSCPG2OPE05	Web Technology								
		25CSCPG2OPE06	Metaverse								
		25CSCPG2OPE07	C # Programming								
		25CSCPG2OPE08	Cyber Security Essentials								
		25CSCPG2OPE09	Natural Language Processing								
		25CSCPG2OPE10	JAVA Programming								

L : Lecture, T: Tutorial, P : Practical

YEAR WISE CREDIT DISTRIBUTION

Semester	Major Core	Core Elective	Open Elective	MOOC	Internship	Dissertation	Total
1	19	-	2	-	-	-	21
2	16	3	3	-	-	-	22
3	10	3	3	3	3	-	22
4	3	6	-	-	-	6	15
Total	**48**	**12**	**8**	**3**	**3**	**6**	**80**

Credits distribution:

Credits for Core Courses	:	48
Credits for Core Elective Courses	:	12
Credits for Open Elective Courses	:	8
Credits for Discipline Specific Elective from MOOC	:	3
Internship	:	3
Dissertation	:	6
Total	:	80

Exit/Entry: As per the regulation of the University
Open Elective courses (interdisciplinary/skill based) must be learnt from other departments
Core Elective: Core Elective courses must be learnt from the Computer Science department.

Regulations: The NEP 2020 based CBCS regulations of the University will be strictly followed for the continuous and end semester assessment.

Programme Outcomes

The students will be able to attain the following after the completion of M.Sc. Computer Science

(i) Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.
(ii) Equip the student with skills to analyze problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.
(iii) Prepare students for pursuing research or careers in industry in mathematical sciences and allied fields
(iv) Imbibe effective scientific and/or technical communication in both oral and writing.
(v) Continue to acquire relevant knowledge and skills appropriate to professional activities and demonstrate highest standards of ethical issues in computer science and related disciplines.
(vi) Create awareness to become an enlightened citizen with commitment to deliver one's responsibilities within the scope of bestowed rights and privileges for supporting the society.

Programme Specific Outcomes

The Computer Science Department's Master of Science program must enable students to attain, by the time of post-graduation

(i) An ability to apply knowledge of computing and mathematics appropriate to the Intelligent Systems.
(ii) An ability to identify, formulate, and develop solutions to computational challenges and to analyse, design and develop cost effective solutions to the societal problems.

(iii) An ability to design, implement, and evaluate a computational intelligent system to meet desired needs within realistic constraints.
(iv) An ability to function effectively on teams to accomplish shared computing design, evaluation, or implementation goals towards computational intelligent systems.
(v) An understanding of professional, ethical, legal, security, and social issues and responsibilities for the design of computational intelligent systems.
(vi) An ability to communicate and engage effectively with diverse stakeholders while designing computational intelligent systems.
(vii) Recognition of the need for and ability to engage in continuing professional development in the field intelligent system.
(viii) An ability to use appropriate techniques, skills, and tools necessary for computational Intelligence.
(ix) An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modelling and design of computational intelligent systems in a way that demonstrates comprehension of the trade-offs involved in design choices and to meet realistic constraints.
(x) Identify, analyze and synthesize scholarly literature relating to the field of computational intelligence

Course Objectives and Course Outcomes

Major Core Courses

25CSCPG1DSC01 - Computational Mathematics

This is a participatory and problem solving skill development course.

Course Objective:
The objective of this course is to equip students with both theoretical foundations and practical skills to mathematically represent real-world problems and develop computational models for their solutions.
By completing this course, students will obtain the following course outcomes:
1. Knowledge to be gained:
(i) Mathematical foundations relevant to computational methods.
(ii) Modelling of real-world problems using mathematical and algorithmic methods.
(iii) Understanding data representation in computers and its impact on numerical algorithms.
2. Skill to be gained:
(iv) Proficiency in implementing mathematical concepts and computational algorithms using AI-related toolboxes and packages in Python or MATLAB.
(v) Critical thinking and analytical skills to design, analyse, and optimize computational algorithms effectively.
3. Competency to be gained:
(vi) Ability to computationally model and solve real-world problems by integrating mathematical theories with algorithmic implementations.

Prerequisites: Basic knowledge in mathematics

25CSCPG1DSC02 - Advanced Data Structures and Algorithms

This is a problem solving skill development course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of advanced data structures and algorithms.

By completing this course, students will obtain the following course outcomes:
1. Knowledge to be gained:

(i) Fundamental concepts of design and analysis of algorithms

2. Skill to be gained:
   (ii) Critical analyzing and choosing appropriate data structures and algorithms to solve a specific problem
   (iii) Design an algorithm in the context of space and time complexity
3. Competency to be gained:
   (iv) Design optimized algorithms with appropriate data structure for real world problems

Prerequisites: Basic knowledge in programming

25CSCPG1DSC03 – Operating Systems

This is an introductory and participatory learning course.

Course Objective:
The main objective of this course is to impart knowledge on the basic principles of operating system design issues.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Management of operating system functionalities (CPU, Memory, File management)
2. Skill gained:
   (ii) Modelling software based on memory requirements
3. Competency gained:
   (iii) Utilization of inter-process communication strategies and access control in an operating system

Prerequisites: Nil

25CSCPG1DSC04 - Object Oriented Programming

The main objective of this course is to introduce the object oriented concepts using C++ language

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Interpret the fundamental syntax and semantics of C++
   (ii) Understanding the object oriented principles in software design process
   (iii) Articulate the Object-Oriented Programming concepts such as encapsulation, inheritance and polymorphism
2. Skill gained:
   (ii) Development of C++ programs for solving the real world problems using object oriented concepts.
3. Competency gained:
   (iii) Apply the object oriented programming concepts for finding solutions of some real life problems.

Prerequisites: Nil

25CSCPG1DSC05 - Computational Intelligent Systems

This is a participatory, experimental and problem solving skill development course.

Course Objective
The objective of the course is to provide theoretical and practical aspects of computational intelligence in representing real world problems and digitally modelling it.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Fundamental concepts of computational intelligence (fuzzy, neural networks and genetic algorithms)
2. Skill gained:
   (ii) Modelling and representation of real world problems using fuzzy logic and neural networks
   (iii) Optimization of real world problems using genetic algorithms.
   (iv) Critical analyzing and logic skills in developing computationally intelligent algorithms.
3. Competency gained:

(v) Development of Computational Intelligence system in a variety of real world problem

Prerequisites: Nil

25CSCPG1DSC06 - Object Oriented Programming Lab

This is a problem solving skill development practical course.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Solve problems using the syntax and semantics of C++ languages.
   (ii) Solve problems using the object oriented concepts
   (iii) Articulate the Object-Oriented Programming concepts such as encapsulation, inheritance and polymorphism
2. Skill gained:
   (ii) Development of C++ programs for solving the real world problems using object oriented concepts.
3. Competency gained:
   (iii) Apply the object oriented programming concepts for finding solutions of some real life problems.

Prerequisites: Nil

25CSCPG1DSC07- Data Structures Lab

This is a problem solving skill development practical course.

Course Objective:
The objective of the course is to provide practical aspects of data structures and algorithms.

By completing this course, students will obtain the following course outcomes:
1. Knowledge to be gained:
   (i) Fundamental concepts of design and analysis of algorithms
2. Skill to be gained:
   (ii) Choosing appropriate data structures and algorithms to solve a specific problem
   (iii) Design an algorithm in the context of space and time complexity
3. Competency to be gained:
   (iv) Design optimized algorithms with appropriate data structure for real world problems

Prerequisites: Basic knowledge in programming

25CSCPG2DSC01- Cryptography and Network Security

This is a participatory, experimental and problem solving skill development course.

Course Objective
The objective of the course is to provide theoretical and practical aspects of cryptography and network security.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Evaluate security mechanisms using rigorous approaches by key ciphers and Hash functions
   (ii) Identify and classify particular examples of attacks and factors driving the need for network security
   (iii) Compare and contrast symmetric and asymmetric encryption systems
   (iv) Usage of network security tools and applications to understand the system level security
2. Skill gained:
   (v) Critically Analyse the vulnerabilities in any computing system
3. Competency gained:
   (vi) Conduct research in cryptography and network security

Prerequisites: Basic knowledge in number theory.

25CSCPG2DSC02 – Image Processing

This is an experimental, problem solving and skill development course.

Course Objective

The objective of the course is to provide theoretical and practical aspects of image processing.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) State-of-art image processing features, algorithms and techniques
2. Skill gained:
   (ii) Critically analyze digital images and get extract required information
3. Competency gained:
   (iii) Implement real world image processing applications
   (iv) To do research on emerging areas of image processing

Prerequisites: Basic knowledge in mathematics.

25CSCPG2DSC03 – Data Mining

This is an experimental, problem solving and skill development course.

Course Objective

The objective of the course is to provide theoretical and practical aspects of data mining and design business rules for decision support systems.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) State-of-art pre and post data processing techniques and algorithms
2. Skill gained:
   (ii) Extract knowledge using data mining techniques
   (iii) Adapt to new data mining tools
   (iv) Ability to analyse the real world data mining problems
3. Competency gained:
   (v) Development of data mining algorithms for real world problems.
   (vi) Ability to participate in data challenges and to do higher order research

Prerequisites: Basic knowledge in algorithms.

25CSCPG2DSC04- Artificial Intelligence and Machine Learning

This is a problem solving skill development course.

Course Objective:

- To impart knowledge about Artificial Intelligence.
- To build the foundation of machine learning.
- To enable students to identify problems where artificial intelligence techniques are applicable.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) Basic concepts of Artificial Intelligence.
   (ii) Critical analysis of classification and regression algorithms.
2. Skill gained:
   (iii) Compare the performance of various Machine Learning algorithms.
3. Competency gained:
   (iv) Solve problems related to DNN, CNN and Genetic Algorithms.
   (v) Solve real life problems using appropriate machine learning models and evaluate the performance measures.

Prerequisites: Basic knowledge in programming.

25CSCPG2DSC05– Artificial Intelligence and Machine Learning Lab

This is a problem solving skill development practical course.

Course Objective: To enable students to identify and solve problems where artificial intelligence and machine learning techniques are applicable.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Practical aspects of Artificial Intelligence and Machine Learning in solving the real world problems.
   (ii) Critical analysis of algorithms used for the development of a model for solving a problem.
2. Skill gained:
   (iii) Implement and compare the performance of various Machine Learning algorithms.
3. Competency gained:
   (iv) Solve problems related to NN, DNN, CNN etc.
   (v) Solve real life problems using appropriate machine learning models and evaluate the performance measures.

Prerequisites: Basic knowledge in programming

25CSCPG2DSC06– Network and Information Security Lab

This is a participatory, problem solving, experimental and skill development course.

Course Objective: The objective of the course is to provide practical aspects of Information security.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Information security issues, tools and techniques that are critical in solving problems in security domains
   (ii) Perspective to information security based on national security policy, IT policy and cyber law
2. Skill gained:
   (iii) Analysing and monitoring potential threats and attacks, devising security architecture and implementing security solutions
3. Competency gained:
   (iv) Identify and evaluate information security threats by applying security measures in model based scenarios.

Prerequisites: Nil

25CSCPG3DSC01 – Big Data Analytics

This is an experimental, problem solving and skill development course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of big data analytics.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) State-of-art Big Data Analytics techniques and algorithms
2. Skill gained:
   (ii) Critically analyze and perform big data analysis using Hadoop and MapReduce technologies
   (iii) Ability to identify the characteristics of data sets and compare the trivial and big data for various applications.
   (iv) Ability to solve problems associated with batch learning and online learning
   (v) Effectually handling big data characteristics such as high dimensionality, dynamically growing data and scalability issues
3. Competency gained:
   (vi) Implement real world big data applications

Prerequisites: Basic knowledge in data mining.

25CSCPG3DSC02– Pattern Recognition

This is a participatory and problem solving course.

Course Objective
The objective of the course is to provide theoretical and practical aspects of pattern recognition.

By completing this course, students will obtain the following course outcomes:
1. Knowledge to be gained:
   (i) Knowledge in mathematical and statistical techniques used in pattern recognition
2. Skill to be gained:
   (ii) Develop methods and algorithms for pattern recognition applications
3. Competency to be gained:
   (iii) Model real world pattern recognition problems.

Prerequisites: Basic knowledge in mathematics.

25CSCPG3DSC03– Full Stack Development Lab

This is an experimental, problem solving and skill based practical course.

Course Objective: The objective of the course is to develop web applications in designing web sites using client side and server side technologies for full stack development.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Understand and experience the technologies used for full stack development.
2. Skill gained:
   (ii) Development of web pages and websites
   (iii) Development of both front end and backend web applications with database integration
3. Competency gained:
   (iv) Design of web sites with performance optimization.

Prerequisites: Basic knowledge of Computer Programming.

25CSCPG3DSC04– Data Analytics Lab

This is an experimental, problem solving and skill based practical course.

Course Objective
The objective of the course is to provide practical aspects of distributed computing and data analytics.

By completing this course, students will obtain the following course outcomes:
1. Knowledge to be gained:
   (i) Knowledge in map reduce functionality and distributed file systems
   (ii) Understand the tools used in Distributed Systems for data analytics
2. Skill to be gained:
   (iii) Develop methods and algorithms for big data analytics
   (iv) Skill in handling large volume of distributed data using the right tools and techniques
3. Competency to be gained:
   (iv) Development of distributed techniques for processing the large volumes of data to identify the hidden insights and valuable information

Prerequisites: Basic knowledge in mathematics.

25CSCPG3INT01– Internship

This is an internship for skill development.

Course Objective:
The objective of the course is to enable the students to develop real time skills.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) State of arts methods /algorithms /procedures for the specific internship undertaken by the student.
2. Skill gained:
   (ii) Report writing skills
   (iii) Critically analysing and modelling real world problems.
3. Competency gained:
   (iv) Competency to handle/model any real world research based problem.

25CSCPG4DIC01– Dissertation

This is an experimental, research based, problem solving, skill development course.

Course Objective:

The objective of the course is to enable the students to develop real time research based projects.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) State of arts methods /algorithms /procedures for the specific project undertaken by the student.
2. Skill gained:
   (ii) Paper writing skills
   (iii) Critically analysing and modelling real world problems.
3. Competency gained:
   (iv) Competency to handle/model any real world research based problem.
   (v) Competency to participate in international data challenges.

25CSCPG4DSC01– Generative AI

Course Objective: The objective of the course is to provide theoretical and mathematical aspects of using Generative AI.

By completing this course, students will obtain the following course outcomes:

1. Knowledge to be gained:
   (i) Basic concepts of Generative AI.
   (ii) Influence of generative AI in real world applications.
2. Skill to be gained:
   (iii) Skills in the usage of Generative AI.
   (iv) Critical analysis and logic skills in the usage of Generative AI.
3. Competency to be gained:
   (v) Development of generative AI applications for real world problems.

Prerequisites: Basic knowledge in logical skill and mathematics

Core Elective Courses

25CSCPG2DSE01 – Data Analysis using R Programming

This is a participatory, experimental and skill based course.

Course Objective:

The objective of the course is to gain proficiency in R programming for data analysis, perform data cleaning, transformation and visualization, apply statistical and machine learning methods using R and to create reproducible and interactive data reports.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) To get knowledge about R Studio installation and R programming concepts for data analysis

2. Skill gained:
   (ii) Skills in applying statistical computations for data analysis
   (iii) Skills in importing data from Web API and databases
   (iv) Skills in cleaning the data and to do pre-processing
3. Competency gained:
   (v) To design various experiments based on graphs and charts for data visualization in R programming.
   (vi) Performing the exploratory data analysis, data visualization, statistical modelling and reproducible research.

Prerequisites: Basic knowledge in programming skill

25CSCPG2DSE02 – Digital Speech Processing

This is a participatory and experimental learning course.

Course Objective:
To train the students and make them understand the methods of understanding the audio visual speech.

By completing this course, students will obtain the following course/learning outcomes:
1. Knowledge to be gained:
   (i) Understanding the audio visual systems and possible ways for analysing the audio visual speech.
2. Skill to be gained:
   (ii) Skills to find effectual features for audio visual speech.
   (iii) Skills to write algorithms for the analysis of audio visual speech.
3. Competency to be gained:
   (iv) Ability to develop methods for effectual understanding of audio visual speech.

Prerequisites: Nil

25CSCPG2DSE03– Web Intelligence

This is a participatory, experimental and skill development course.

Course Objective: The objective of the course is to gain knowledge on computer networks, web intelligence, client side and server side technologies for web site and full stack development.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Basic concepts of computer networks, web transactions, web intelligence and management of web servers.
2. Skill gained:
   (ii) Practical skill for network programming and development of web applications with database integration
3. Competency gained:
   (iii) Design of computer networks
   (iv) Development of full stack development

Prerequisites: Basic knowledge of Computer Programming.

25CSCPG3DSE01 – Deep Learning

This is an experimental and problem solving course.

Course Objective: The objective of the course is to provide theoretical and practical aspects of deep learning.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Fundamental concepts of deep learning.
2. Skill gained:
   (ii) Development of algorithms for deep learning applications.
3. Competency gained:
   (iii) Computational modelling of various real world problems using deep learning techniques.

Prerequisites: Basic knowledge of algorithms.

25CSCPG3DSE02– High Performance Computing

This is a participatory, problem solving and skill development course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of implementing high performance computing.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) In-depth concepts of high performance computing
2. Skill gained:
   (ii) Skills in solving computationally intense problems using parallel algorithms
3. Competency gained:
   (iii) Computational modelling of parallel algorithms using OpenMP, pthread and MPI

Prerequisites: Basic knowledge in programming.

25CSCPG3DSE03- C # .NET Framework and Unity

This is a problem solving skill development course.

Course Objective: The objective of the course is to introduce the object oriented programming concepts and to develop graphical user interface, web and database applications on Unity platform.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) State of art of programming techniques using C# and Unity
2. Skill gained:
   (ii) Designing Graphical User Interface and development of object oriented programming concepts, web and database applications in C# on Unity platform.
3. Competency gained:
   (iii) Development of real life applications using C# and Unity

Prerequisites: Programming skill

25CSCPG4DSE01 – Web Mining and Social Networking

This is a participatory and problem solving course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of techniques for data mining applied on Internet related data and social networking.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Modelling of web content mining, web structure mining and web usage mining.
   (ii) Development of architecture and its related algorithms commonly used in web mining applications
2. Skill gained:
   (iii) Skills in sentiment analysis, targeted marketing, linguistic forensics, topic/trend-detection-tracking and multi-document summarization
   (iv) Skills to analyze the patterns involved in social media data
3. Competency gained:
   (v) Solve practical web mining problems using tools and techniques

Prerequisites: Basic knowledge of data mining

25CSCPG4DSE02– Natural Language Processing

This is a participatory, experimental and problem solving skill development course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of natural language processing.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) State of art methods and algorithms for natural language processing
2. Skill gained:
   (ii) Skills in applying statistical approaches in natural language processing
   (iii) Skills in develop language modelling
3. Competency gained:
   (iv) Expertise in developing natural language processing algorithms for real world applications

Prerequisites: Basic knowledge in logical reasoning

25CSCPG4DSE03- Computer Graphics

This is an experimental and problem solving course.

Course Objective
The objective of the course is to provide theoretical and practical aspects of computer graphics.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Mathematical concepts of computer graphics and visualization
2. Skill gained:
   (ii) modelling of 2D and 3D transformations.
   (iii) Projection from 3D to 2D
   (iv) Implementing Clipping algorithms.
3. Competency gained:
   (v) Development of algorithms for various techniques in computer graphics

Prerequisites: Basic knowledge in mathematics.

25CSCPG4DSE04– Cyber Security

This is a participatory, problem solving, experimental and skill development course.

Course Objective: The objective of the course is to provide theoretical and practical aspects of cyber security.

By completing this course, students will obtain the following course outcomes:
4. Knowledge gained:
   (v) cyber security issues, tools and techniques that are critical in solving problems in cyber security domains
   (vi) perspective to information security based on national security policy, IT policy and cyber law
5. Skill gained:
   (vii) analysing and monitoring potential threats and attacks, devising security architecture and implementing security solutions
6. Competency gained:
   (viii) Identify and evaluate information security threats by applying security measures in model based scenarois.

Prerequisites: Basic knowledge in computer networks

25CSCPG4DSE05– Blockchain Technology

This is a theoretical, participatory and experimental course.

Course Objective:

The objective of the course is to provide theoretical and practical aspects of block chain.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) State of art methods for developing block chain
2. Skill gained:
   (ii) Investigating the need and necessity of block chain applications
3. Competency gained:
   (iii) Development of prototypes for various applications using block chain technology.

Prerequisites: Nil

25CSCPG4DSE06– Cloud Computing Security

This is a participatory and experimental course.

Course Objective:
The objective of the course is to equip students with practical skills and comprehensive knowledge to secure cloud environments across AWS, Azure, and Google Cloud, using industry-standard tools and best practices for identity management, infrastructure, data, and application security.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Configure secure cloud environments using industry tools and best practices.
2. Skill gained:
   (ii) Auditing IAM policies, including federated identity and secret management, in real-world scenarios.
3. Competency gained:
   (iii) Secure cloud infrastructure and manage migrations, configurations, and audits effectively.
   (iv) Apply data protection strategies and conduct audits for cloud data and key management.

Prerequisites: Basic knowledge in Information Security

Open Elective Courses

25CSCPG1OPE01 - Enjoyable Programming

This is a problem solving and employability based skill development course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of enjoyable programming.

By completing this course, students will obtain the following course outcomes:
1. Knowledge to be gained:
   (i) Programming concepts and its usage.
2. Skill to be gained:
   (ii) Visual modelling of environment and its coding
3. Competency to be gained:
   (iii) Development of videos and games

Prerequisites: Nil

25CSCPG1OPE02 – C Programming

This is a problem solving skill development course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of programming using C.

By completing this course, students will obtain the following course outcomes:

1. Knowledge to be gained:
   (i) fundamental concepts of design of algorithms using C
2. Skill to be gained:
   (ii) Critical analyzing and choosing appropriate data structures and algorithms to solve a specific problem using C
3. Competency to be gained:
   (iii) Design algorithms with appropriate data structure for real world problems using C

Prerequisites: Nil

25CSCPG1OPE03– MATLAB

This is a problem solving skill development course.

Course Objective:
The main objective of this course is to impart knowledge on the basic principles of programming using MATLAB.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) State of art of programming techniques using MATLAB
2. Skill gained:
   (ii) Designing algorithms using MATLAB
3. Competency gained:
   (iii) Development of real life applications using MATLAB.

Prerequisites: Nil

25CSCPG1OPE04– R Programming

This is an audited/value added course and the credits will not be added to mark list.

Course Objective:
The main objective of this course is to impart knowledge on programming with R.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) State of art programming using R
2. Skill gained:
   (ii) Designing and modelling applications using R
3. Competency gained:
   (iii) Solving real life problems using R.

Prerequisites: Nil

25CSCPG1OPE05- Internet of Things

This is a participatory, experimental and flipped classroom skill development course.

Course Objective:
The objective of the course is to provide practical aspects of learning and developing applications based on internet of things.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) Fundamental concepts of Internet of Things
2. Skill gained:
   (ii) Skills in the development of embedded code
3. Competency gained:

(iii) Development of Internet of things applications for various real world applications.

Prerequisites: Basic knowledge of programming and electronic components.

25CSCPG1OPE06 Fundamentals of Generative AI

This is a participatory and problem solving skill development course.

Course Objective: The objective of the course is to provide theoretical and mathematical aspects of using Generative AI.

Course outcomes:

i) Knowledge to be gained:
(vi) fundamental concepts of Generative AI.
(vii) Influence of generative AI in real world applications.
ii) Skill to be gained:
(viii) Skills in the usage of Generative AI.
(ix) Critical analyzing and logic skills in the usage of Generative AI.
iii) Competency to be gained:
(x) Generative AI applications in real world problem.

Prerequisites: Basic knowledge in logical skill and mathematics

25CSCPG2OPE01 C++ Programming

This is a problem solving skill development course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of programming using C++.

By completing this course, students will obtain the following course outcomes:

1. Knowledge to be gained:
   (i) Fundamental concepts of design of algorithms using C++
2. Skill to be gained:
   (ii) Critical analyzing and choosing appropriate data structures and algorithms to solve specific problems using C++
3. Competency to be gained:
   (iii) Design algorithms with appropriate data structure for real world problems using C++

Prerequisites: Nil

25CSCPG2OPE02- Python Programming

This is a problem solving and employability based skill development course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of programming concepts using python.

By completing this course, students will obtain the following course outcomes:

1. Knowledge to be gained:
   (i) Interpret the fundamental Python syntax and semantics and the usage of Python Control flow statements.
   (ii) Express proficiency in the handling of strings and functions.
   (iii) Determine the methods to create and manipulate Python programs by utilizing the data structures like lists, dictionaries, tuples and sets.
   (iv) Identify the commonly used operations involving file systems and Exception Handling.
   (v) Articulate the Object-Oriented Programming concepts such as encapsulation, inheritance and polymorphism as used in Python.
2. Skill to be gained:
   (vi) Problem solving and programming capability using python
3. Competency to be gained:
   (vii) Design and implement a program using python to solve a real world problem

Prerequisites: Nil

25CSCPG2OPE03- Data Analytics with Python

This is a participatory, experimental and problem-solving course.

Course Objective:
To equip students with the knowledge and practical skills necessary to manipulate, visualize, and analyze data using Python libraries.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) Fundamental concepts of data analysis and machine learning.
2. Skill gained:
   (ii) Practical skills in statistical and exploratory data analysis, and machine learning using Python.
3. Competency gained:
   (iii) Computational modeling of various data analytics problems.

Prerequisites: Basic knowledge of programming

25CSCPG2OPE04- Machine Learning

This is a participatory and problem solving skill development course.

Course Objective: To enable students to identify and solve problems where machine learning techniques are applicable.
By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Basic concepts of Machine Learning.
   (ii) Critical analysis of classification and regression algorithms.
2. Skill gained:
   (iii) Learn the performance of various Machine Learning algorithms.
3. Competency gained:
   (iv) Understand the problems related to DNN, CNN and Genetic Algorithms.
   (v) Solve real life problems using appropriate machine learning models and evaluate the performance measures.

Prerequisites: Basic knowledge in programming

25CSCPG2OPE05- Web Technology

Course Objective: The objective of the course is to gain knowledge in web site development with database integration.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:

   (i) Development of web application with database connectivity.

2. Skill gained:

   (ii) Design and development of front-end and back-end applications with data base connectivity.

3. Competency gained:

   (iii) Performance optimization of web applications and web transactions.

Prerequisites: Basic knowledge of Computer Programming

25CSCPG2OPE06 - Metaverse

This is a participatory and skill oriented course focusing on Metaverse

Course Objectives:

1. To introduce technological developments through demonstrations and applications with a futuristic vision
2. To understand multi-technology perspective in Metaverse and its challenges
3. To identify the recent developments and to focus on research initiatives in Metaverse

By completing this course, students will obtain the following course outcomes:

1. Knowledge to be gained: 2
   (i) Familiarize multiple technologies used in Metaverse
   (ii) Understand the security threats and its countermeasures in metaverse
2. Skill to be gained:
   (iii) Skills to develop AR, VR and blockchain applications with Graphical User Interface
3. Competency to be gained:
   (iv) Analyse the applications and their performance in Metaverse

Prerequisites: Programming Skill

25CSCPG2OPE07- C # Programming

This is a problem solving skill development course.

Course Objective: The objective of the course is to introduce the object oriented programming concepts and to develop graphical user interface, web and database applications on Unity platform.

By completing this course, students will obtain the following course outcomes:

1. Knowledge gained:
   (i) State of art of programming techniques using C# and Unity
2. Skill gained:
   (ii) Designing Graphical User Interface and development of object oriented programming concepts, web and database applications in C# on Unity platform.
3. Competency gained:
   (iii) Development of real life applications using C# and Unity

Prerequisites: Programming skill

25CSCPG2OPE08– Cyber Security Essentials

This is an audited/value added course and the credits will not be added to mark list.

Course Objective:
The main objective of this course is to impart knowledge on the basic ways of handling cyber security.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Understanding all the cyber security threats
2. Skill gained:
   (ii) Handling cyber security threats.
3. Competency gained:
   (iii) To be secured from all future threats.

Prerequisites: Nil

25CSCPG2OPE09– Natural Language Processing

This is a participatory, experimental and problem solving skill development course.

Course Objective:
The objective of the course is to provide theoretical and practical aspects of natural language processing.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) State of art methods and algorithms for natural language processing
2. Skill gained:
   (ii) Skills in applying statistical approaches in natural language processing
   (iii) Skills in develop language modelling
3. Competency gained:
   (iv) Expertise in developing natural language processing algorithms for real world applications

Prerequisites: Basic knowledge in logical reasoning

25CSCPG2OPE10 – JAVA Programming

This is a skill based audited/value added course and the credits will not be added to mark list.
Course Objective:
The main objective of this course is to introduce the concepts and constructs of Java language and object oriented design techniques

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Understanding the object oriented principles in software design process
2. Skill gained:
   (ii) Development of JAVA programs for solving the real world problems using object oriented concepts or multithreading or networking or database applications
4. Competency gained:
   (iii) Apply the constructs of JAVA programming and create GUI based applications with database at back end for developing some real life applications

Prerequisites: Nil

OVERALL COURSE OUTCOME MAPPING WITH PROGRAMME OUTCOME							
Course code	**Course Title**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
SEMESTER I							
25CSCPG1DSC01	Computational Mathematics	H	H	H	L	L	L
25CSCPG1DSC02	Advanced Data Structures and Algorithms	H	M	H	M	H	H
25CSCPG1DSC03	Operating Systems	M	H	H	L	M	M
25CSCPG1DSC04	Object Oriented Programming	M	H	H	L	M	M
25CSCPG1DSC05	Computational Intelligent Systems	H	H	H	M	H	H
25CSCPG1DSC06	Object Oriented Programming Lab	M	H	H	L	M	M
25CSCPG1DSC07	Data Structures Lab	H	M	H	M	H	H
SEMESTER II							
25CSCPG2DSC01	Cryptography and Network Security	H	M	M	M	H	M
25CSCPG2DSC02	Image Processing	L	L	M	L	H	L
25CSCPG2DSC03	Data Mining	M	H	H	H	H	M
25CSCPG2DSC04	Artificial Intelligence and Machine Learning	M	H	H	H	H	M
25CSCPG2DSC05	Artificial Intelligence and	M	H	H	H	H	H

	Machine Learning Lab						
25CSCPG2DSC06	Network and Information Security Lab	M	H	H	H	H	H
SEMESTER III							
25CSCPG3DSC01	Big Data Analytics	H	H	H	H	M	M
25CSCPG3DSC02	Pattern Recognition	M	H	H	H	H	M
25CSCPG3DSC03	Full Stack Development Lab	M	L	H	L	H	H
25CSCPG3DSC04	Data Analytics Lab	M	H	H	H	H	M
25CSCPG3DSC01	Internship	M	H	H	H	H	M
SEMESTER IV							
25CSCPG4DIS01	Dissertation	H	H	H	H	H	H
25CSCPG4DSC01	Generative AI	H	H	H	M	H	M
Core Electives							
25CSCPG2DSE01	Data Analysis using R Programming	H	H	H	M	H	M
25CSCPG2DSE02	Digital Speech Processing	M	H	H	M	M	L
25CSCPG2DSE03	Web Intelligence	H	H	M	M	H	M
25CSCPG3DSE01	Deep Learning	H	H	H	M	H	M
25CSCPG3DSE02	High Performance Computing	H	M	H	H	H	M
25CSCPG3DSE03	C# .NET Framework and Unity	M	H	H	M	H	M
25CSCPG4DSE01	Web Mining and Social Networking	M	M	H	M	H	H
25CSCPG4DSE02	Natural Language Processing	M	H	H	M	H	M
25CSCPG4DSE03	Computer Graphics	L	M	M	L	H	L
25CSCPG4DSE04	Cyber Security	M	H	H	M	H	M
25CSCPG4DSE05	Blockchain Technology	M	H	M	L	H	M
25CSCPG4DSE06	Cloud Computing Security	L	H	M	L	H	M
Open Electives							
25CSCPG1OPE01	Enjoyable programming	H	L	H	L	M	L
25CSCPG1OPE02	C Programming	H	M	H	L	L	L
25CSCPG1OPE03	MATLAB	H	M	H	L	L	L
25CSCPG1OPE04	R Programming	H	M	H	L	L	L
25CSCPG1OPE05	Internet of Things	L	L	H	L	H	H
25CSCPG1OPE06	Fundamentals of Generative AI	H	M	H	M	H	H
25CSCPG2OPE01	C++ Programming	H	M	H	L	L	L
25CSCPG2OPE02	Python Programming	H	L	H	L	L	L
25CSCPG2OPE03	Data Analytics with Python	H	L	H	L	H	L
25CSCPG2OPE04	Machine Learning	M	H	H	H	H	H
25CSCPG2OPE05	Web Technology	H	L	M	M	H	M
25CSCPG2OPE06	Metaverse	H	M	M	M	M	H
25CSCPG2OPE07	C # Programming	H	L	H	M	M	M
25CSCPG2OPE08	Cyber Security Essentials	L	L	H	M	H	H
25CSCPG2OPE09	Natural Language Processing	M	H	H	M	H	M
25CSCPG2OPE10	JAVA Programming	H	H	H	M	H	L

	OVERALL COURSE OUTCOME MAPPING WITH PROGRAMME SPECIFIC OUTCOME										
Course code	**Course Title**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
	SEMESTER I										

25CSCPG1DSC01	Computational Mathematics	H	M	M	M	L	M	H	H	H	L
25CSCPG1DSC02	Advanced Data Structures and Algorithms	H	H	H	H	H	M	H	H	H	H
25CSCPG1DSC03	Operating Systems	H	H	H	H	M	M	H	H	M	M
25CSCPG1DSC04	Object Oriented Programming	H	H	H	H	M	M	H	H	M	M
25CSCPG1DSC05	Computational Intelligent Systems	H	H	H	H	H	M	H	H	H	H
25CSCPG1DSC06	Object Oriented Programming Lab	H	H	H	H	M	M	H	H	M	M
25CSCPG1DSC07	Data Structures Lab	H	H	H	H	H	M	H	H	H	H
	SEMESTER II										
25CSCPG2DSC01	Cryptography and Network Security	H	H	H	H	H	M	H	H	H	H
25CSCPG2DSC02	Image Processing	H	H	H	H	H	H	H	H	H	H
25CSCPG2DSC03	Data Mining	M	H	H	H	H	M	H	H	H	H
25CSCPG2DSC04	Artificial Intelligence and Machine Learning	H	H	H	H	H	M	H	H	H	H
25CSCPG2DSC05	Artificial Intelligence and Machine Learning Lab	H	H	H	H	H	M	H	H	H	H
25CSCPG2DSC06	Network and Information Security Lab	H	H	H	H	H	M	H	H	H	H
	SEMESTER III										
25CSCPG3DSC01	Big Data Analytics	H	H	H	H	H	M	H	H	H	H
25CSCPG3DSC02	Pattern Recognition	H	H	H	H	H	M	H	H	H	H
25CSCPG3DSC03	Full Stack Development Lab	H	H	H	H	H	H	H	H	H	H
25CSCPG3DSC04	Data Analytics Lab	M	M	H	H	M	H	H	H	H	H
25CSCPG3INT01	Internship	H	H	H	H	H	H	H	H	H	H
	SEMESTER IV										
25CSCPG3DIS01	Dissertation	H	H	H	H	H	H	H	H	H	H
25CSCPG4DSC01	Generative AI	H	H	H	H	H	M	H	H	H	H
Core Electives											
25CSCPG2DSE01	Data Analysis using R Programming	M	H	H	H	M	M	H	H	M	H
25CSCPG2DSE02	Digital Speech Processing	M	M	H	H	M	H	H	H	M	M
25CSCPG2DSE03	Web Intelligence	M	H	H	H	M	M	H	H	M	H
25CSCPG3DSE01	Deep Learning	H	H	H	H	H	M	H	H	H	H
25CSCPG3DSE02	High Performance Computing	H	H	H	H	M	H	H	H	H	H
25CSCPG3DSE03	C# .NET Framework and Unity	N	H	H	H	M	L	H	H	M	M
25CSCPG4DSE01	Web Mining and Social Networking	H	H	H	H	H	M	H	H	H	H
25CSCPG4DSE02	Natural Language Processing	H	H	H	H	M	L	H	H	M	H
25CSCPG4DSE03	Computer Graphics	L	H	H	H	M	L	H	H	H	H
25CSCPG4DSE04	Cyber Security	H	H	H	H	H	M	H	H	H	H
25CSCPG4DSE05	Blockchain Technology	M	H	H	H	H	M	H	H	H	H
25CSCPG4DSE06	Cloud Computing Security	M	H	H	H	M	L	H	H	H	H
	Open Electives										

25CSCPG1OPE01	Enjoyable programming	L	M	M	M	L	L	H	H	H	L
25CSCPG1OPE02	C Programming	L	M	M	M	L	L	H	H	H	L
25CSCPG1OPE03	MATLAB	L	M	M	M	L	L	H	H	H	L
25CSCPG1OPE04	R Programming	L	M	M	M	L	L	H	H	H	L
25CSCPG1OPE05	Internet of Things	L	M	M	M	L	L	H	H	H	L
25CSCPG1OPE06	Fundamentals of Generative AI	M	M	M	M	M	H	H	H	H	M
25CSCPG2OPE01	C++ Programming	H	H	H	H	M	M	H	H	H	M
25CSCPG2OPE02	Python Programming	L	H	H	M	H	H	H	H	H	H
25CSCPG2OPE03	Data Analytics with Python	M	M	M	M	M	H	H	H	H	M
25CSCPG2OPE04	Machine Learning	H	M	H	H	M	M	H	H	H	M
25CSCPG2OPE05	Web Technology	L	M	M	M	L	L	H	H	H	M
25CSCPG2OPE06	Metaverse	H	H	H	H	H	M	H	H	H	H
25CSCPG2OPE07	C # Programming	H	H	H	H	H	M	H	H	H	H
25CSCPG2OPE08	Cyber Security Essentials	H	H	H	H	H	M	H	H	H	H
25CSCPG2OPE09	Natural Language Processing	H	H	H	H	H	M	H	H	M	H
25CSCPG2OPE10	JAVA Programming	L	M	M	M	L	L	H	H	H	L

SYLLABUS

Semester 1

25CSCPG1DSC01- Computational Mathematics

Module 1
Vectors and vector spaces, matrix operations, linear independence, rank of a matrix, systems of linear equations and solutions, Eigen values and Eigen vectors, PCA, SVD.

Module 2
Basic set operations, review on probability, Baye's theorem, random variables, discrete probability distributions, continuous probability distributions, expectation, variance, covariance, hypothesis testing, mutual information, entropy, cross-entropy, information gain.

Module 3
Derivatives, gradients, partial derivatives, Jacobians, Taylor series expansion, chain rule, back propagation, convexity and convex functions, cost functions, convergence, constraint and unconstraint optimization.

Module 4
Graph theory, basic terminologies and properties, graph traversals, shortest path algorithms, trees and spanning tress, network flows and matching, graph colouring and chromatic number, graph isomorphism, spectral graph theory.

Text Books:

- Marc Peter Deisenroth, A. Aldo Faisal and Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
- Ronald Walpole, Raymond H. Myers, Sharon L. Myers, and Keying E. Ye, Probability and Statistics for Engineers and Scientists, 9th Edition, Prentice Hall, 2010.
- Stephen Boyd and Lieven Vandenberghe, Convex Optimization, Cambridge University Press, 2023.
- Douglas B. West, Introduction to Graph Theory, 2nd Edition, Pearson, 2000

Reference Books

- David C. Lay, Linear Algebra and Its Applications, 5th Edition, Pearson, 2023.

- David J.C. Mackay, Information Theory, Inference and Learning Algorithms, Version 7.2 (fourth printing), Cambridge University Press, 2005.
- Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley, 2010.

25CSCPG1DSC02 - Advanced Data Structures and Algorithms

Module 1
Tree structures and its operations: - Introduction to heaps, operations on heaps, min-max heaps, deaps, binomial heaps, fibonacci heaps, applications of heaps. Binary search trees, AVL trees, B-trees.

Module 2
Introduction to algorithms: Role of Algorithms in computing, growth of functions: asymptotic notations, functions and running times. Randomized algorithms: Basics of probability theory, an Informal description.

Module 3
Divide and Conquer: General method, maximum sub array problem, convex hull problem. Greedy Method: The general method, knapsack problem, minimum cost spanning trees.

Module 4
Dynamic Programming: The general method, matrix chain multiplication, rod cutting problem. back tracking: The general method, 8-queen's problem, knapsack problem. NP-Hard and NP-Complete problems.

Text Books/References:
1. Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest, Introduction to Algorithms, Third Edition, PHI 2009.
2. E. Horowitz, S. Sahni and Dinesh Mehta, Fundamentals of Data structures in C++, Galgotia, 1999.
3. G. Brassard and P. Bratley, Algorithmics: Theory and Practice, Printice –Hall,1988.
4. V.S. Subrahmanian, Principles of Multimedia Database systems, Morgan Kaufman, 1998.
5. E. Horowitz, et.al., Fundamentals of Computer Algorithms, Galgotia Publications, 1998.

25CSCPG1DSC03 – Operating Systems

Module 1
Introduction : Basic concepts, batch processing, multiprogramming, time sharing, real time system, functions and components of an operating system, OS structure, Multiprocessor system, Distributed system. Operating system services. Information management: File concepts, file system, directory structure, basic file system calls, sharing and security, operation on files, file protection, allocation methods.

Module 2
Process management : Process, States, Process Control Block, Context Switching, CPU scheduling, scheduling concepts, scheduling algorithm, Multiprocessor scheduling, Concurrent process, Critical section, Mutual Exclusion, Semaphores, Process coordination, Process Synchronization. Inter Process Communication: Shared Memory, Message Passing, RPC, Threads.

Module 3
Memory management : Preliminaries, swapping, fixed partitions, variable partitions, paging, segmentation, virtual memory concepts, overlay, demand paging, page replacement algorithms, space allocation policies, segmented paging, dynamic linking, caching of secondary storage information.

Module 4
Device management : Physical characteristics, FCFS, SSF, C–SCAN, selecting a disk scheduling algorithm, sector queuing. I/O scheduling policies, terminal I/O handling, virtual devices, RAID.
Dead locks : Dead lock problem, characteristics, prevention, avoidance, detection, recovery from dead lock, Resource allocation graphs, Bankers algorithm, Protection : goals of protection, mechanisms and policies, access matrix and its implementation.

Text Books
1. Abraham Silberschatz Peter B Galvin, G. Gagne, "Operating Systems Concepts", Tenth Edition, Addison Wesley, 2018.
2. Andrew S Tanenbaum, "Modern Operating Systems", 4th Edition, Prentice Hall, 2015.

Reference Books

1. William Stallings, “Operating Systems: Internals and Design Principles”, Tenth Edition, Prentice Hall, 2021.
2. Milan Milenkovic, Operating Systems, TMH.
3. D.M.Dhamdhere, “Operating Systems”, 2nd Edition, Tata McGraw Hill, 2011.

25CSCPG1DSC04-Object Oriented Programming

Module 1
Structure of C++ program, Compiling and Executing C++ Program. Data types, expressions, Scope and Visibility of variables, Control statements, Structured Programming Concepts, Procedure oriented programming, Functions, recursion.

Module 2
Introduction to object oriented concepts: Data Abstraction, Encapsulation, Classes, Inheritance and Polymorphism, class Hierarchies. Fundamentals of object-oriented Design: objects, user defined types, constructors/destructors, object oriented design diagram.

Module 3
Inheritance and polymorphism in C++: Derived class and base class, Access specifiers: private/public/protected, “this” pointer. Types of inheritance, Classes within classes, Array of class objects, Dynamic allocation and deallocations of objects, Static function, Friend function.

Module 4
Polymorphism, Operator overloading: Overloading unary operator, overloading binary operator, cout/cin operator overloading, Overriding member functions, Virtual functions, File streams, File modes, Operations on files, Exception handling.

Text Books/References:
1. Balagurusamy E., Object Oriented Programming with C++, Tata Mac Graw Hill
2. H. Schildt, Teach yourself C++, Tata McGraw Hill.
3. J.R. Hubbard, Schaum’s outline of programming with C++.
4. D.S. Malik, C++ Programming from problem analysis to program design 3rd Edn., Thomson Publications
5. Rober Lafore, Object Oriented Programming in Microsoft C++, Galgotia Book House.

25CSCPG1DSC05- Computational Intelligent Systems

Module 1
Introduction to computational intelligence - relevance, advantages, components and applications of computational intelligence - ability of computational intelligence to handle uncertainty, vagueness, ambiguity.

Module 2
Introduction to fuzzy logic - applications of fuzzy logic - types of membership functions, fuzzy inference system - fuzzifier - defuzzifier - inference engine - rule base, fuzzy rules - mamdani type and Takagi-Sugeno type fuzzy rules.

Module 3
Introduction to Genetic Algorithm (GA) - applications of GA - concepts of genes, chromosomes, population and its initialization - fitness function – selection, crossover, mutation, reinsertion - steps of simple genetic algorithm

Module 4
Introduction to the importance of randomness and unbiasedness in Nature Inspired Computing. Particle swarm optimization – structure of particles, position and velocities of particles and its update equations. Introduction to biological neurons and its equivalence in computational intelligence and its basic implementation strategies.

Text Books:
1. J.J. Buckley, Esfandiar Eslami, *An introduction to fuzzy logic and fuzzy sets*, Springer International edition, 2002
2. S.N. Sivanandam, S.N. Deepa, *Introduction to genetic algorithms*, Springer, 2008
3. S. Sivanandam, S. Sumathi, *Introduction to Neural Networks using Matlab* 6.0, The McGraw-Hill, 2005
4. E. Bonabeau, Marco Dorigo, Guy Theraulaz, *Swarm Intelligence: From Natural to Artificial Systems*, Oxford University press, 2000

References:

1. Yen & Langari, *Fuzzy Logic: Intelligence, Control, and Information*, 1/E, Prentice Hall, 1999.
2. Timothy J. Ross, *Fuzzy logic with engineering applications*, 3rd ed, Wiley India, 2010

25CSCPG1DSC06 – Object Oriented Programming Lab

List of Exercises

1. Write a program to find the area and Perimeter of a circle
2. Write a program to find the roots of a quadratic equation
3. Write a program to enter Name, Roll No., Marks of three subjects of student. Calculate the total, percentage and grade as given below.
   If percentage>=50 print Result="pass" else Result="Fail".
   If percentage is :
   >=90 print Grade="Excellent",
   >=80 and <90 Grade="Good" ,
   >=70 and <80 Grade="Satisfactory",
   >=50 and <70 Grade="Poor"
4. Write a program to find the sum of the first n natural numbers
5. Write a program to display the multiplication table of a given number
6. Find the factorial using recursion.
7. Write a program to find ${}^{n}C_{r}$ using function.
8. Write a program to evaluate the following series. $S=X - X^3/3 !+ X^5/5! - X^7/7! +\ldots\ldots\ldots\ldots\ldots - X^n/n!$
9. Write a program to check whether given string is palindrome or not.
10. Write a program to accept line of text and find the number of characters, number of vowels and number of blank spaces in it
11. Write a program to append text to a file and display the text.
12. Write a program to find the longest words written in a given file and replace it with another word.
13. Write a program to read a random line from a file.
14. Write an exception handling program to read the numbers stored in the file and perform division operation by taking any two numbers from the file randomly.
15. Write a program to create a class with data members as account number, name and address of a person for maintaining bank account and required functions to perform the credit/debit operations by keeping a minimum balance of Rs. 1000.
16. Write a program to calculate the mark list of students using inheritance. Write a base class for accepting the name and roll number of the students with a display function to print these details. Create one derived class for publishing the result of SSLC and another class for publishing the result of Plus two by considering the marks of both theory and practical examination together.
17. Write a program to calculate the rank list of students using inheritance. Write a base class for accepting the name and roll number of the students with a display function to print these details. Create one derived class for publishing the result of under graduate course and another class for publishing the result of post graduate course by considering the marks of both theory and practical examination together. At least 50% of marks to be obtained for getting pass mark in each course. Display the rank list for the students who got pass marks.
18. Write a program to calculate the salary of an employee working in a shop and total stocks of any three items in a shop using inheritance. Write a base class to get the name of the employee and the quantity of each item available with a display function to print the details. Create one derived class for identifying the number of days worked by the employee in a month and to calculate the salary based on the number of days worked. Create another derived class for calculating the bill to be paid when ordering new items by customers, name of the employee who handled this order and maintaining the stock of the items.
19. Write a program to demonstrate the method overloading by using a method compute_salary for displaying the salary of daily wage employees, contract employees and regular employees.
20. Write a program to demonstrate the overloading of the cin and cout operators.
21. Write a program to overload the greater than comparison operator for separating generated random numbers into two list: one list will be containing the numbers less than or equal to 100 and another list will be containing the numbers greater than 100.

25CSCPG1DSC07 – Data Structures Lab

List of Exercises

1. Write a program to find elements in the array using Binary Search
2. Write a program to compute x^n in O(log n) time
3. Implement randomized algorithm to identify a repeated element
4. Write a program to implement min heap using arrays
5. Create a max heap and do the following:
    - Display it
    - Insert a new element
    - Delete the max element
6. Sort the list of elements using heap sorting
7. Create a BST and perform operations on it
8. Create a Deep and perform operations on it
9. Create a min-max heap and perform operations on it
10. Create a B-Tree and perform operations on it
11. Implement the Maximum subarray sum problem using the Divide & Conquer method.
12. Write a program to compute the convex hull using the Divide & Conquer method
13. Write a program to find maximum and minimum element of array using Divide and Conquer method
14. Implement a solution for the Knapsack problem using the Greedy method
15. Implement MCST using Prim's method
16. Implement MCST using Krukals' method.
17. Implement a solution for Matrix chain multiplication using dynamic programming
18. Implement a solution for the rod cutting problem using dynamic programming
19. Implement the Maximum subarray sum problem solution using dynamic programming
20. Write a program to solve the N-Queens problem

Semester 2

25CSCPG2DSC01- Cryptography and Network Security

Module 1
Introduction to security attacks, services and mechanism, Classical encryption techniques substitution ciphers and transposition ciphers, Stream and block ciphers, cryptanalysis, steganography. Modern Block Ciphers: Block ciphers principles, Shannon's theory of confusion and diffusion, Fiestal structure, Data encryption standard (DES), Strength of DES, Triple DES.

Module 2
Advanced Encryption Standard (AES) encryption and decryption, Principals of public key crypto systems, RSA algorithm, Other Public-Key Cryptosystems. Hash functions, security of hash functions, Secure hash algorithm (SHA), Message Authentication Codes, Digital Signatures, Digital signature standards (DSS).

Module 3
Key Management and distribution: Symmetric key distribution, Diffie-Hellman Key Exchange, Public key distribution, X.509 Certificates, Public key Infrastructure. Authentication Applications: Kerberos Electronic mail security: pretty good privacy (PGP), S/MIME.

Module 4
IP Security: Architecture, Authentication header, encapsulating security payloads, combining security associations, key management. System Security: Intruder, Intrusion detection, Malicious software, firewalls.
Case Studies on Cryptography and Security: Cryptographic solution, Denial of Service Attacks, IP Spoofing Attacks, Cross Site Scripting Vulnerability, Contract Signing, Secret Splitting, Creating a VPN.

Text books and References:
1. William Stallings, *Cryptography and Network Security*, Pearson Education, 5th Edition, 2011.
2. Forouzan Mukhopadhyay, *Cryptography and Network Security*, Mc Graw Hill, 2nd Edition, 2010.

3. Michael E. Whitman, Herbert J. Mattord, *Principles of Information Security*, Cengage Learning, 4th Edition, 2012.
4. R. Rajaram, *Network Security and Cryptography*, SciTech Publication, First Edition, 2013.
5. C. K. Shyamala, N. Harini, T. R. Padmanabhan, *Cryptography and Network Security*, Wiley India, 1st Edition, 2011.
6. Bernard Menezes, *Network Security and Cryptography*, CENGAGE Learning, 2012.
7. Atul Kahate, *Cryptography and Network Security*, Mc Graw Hill, 3rd Edition, 2013
8. Bruce Schiener, *Applied Cryptography*, John Wiley & Sons, 1996
9. Neal Krawetz, *Introduction to Network Security*, CENGAGE Learning, 2007
10. Yang Xiao, Frank H Li, Hui Chen, *Handbook of Security of Networks*, World Scientific, 2011.

25CSCPG2DSC02 – Image Processing

Module 1
Digital Image Fundamentals**:** - Image representation and modelling - Image sampling and quantization, gray level resolution. Relationships between pixels, adjacency, connectivity, regions and boundaries, distance measures, image operations on pixel basis. Image Enhancement in the spatial domain: - point operations, spatial operations. Color models and conversions.

Module 2
Image Enhancement in frequency domain - Fourier Transform, DFT and its inverse, filtering in the frequency domain. Smoothing and sharpening filters in frequency domain, Homomorphic filters-Unsharp Masking, High-Boost Filtering, High-frequency Emphasis Filtering. Concepts of image restoration and degradation models.

Module 3
Morphological Image Processing: Logical operations on binary Images-Dilation-Erosion-Opening and Closing-Hit-or-Miss Transformation. Morphological Algorithms: - Boundary Extraction-Region Filling-Extraction of connected Components-Convex Hull-Thinning-Thickening-Skeletons-Pruning.

Module 4
Image Segmentation: - Detection of discontinuities: -point detection-line detection-edge detection. Hough Transform, Thresholding. Region-based segmentation, Region Growing/splitting/merging. Fundamentals of video processing.

Text Books:
1. Rafael C. Gonzalez, Richard E. Woods, "*Digital Image Processing*", 3rd Ed., PHI, 2007.
References:
2. Anil K. Jain, "*Fundamentals of Digital Image Processing*", Prentice Hall, US Ed., 1988.
3. William K. Pratt, "*Digital Image Processing: PIKS Scientific Inside*", Wiley Interscience, 4th Ed., 2007.
4. Azriel Rosenfield, Avinash C. Kak, "*Digital Picture Processing*", Morgan Kaufmann, 2nd Ed., 1982.
5. Bernd Jahne, "*Digital Image Processing*", Springer, 6th Ed., 1997

25CSCPG2DSC03 – Data Mining

Module 1
Introduction: Fundamentals of data mining, data mining functionalities, classification of data mining systems, major issues in data mining, data pre-processing: Why pre-processing the data, data cleaning, data integration and transformation, data reduction, discretization, and concept hierarchy generation.

Module 2
Mining data streams: The Stream Data Model, Sampling data in a Stream, filtering Streams, counting distinct elements in a Stream, estimating moments, counting ones in a window, decaying windows. Frequent pattern mining in data streams, streaming outlier detection, and stream classification.

Module 3
Mining Image data: Color feature extraction: Color space, color feature extraction. Texture feature extraction: Spatial texture feature extraction methods, spectral feature extraction methods. Shape representation: Perceptual shape descriptors, Contour-based shape methods, Region-based shape feature extraction. Image classification

Module 4
Mining sequence data: Introduction, examples and applications of sequence data, basic definitions, frequent and closed sequence patterns, GSP: An Apriori-like method, prefix span: A pattern-growth, depth-first search, features and distances of sequence data.
Introduction to Big Data: Challenges of conventional systems, characteristics of Big Data, Big Data applications.

Text Books/References:

1. Jiawei Han, M. Kamber, Jian Pei, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2nd Ed., 2005.
2. Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, Mining of Massive Data Sets, Cambridge University Press, Second Edition, 2014.
3. Arun K Pujari, Data Mining Techniques, Universities Press, 2nd Ed., 2010.
4. Guozhu Dong, Jian Pei. Sequence Data Mining, Springer,2007.
5. Dengsheng Zhang, Fundamentals of Image Data Mining: Analysis, Features, Classification and Retrieval, Springer, 2nd Edition, 2021.

25CSCPG2DSC04 - Artificial Intelligence and Machine Learning

Module 1
Artificial Intelligence-Solving Problems by Searching- Uninformed Search Strategies-Informed (Heuristic) Search Strategies, Depth-First Search (DFS) for Maze Navigation, Breadth-First Search (BFS) for Pathfinding in a Graph, A* Search, Greedy Best-First Search on a given weighted graph, Rule-Based Knowledge Representation.
Module 2
Machine Learning, supervised and unsupervised learning, Classification, Regression - Linear and Logistic regression, Review of supervised learning methods- support vector machines, Decision Tree and Random Forest.
Module 3
Types of error calculations and evaluation measures, confusion table, cross validations-LOOCV, 5fold and 10-fold. Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve (ROC), Area Under Curve (AUC). Introduction to Neural Networks: Perceptron, Multilayer perceptron, activation functions, architecture design, Loss functions, Introduction to optimization-Gradient descent-based algorithms.
Module 4
Convolutional Neural Networks: convolution and pooling operations, Convolutional layers in neural network.
Autoencoders: Introduction, Stacked autoencoders, Variational Autoencoders. Case Study: Develop a classifier for object detection.

Text Books/References:

1. Tom M. Mitchell, “Machine Learning”, McGraw-Hill, 2010
2. Ethem Alpaydin, (2004) “Introduction to Machine Learning (Adaptive Computation and Machine Learning)”, The MIT Press.
3. N.P.Padhy:Artificial Intelligence and Intelligent Systems, Oxford University Press, 2009.
4. J S.N. Sivanandam, S.N. Deepa, Introduction to genetic algorithms, Springer, 2008
5. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.
6. Yuxi (Hayden), Liu and Savansh Mehta, “Hands-on Deep Learning Architectures with Python”, Packt, 2019.
7. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995
8. Kevin P. Murphy, “Machine Learning, a probabilistic perspective”, The MIT Press Cambridge, Massachusetts, 2012.
8. Shalev-Shwartz,S., Ben-David,S., (2014), Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press.

25CSCPG2DSC05 – Artificial Intelligence and Machine Learning Lab

List of Exercises

1. Implement Breadth-First Search (BFS) for Pathfinding in a Graph.
2. Implement Depth-First Search (DFS) for Maze Navigation.

3. Solve the “Word Ladder” Problem Using A* Search.
4. Implement Greedy Best-First Search on a given weighted graph where each node has a heuristic value, and trace the steps to reach the goal.
5. Write a program that uses a simple rule-based expert system to diagnose a basic medical condition.
   a) Load the dataset and visualize it using pie charts, bar charts, box plots, histograms
   b) Fill the all missing values of all attributes using different methods.
6. a) Implement normalization techniques using min max, z score, and decimal scaling
   b) Implement correlation analysis using Pearson product movement & chi-square analysis.
7. Implement Bloom filter.
8. Extract (a) Color features (b) Texture features (c) Shape features of a given image dataset
9. Perform GLCM feature extraction of a given image dataset
10. Implement GSP algorithm for extracting frequent sequence patterns
11. Implement Prefixspan algorithm for extracting frequent sequence patterns.
12. Write a Machine Learning program using linear regression to predict an employee's salary when the hours worked are given.
13. Write a Machine Learning program using logistic regression to predict whether the student will PASS/FAIL when a number of hours studied is given.
14. Write a Machine Learning program using logistic regression to predict the fruit, given the shape and weight of the fruit.
15. a. Write a Machine Learning program using an SVM classifier to predict the fruit when the shape and weight of the fruit are given.
    b. For the previous SVM question, use different kernels in SVM, say linear, RBF, Gaussian, and polynomial kernels, and compare the results.
16. Write a Machine Learning program using a decision tree to classify cats and dogs when the features are given.

25CSCPG2DSC06– Network and Information Security Lab

1. Perform encryption, decryption using the following substitution techniques
   a). Ceaser cipher b). Playfair cipher c). Hill Cipher d). Vigenere cipher
2. Perform encryption and decryption using following transposition techniques.
   a). Rail fence b). Row & Column Transformation
3. Apply (a) DES algorithm (b) AES algorithm for practical applications.
4. Implement RSA Algorithm.
5. Implement Hash algorithms and calculate the message digest of a text using the hashing algorithms.
6. Implement the Signature Scheme - Digital Signature Standard.
7. Implement the Diffie-Hellman Key Exchange algorithm.
8. Demonstration on Man-in-the-Middle (MITM) Attack.
9. Demonstration on Information Gathering & Scanning Tools using Nmap, Zenmap GUI, NetDiscover or Angry IP Scanner for the following:
   Discover Live Hosts (Ping Sweep), TCP Port Scanning, Service and Version Detection, OS Fingerprinting, Vulnerability Scanning, Network Scanning using Zenmap GUI, UDP Scan.
10. Demonstration on Footprinting & Scanning Tools using Whois, nslookup, dig, theHarvester, traceroute, Maltego for the following:
    Domain Info, DNS Enumeration, Email Footprinting, Traceroute, Network Mapping
11. Demonstration on Social Engineering Tools using SET, MSFVenom for the following:
    Email Phishing Simulation, Creating Fake Login Page (Credential Harvester), USB-based Payload Delivery (Simulation Only), Social Media Profiling (Manual or Using Tools).
12. Demonstration on DoS/DDoS attack tools PentMenu, Hping3, LOIC (Low Orbit Ion Cannon)
13. Demonstration on Packet Sniffing using Wireshark Tool.
14. Demonstration on Password Cracking using Cain & Abel Tool (Windows)
15. Demonstration on Password Cracking using hydra, john the ripper.
16. Demonstration on Phishing attack using Zphisher Tool.
17. Firewall configuration in windows and creating Basic Firewall Rules with iptables.
18. IDS Detection using Snort or using Suricata.

19. Block brute-force login attempts using fail2ban and demonstration on keyloggers.
20. Working with DVWA Tool
21. Working with Burp Suite

Semester 3

25CSCPG3DSC01– Big Data Analytics

Module 1
Introduction to Big Data, challenges of conventional systems, characteristics of Big Data: Volume, Variety, Velocity, Veracity, Big Data analytics, Big Data applications. Introduction to enabling technologies for Big Data, introduction to Big Data stack, introduction to some Big Data distribution packages.

Module 2
Introduction to Big Data platforms, overview of Apache Spark, YARN, Hadoop. Hadoop distributed file system, components of Hadoop, Hadoop architecture, analysing the data with Hadoop, introduction to MapReduce, MapReduce programming model, MapReduce examples.

Module 3
Introduction to Big Data storage platforms for large scale data storage, introduction to Big Data streaming platforms for fast data. Introduction to Big Data applications, overview of Big Data Machine Learning, Mahout introduction, Big Data Machine Learning algorithms in Mahout- Kmeans and Naïve Bayes.

Module 4
Predictive Analytics: Simple linear regression, multiple linear regression, interpretation of regression coefficients. Visualizations: Visual data analysis techniques, interaction techniques-systems and applications.

Text Books/References:

1. Dirk Deroos et al., Hadoop for Dummies, Dreamtech Press, 2014, ISBN: 978-1-118-60755-8(pbk), 978-1-118-65220-6(ebk), 978-1-118-70503-2(ebk).
2. Chuck Lam, Hadoop in Action, December, 2010, Manning Publications, ISBN: 9781935182191
3. Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, 2nd Edition, Elsevier, Reprinted 2008, ISBN 978-0-12-381479-1.
4. J. Leskovec, A. Rajaraman, J.D. Ullman, Mining of Massive Datasets, Cambridge University Press, ISBN: 978-1-107-07723-2., 9781108476348, 2020
5. Arshdeep Bahga, Vijay Madisetti, “Big Data Science & Analytics: A Hands On Approach“, VPT, 2016, ISBN: 978-0996025539.

25CSCPG3DSC02 – Pattern Recognition

Module 1
Pattern Recognition Systems – Definitions, data representation, representations of patterns and classes. Types of pattern recognition systems. Applications of pattern recognition systems. Bayesian decision making and Bayes Classifier for continuous and discrete features.

Module 2
Min-max and Neymann-Pearson classifiers, Discriminant functions, decision surfaces. Maximum likelihood estimation and Bayesian parameter estimation. Overview of Nonparametric density estimation – Histogram based approach, classification using Parzen window.

Module 3
K-nearest neighbour estimation and classification. Classification of clustering algorithms – hierarchical clustering – agglomerative clustering. Partitional clustering – Forgy’s algorithm. K-means clustering.

Module 4
Introduction to feature selection – filter method – sequential forward and backward selection algorithms. Wrappers method and embedded methods. Feature extraction methods – principal component analysis, fisher linear discriminant analysis, ICA.

Text Books/References:

1. Duda R.O., Hart P.E., Stork D.G., *Pattern Classification*, John Wiley and Sons, 2nd Edition, 2001
2. Bishop C.M., *Pattern Recognition and Machine Learning,* Springer, 2nd Edition, 2006
3. Theodoridis S., Pikrakis A., Koutroumbas K., Cavouras D., *Introduction to Pattern Recognition: A Matlab approach*, Academic Press, 2010

25CSCPG3DSC03- Full Stack Development Lab

List of Exercises

1. Display web pages for the registration of employees working in an organization and their service details using HTML and CSS.
2. Write a JAVASCRIPT, HTML and CSS program that performs the front-end operations and validation during the registration of students having more than 75% of attendance for writing the examination.
3. Write a JAVASCRIPT, HTML and CSS program for front end application and validation during lending and returning of books for the students of age between 18 and 30.
4. Write a JavaScript program to display the domain name of the server that loaded the document in a beautiful style using CSS.
5. Develop a website to include your biodata and photos.
6. Develop a website for CS Department for uploading the details of workshop conducted during a particular period with its flyer, photos and reports using PHP and MySQL.
7. Develop a web application using PHP and MySQL for displaying the rank list of students appeared for end semester examination for three courses.
8. A database contains employee name, employee ID and salary. Write a PHP program to update the salary of employees available in the database by giving 10% increase in their salary and display the updated information of the employees whose salary is greater than Rs. 50,000.
9. A database contains product name, product ID and price. Write a PHP program to update the price of products available in the database by giving 5% increase in their price.
10. Develop a client server program using socket programming. The server waits for the client requests for reversing the message received from clients. The client accepts a sentence from user and forwards it to the server for doing the reverse operation and it displays the output to the user.
11. Develop a client server program using socket programming. The server waits for the client requests for displaying the abbreviations by taking the first character of each word and returning the results to the clients. The client accepts a sentence from user and forwards it to the server for finding the abbreviations and it displays the output to the user.
12. Accept a list of numbers from user. Write a multithreading program for handling two threads, one thread for printing the prime numbers and another thread for printing the odd numbers from the list entered by the user.
13. Write a multithreaded server program for accepting the request of several clients for performing the requested operations available in the calculator using two numbers sent by the clients and the output will be returned to the clients from the servers.
14. Create a student database for course registration using MongoDB and perform CURD operations.
15. Write a MongoDB query to update the salary field by incrementing the salary of all employees by 1000 in the employee database.
16. A MongoDB database contains student name, roll number and marks of a subject. Perform aggregation operations that allow to sort the marks of students then group the marks of students whose names are same and find their sum of marks.
17. Develop a MongoDB program for storing and updating the stock details in a shop.
18. Develop a web site for Hospital Administration for paying the salary of daily wage employees using MERN Stack development.
19. Develop both front end and back end web application for displaying and searching of employees working in an organization using MERN Stack development.
20. Write a MERN Stack development web application for maintaining a job portal which contains the options to list the vacancies to apply for jobs.

25CSCPG3DSC04 - Data Analytics Lab

List of Exercises

1. Install Hadoop and perform HDFS tasks such as adding files and directories, retrieving files, and deleting files.
2. Calculate the frequency of the words in a given file using Hadoop MapReduce
3. Implementation of Matrix Multiplication with Hadoop MapReduce
4. Find the tags associated with each movie by analyzing Movie Lens data using MapReduce
5. Write queries to sort and aggregate the data in a table using HiveQL.
6. Develop a Java application to find the maximum temperature using Spark.
7. Practice importing and exporting data from various databases. Software Requirements: Cassandra, Hadoop, JAVA, Pig, Hive, and HBase.
8. Install and configure MongoDB/ Cassandra/ HBase/ Hyper table to execute NoSQL Commands
9. Implement Functions: count, sort, limit, Skip, aggregate using MongoDB.
10. Implement an application that stores big data in HBase / MongoDB / Pig using Hadoop / R
11. Implement clustering techniques using SPARK.
12. Implement and perform streaming data analysis using Flume for data capture, PYSpark/ HIVE for data analysis of Twitter data, chat data and weblog analysis.
13. Implement Bayes' Theorem for two-class classification using iris dataset
14. Build a Naive Bayes Classifier on a text dataset (e.g., SMS spam detection).
15. Compare Gaussian and Bernoulli Naive Bayes on image dataset
16. Implement Bayes' Theorem for multi class classification using image dataset
17. Use histograms density estimation on 1D and 2D data.
18. Apply Maximum Likelihood Estimation for image dataset
19. Apply Parzen Window method for non-parametric density estimation.
20. Apply Agglomerative and Hierarchical Clustering and dendrogram plotting.
21. Apply K - Nearest Neighbor algorithm for the classification of handwritten image dataset
22. Principal Component Analysis (PCA) on high-dimensional data (e.g., Iris).
23. Apply Integrated Component Analysis to isolate singing voice from a song

25CSCPG3INT01– Internship

Each student is required to carry out an internship during vacation under the supervision of a mentor in the Department. Internship must be done in industry or government research organizations or national institutes (like NIT, IIT, ISER, Central Universities, State Universities) or academic training institutes with the consent of the Department/Institute. The mentor shall monitor the progress of the student continuously. There will be a final presentation of the internship at the end of the third semester in front of internal examiners based on the internship report submitted. Four credits will be awarded after submitting the successful completion of the internship certificate and the internship report.

Semester 4

25CSCPG4DIS01 – Dissertation

Each student is required to carry out a research based project under the supervision of one or more faculty member of the Department. However, a student may also opt to pursue his/her project work in industry (CMM level 3 and above) or government research organizations with the consent of the Department/Institute. In such cases, the department must look into the suitability of the projects and assign one or more internal guide/supervisor. The internal supervisor shall monitor progress of the student continuously. The decision to allow the students outside will be decided on a case to case basis by the faculty council based on the rules and regulation of the University for dissertation/projects and the decision thus taken will be final. A candidate is required to present the progress of the project work (at least twice) during the semester at an appropriate time decided by the department. There will be a final end semester presentation of the project work in front of examiners based on the work done and the dissertation submitted.

25CSCPG4DSC01- Generative AI

Module 1

Generative AI: Definition and scope of Generative AI. Overview of generative models and their applications.

Importance of Generative AI in various domains. Brief discussion on ethical considerations and challenges.

Module 2
Prompt Engineering, Generative AI Models, Text Generation Models: GPT-3, GPT-4, Large Language Model Meta AI (LLaMA), Claude, Gemini, Grok. Common Challenges in Large Language Models: Hallucination, Ambiguity in Prompt Design, Bias and Fairness.

Module 3
Long Short-Term Memory (LSTM), Attention Mechanism, Transformer Model, Generative Adversarial Networks (GAN). DALL-E AI image generator, AI voice generators, AI video generators, Multimodal AI models: CLIP, Flamingo. Open AI Codex, AI Studio.

Module 4
Sentiment Analysis, Challenges of Sentiment Analysis, Fine-Grained Sentiment Analysis, Aspect-Based Sentiment Analysis, Multilingual Sentiment Analysis, Word embedding: GloVe, Word2Vec, One-Hot Encoding, Term frequency, Inverse document frequency, Code Mixing, Code Switching. Sentiment Analysis in Social Media, Role of Generative AI in Sentiment Analysis.

Text Books/References:

1. David Foster , Generative Deep Learning, O'Reilly Media, 2019.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville , Deep Learning, MIT Press, 2016.
3. Yoav Goldberg, Morgan & Claypool Publishers, Neural Network Methods for Natural Language Processing, 2017.
4. Cathryn van Kessel, Christopher H. Clark, AI in Social Studies Education, Teachers College Press, 2025.
5. Arokiaraj David, Jeganathan Gomathi Sankar, Generative AI and Implications for Ethics, Security, and Data Management, IGI Global, 2024.

Core Elective Courses

25CSCPG2DSE01 – Data Analysis using R Programming

Module 1: Introduction to R and Basic Data Operations
Overview of R and RStudio IDE, installing R packages from CRAN, GitHub. R syntax and basic programming constructs: variables, data types, data structures: vectors, lists, matrices, arrays, data frames, factors. Writing user-defined functions and control flow, if-else, loops.

Module 2: Data Loading and Cleaning
Data input/output: Reading/writing CSV, Excel, text files. Importing data from web APIs and databases using DBI, RMySQL, etc.
Data cleaning techniques: Handling missing data, outliers, duplicates, data type conversions, and encoding. Data transformation using: dplyr: filter, select, mutate, arrange, summarise, group_by, and tidyr: pivoting, unnesting, reshaping.

Module 3: Exploratory Data Analysis (EDA) and Data Visualization
Exploratory Data Analysis: Descriptive statistics: mean, median, mode, SD, variance, frequency tables, cross-tabulations, Correlation, covariance.
Data visualization using Base R graphics: ggplot2-histograms, bar plots, boxplots, scatterplots, line charts. Advanced visualization: facets, themes, labels, color aesthetics.

Module 4: Statistical Modelling and Reproducible Research
Inferential statistics in R: Hypothesis testing- t-test, chi-square test, ANOVA, confidence intervals, p-values. Regression modelling: Simple and multiple linear regression using lm(), logistic regression using glm(), model diagnostics, and interpretation.
Reproducible Research: Reporting with R Markdown. Introduction to Shiny for building interactive web apps.

Textbooks & Reference Materials
Core Textbooks:

1. R for Data Science by Hadley Wickham & Garrett Grolemund
2. The Art of R Programming by Norman Matloff
3. Data Analysis Using Regression and Multilevel/Hierarchical Models by Gelman & Hill

Online Resources:
- RStudio Cheatsheets
- CRAN Task Views (for domain-specific packages)

- DataCamp, Coursera R programming tracks (optional learning)

25CSCPG2DSE02– Digital Speech Processing

Module 1
Basic elements of a Digital Signal Processing Systems, Classification of Signals, Concept of Frequency in Continuous -Time and Discrete –Time Signals, Speech Signal: Speech Production Mechanism, perception-Acoustic Phonetic Characterization and classification.

Module 2

Audio Visual Systems, Speech Production Process-Representing speech in Time Frequency Domains-Speech Sounds and Features. Speech Analysis: The Bank of Filters Front End Processor-Linear Predictive Coding for Speech Recognition-Vector Quantization.

Module 3
Audio detection-Time delay estimation, Beamforming, Visual tracking algorithms:-Template matching and Mean-shift algorithms, Multimodal integration -likelihood combination, Tracker output combination, Partitioned sampling.

Module 4
Representing Meaning: Meaning Structure of Language, Predicate-Argument Structure, First Order Predicate Calculus. Semantic Analysis: Syntax-Driven Semantic Analysis, Attachments for a Fragment of English, Lexical Semantics: Relations among Lexemes and Their Senses, WordNet: A Database of Lexical Relations, The internal Structure of Words.

Text Books/References:

1. John J Proakis & Dimitris G Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, Pearson, 2007.
2. Michael J. Robberts, *Signals and systems*, McGraw-Hill Higher Education, 2004
3. *Fundamentals of Speech Recognition- Lawrence Rabiner, Biing-Hwang Juang, Prentice Hall. 1993*
4. *Digital processing of speech signals- L.R. Rabiner and R.W Schafer, Prentice Hall, 1978*
5. *Speech and Language Processing- Daniel Jurafsky and James H. Martin, Prentice Hall, 2000*
6. *Audio –Visual Person Tracking A Practical Approach – Fotios Talantzis, A.Pnevmatikakis and A.G. Constatinides, Imperial College Press, 2012*

25CSCPG2DSE03 – Web Intelligence

Module 1
Introduction to Computer Networks and Distributed Systems, Web Server, Physical Address, IP Address, IP fragmentation, Network Address Translation, Subnetting, Supernetting, Stream sockets, Datagram Sockets, Socket Programming, Client and server programs using Multithreading.

Module 2
Web personalization, Adaptive websites, Overview of Web Intelligence, Benefits of Web Intelligence, Web Intelligence Architecture, Web Intelligence Rich Client, Web Intelligence Interactive Viewer, Web Intelligence Document, HTML Basics, Structure of an HTML page, Common HTML tags, Styling with CSS: Selectors, properties and values, JavaScript: Basics, Control structures, Loops and Functions, Document Object Model.

Module 3
Social Media Intelligence, Human-machine Co-intelligence in the Connected World, Server side scripting, PHP: Embedding PHP in HTML, Embedding HTML in PHP, Conditional Statements, Loops, Reading and Writing Files, Database Connectivity, Building database applications using PHP and MySQL.

Module 4
Full stack development using Django/MEAN/MERN stack, Development of both front end and back end of web

application with Database integration, Web caching, Content Delivery Networks, AI-Powered browser, Intelligent management of Web servers.

Text Books/References:

1. Ning Zhong, Jiming Liu and Yiyu Yao, Web Intelligence (WI): A New Paradigm for Developing the Wisdom Web and Social Network Intelligence, Springer, ISBN: 978-3-642-07936-8, 2003.
2. Zeeshan UI Hassan Usmani, Web Intelligence and Intelligent Agents, ISBN : 978-953-7619-85-5, 2010.
3. Richard Blum, PHP, MySQL & JavaScript All-in-One for Dummies, Wiley, ISBN: 978-8126576005, 2018.
4. Anthony O. O., React.js Design Patterns: Learn how to build scalable React apps with ease, ISBN: 978-9355513649, 2023.
5. Alex Banks, Eve Porcello, Learning React: Functional Web Development with React and Redux, Oreilly, 2017.
6. Antonio Mel, Django 4 By Example, Packt Publishing, ISBN: 978-1801813051, 2022.
7. Brad Dayley, Bredan Dayley, Caleb Dayley, Node.Js, Mongodb and Angular Web Development: The Definitive Guide to Using the Mean Stack to Build Web Applications, ISBN: 978-0134655536, 2018.
8. Colin J. Ihrig, Adam Bretz, Full Stack JavaScript Development With MEAN: MongoDB, Express, AngularJS, and Node.JS, Shroff Publishers and Distributors Pvt. Ltd., 2015
9. Pinakin Ashok Chaubal, Mastering MEAN Stack: Build full stack applications using MongoDB, Express.js, Angular, and Node.js, ISBN: 978-9355510525 , 2023.
10. Menal Dahiya, Nikita Malik, Sargam Gupta, Getting Started with Web Technologies : HTML, CSS, Bootstrap Javascript and XML, ISBN: 979-8888333174, 2022.

25CSCPG3DSE01– Deep Learning

Module 1
Introduction, Deep neural networks, Better activation functions, Backpropagation, Optimization techniques: Gradient Descent (GD), Momentum Based GD, Stochastic GD, AdaGrad, RMSProp, Adam.

Module 2
Regularization: Bias-Variance Trade-off, L1&L2 regularization, Early stopping, Dataset augmentation, Dropout, Batch normalization. PCA, SVD, Autoencoders and its relation to PCA, Denoising autoencoders.

Module 3
Convolutional Neural Networks (CNN), Pre-trained CNN models, Transfer learning, Recurrent Neural Networks (RNN), Vanishing and Exploding Gradients, Gated Recurrent Units (GRU), Long Short Term Memory networks (LSTM).

Module 4
Encoder-Decoder Models, Transformers, Attention Mechanism, Introduction to generative AI, Generative Adversarial Networks**,** Explainable AI.

Text Books/References:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, An MIT Press book, 2016.
2. http://www.deeplearningbook.org
3. GANs in Action: Deep learning with Generative Adversarial Networks, Jakub Langr and Vladimir Bok, First Edition, MANNING.
4. Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning: An Introduction to Xai, John Liu, Uday Kamath, 2021, Springer.

25CSCPG3DSE02 – High Performance Computing

Module 1
The von Neumann architecture, Modifications to the von Neumann Model – Caching, Virtual memory, instruction level parallelism, hardware multithreading, motivation and scope of parallel computing, Flynn's taxonomy.
Module 2
Sources of overhead in parallel programs, performance metrics for parallel systems, speedup & efficiency, Amdahl's law, foster's design methodology.

Module 3
Thread Basics, the POSIX thread API, Thread Creation and Termination, Synchronization Primitives in Pthreads, thread cancellation.

Module 4
The shared memory model, types of OpenMP constructs, OpenMP compiler directives, parallel constructs, work-sharing construct, combined parallel work-sharing constructs, synchronization directives, combining MPI and OpenMP.

Module 5
Principles of Message-passing, send and receive operations, message passing interface (MPI), and case studies.

Text Books/References:

1. Hesham El-Rewini and Mostafa Abd-El-Barr, *Advanced Computer Architecture and Parallel Processing*, John Wiley & Sons, Inc Publication, 2005.
2. Peter S. Pacheco, *An introduction to parallel programming*, Elsevier Inc., 2011
3. Anantha Grama, Anshul Gupta, George Karypis, Vipin Kumar, *Introduction to Parallel Computing*, Addison Wesley, 2003.
4. Michael J. Quinn, *Parallel programming in C with MPI and OpenMP, MC Graw Hill, 2003*

25CSCPG3DSE03 - C # .NET Framework and Unity

Module 1
Introduction to .NET framework, Basics of C#: Variables, Data Types, Operators, Expressions, Branching, Looping, Methods, Arrays, Strings, Structures, Enumerations, Object Oriented Aspects: Classes, Objects, Inheritance, Polymorphism, Interfaces, Delegates. Handling of Events.

Module 2
Application Development on .NET : Building Windows Applications, Accessing, searching and storing files. Application development using threads, ADO.NET, Programs for inserting, retrieving and searching data from the database. Network Programming in C#: Basic concepts required for data transmission through Network, Socket Programming, Building simple client and server applications using Multithreading.

Module 3
Basics of Unity : Introduction, Features, Advantages, Simple programs using object oriented concepts and event handling, Importing assets, Manipulating 2D and 3D scenes, Unity Components, Programs for manipulating components, programs for simple game physics concepts, programs for Graphical User Interface and adding sounds to objects.

Module 4
Computer graphics in Unity : Translation, Rotation and Scaling on 2D and 3D objects, Animations, Visual effects, Operations on multimedia objects, Programs for A*, Depth first and Breadth first searching with animation. Basic concepts for developing simple 2D and 3D games using artificial intelligence.

Text Books/References:

1. Programming in C#, E Balagurusamy, Tata Mcgraw Hill Publishing Co Ltd.
2. C# The Complete Reference , Herbert Schildt, Tata Mcgraw Hill Publishing Co Ltd.
3. Programming C# - Best-Selling Guide to Building Windows and Web Applications with C#, Jesse Liberty, Donald Xie, O'Reilly Media.
4. Network programming in .NET, Fiach Reid, Publisher: Digital Press.
5. Learning C# Programming with Unity 3D, Alex Okita ,A K Peters/CRC Press.
6. Unity 4.X Game AI Programming, AungSithuKyaw, Clifford Peters, ThetNaingSwe, Packt *Publishing.*
7. Unity 3D UI Essentials, Simon Jackson, Packt Publishing.

25CSCPG4DSE01 – Web Mining and Social Networking

Module 1
Introduction: Data Mining and Web Mining, web Community and Social network Analysis. Theoretical Backgrounds: Web Data Model, Textual linkage and usage expressions, Similarity functions, Eigenvector, SVD, tensor expression and decomposition, Basic concepts of social networks.

Module 2
Web Mining: Web content mining: Vector space model, web search, feature enrichment of short texts, latent semantic indexing, automatic topic extraction from web documents, opinion search and opinion span. Web Linkage Mining: Web search and hyperlink, co-citation and bibliographic coupling, Page rank and HITS algorithm, web community discovery, web graph measurement and modelling, using link information for web page classification.

Module 3
Web usage mining: Modelling web usage interface using clustering, WUM using probabilistic latent semantic analysis, finding user access pattern, co-clustering analysis of webblogs using bipartite spectral projection approach, web usage mining applications.

Module 4
Extracting and analyzing web social networks: Extracting evaluation of web community from a series of web achieve, temporal analysis on semantic graph using three way tensor decomposition, analysis of communities and their evaluations in dynamic networking, Socio-Sence: A system for analyzing the societal behavior from web archive.

Text Books/References:

1. Guandong Xu Yanchun Zhang Lin Li, *Web Mining and Social Networking*, Springer, 2011.
2. Aggarwal, Charu C, *Social network data analytics*, Springer, 2011.
3. Lee Giles, Mark Smith, *Advances in Social Network Mining and Analysis*, Springer 2008.
4. Bing Liu, *Web Data Mining*, Springer, 2011.

25CSCPG4DSE02 – Natural Language Processing

Module 1: Morphology and Finite-State Transducers
Survey of (Mostly) English Morphology, Finite-State Morphological Parsing, Combining FST Lexicon and Rules, Lexicon-free FSTs: The Porter Stemmer, Human Morphological Processing.

Module 2: Probabilistic Models of Pronunciation and Spelling
Dealing with Spelling Errors, Spelling Error Patterns, Detecting Non-Word, Probabilistic Models, Applying the Bayesian method to spelling, Minimum Edit Distance, English Pronunciation Variation, The Bayesian method for pronunciation, Weighted Automata, Pronunciation in Humans.

Module 3: N-grams
Counting Words in Corpora, Simple (Unsmoothed) N-grams, Smoothing, Backoff , Deleted Interpolation, N-grams for Spelling and Pronunciation, Entropy.

Module 4: HMMs and Speech Recognition
Speech Recognition Architecture, Overview of Hidden Markov Models, The Viterbi Algorithm Revisited, Advanced Methods for Decoding, Acoustic Processing of Speech, Computing Acoustic Probabilities, Waveform Generation for Speech Synthesis, Human Speech Recognition.

Text Books and References:

1. Daniel Jurafsky and James H. Martin, *Speech and language processing: an introduction to natural language processing, computational linguistics, and speech recognition*, Pearson Education Series in Artificial Intell., 2008.
2. Allen, James, *Natural Language Understanding*, Second Edition, Benjamin/Cumming, 1995.
3. Manning, Christopher and Heinrich, Schutze, *Foundations of Statistical Natural Language Proc.*, MIT Press, 1999.

25CSCPG4DSE03 - Computer Graphics

Module 1
History of computer graphics. Introduction to OpenGL. Raster algorithms – DDA and Bresenham's line drawing algorithms, Circles and Ellipse drawing algorithms.

Module 2
Geometric transformation in 2D space – translation, rotation, scaling, reflection. Homogenous co-ordinates and Composite

transformation. Affine transformation. Two Dimensional Viewing transformation – Line/Polygon Clipping.

Module 3
Geometric transformation in 3D space – translation, rotation, scaling, reflection. Projections.

Module 4
Knowledge about Visible–Surface Detection. OpenGL light and material properties and models. Color Models and Color Applications: RGB – YIQ – CMY – HSV.

Text Books/References:

1. Donald Hearn and M. Pauline Baker, 'Computer Graphics C Version', Prentice – Hall of India, Second Edition, 1997
2. Hill, Francis S., Computer Graphics Using OpenGL, Prentice-Hall, 2001.
3. Sumanta Guha, Computer Graphics through OpenGL, CRC Press, 2011.
4. D.D. Hearn, M.P. Baker, Computer Graphics with OpenGL, 4/e, pearson, 2011
5. Dave Shreiner, "OpenGL Programming Guide: The Official Guide to Learning OpenGL, Versions 3.0 and 3.1", Addison Wesley, 7th Ed., 2009

25CSCPG4DSE04 – Cyber Security

Module-1
Cyber Security Concepts: CIA, Risks, Breaches, Threats, Attacks, Exploits. Information Gathering (Social Engineering, Foot Printing & Scanning). Open Source/ Free/ Trial Tools: nmap, zenmap, Port Scanners, Network scanners.

Infrastructure and Network Security: Introduction to System Security, Server Security, OS Security, Physical Security, Cyber-Physical System, Network packet Sniffing, DOS/ DDOS attacks. Intrusion detection and Prevention Techniques, Host based Intrusion prevention Systems, Network Session Analysis. Open Source/ Free/ Trial Tools: DOS Attacks, DDOS attacks, Wireshark, Cain & abel, iptables/ Windows Firewall, Snort, Suricata, fail2ban

Module-2
Cyber Security Vulnerabilities: Internet Security, Cloud Computing & Security, Social Network sites security, Cyber Security Vulnerabilities.

Cyber Security Safeguards: Overview, Access control, IT Audit, Authentication. Open Web Application Security Project (OWASP), Web Site Audit and Vulnerabilities assessment. Open Source/ Free/ Trial Tools: WinAudit, Zap proxy (OWASP), burp suite, DVWA kit.

Module-3
Malware: Explanation of Malware, Types of Malware: Virus, Worms, Trojans, Rootkits, Robots, Adware's, Spywares, Ransom wares, Zombies etc., OS Hardening (Process Management, Memory Management, Task Management, Windows Registry/ services another configuration), Malware Analysis. Open Source/ Free/ Trial Tools: Antivirus Protection, Anti Spywares, System tuning tools, Anti Phishing.

Module-4
Cyber Laws: Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013.
Cyber Forensics: Introduction to Cyber Forensics, Need of Cyber Forensics, Cyber Evidence, Documentation and Management of Crime Sense, Image Capturing and its importance, Partial Volume Image, Web Attack Investigations, Denial of Service Investigations, Internet Crime Investigations, Internet Forensics, Steps for Investigating Internet Crime, Email Crime Investigations.
Open Source/ Free/ Trial Tools: Case Studies related to Cyber Law, Common Forensic Tools like dd, md5sum, sha1sum, Ram dump analysis, USB device.

Text Book/References:

1. William Stallings, Cryptography and Network Security, Pearson Education, 7th Edition, 2017.
2. V.K. Jain, Cryptography and Network Security, Khanna Publishing House, 1st Edition, 2020.
3. Sarika Gupta, Gaurav Gupta, Information Security and Cyber Laws, Khanna Publishing House, 2019
4. Atul Kahate, Cryptography and Network Security, McGraw Hill, 4th Edition, 2019.
5. V.K. Pachghare, Cryptography and Information Security, PHI Learning, 3rd Edition, 2019.
6. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India Pvt Ltd, 2011.

7. Bothra Harsh, Mastering Hacking, Khanna Publishing House, Delhi, 2019.
8. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.

25CSCPG4DSE05 – Blockchain Technology

Module 1

Introduction and Basic Crypto Primitives: Overview of Blockchain, Need of Blockchain, Structure of Blockchain, Transactions, Distributed Consensus, Public vs. Private Blockchain, Understanding Cryptocurrency, Security aspects of Blockchain. Data Privacy in Block chain, Data Privacy Threads. Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography.

Module 2

Distributed Ledger and Smart Contracts: Distributed Ledger Technology, Features, Types: Permissioned, Permissionles and hybrid distributed ledgers. Smart Contracts in Blockchain, Types: Decentralized Autonomous Organizations, Smart Legal Contracts, Application Logic Contracts, Creation of Smart Contracts, Operation of Smart Contracts.

Module 3

Solidity Programming, Truffle Frame work and DAPP: Fundamentals, Remix IDE, Layout of solidity source file, Solidity syntax and semantics, solidity data types, contract types, data structures, control structures, functions, access classifiers, Smart Contract creation for online banking using solidity. Truffle frame work, features of Truffle, Deployment Process, creating projects using Truffle, DAPP architecture, DAPP development framework.

Module 4

Bitcoin and Blockchain: Components of Bitcoin, Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Bitcoin Mining, Role of Bitcoin Miners. Working with Consensus in Bitcoin**:** Distributed consensus in open environments, Consensus in a Bitcoin network, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW.

Text Books/References:

1. Melanie Swan, “Blockchain: Blueprint for a New Economy”, O’Reilly, 2015.
2. Josh Thompsons, “Blockchain: The Blockchain for Beginners-Guide to Blockchain Technology and Leveraging Blockchain Programming”, CreateSpace Independent Publishing Platform, 2017
3. Daniel Drescher, “Blockchain Basics”, Apress; 1st Edition, 2017.
4. Anshul Kaushik, “Blockchain and Crypto Currencies”, Khanna Publishing House, Delhi, 1st Edition, 2019
5. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained”, Packt Publishing, 2nd Edition, 2018.
6. Ritesh Modi, “Solidity Programming Essentials: A Beginner’s Guide to Build Smart Contracts for Ethereum and Blockchain”, Packt Publishing, 2018.
7. Salman Baset, Luc Desrosiers, Nitin Gaur, Petr Novotny, Anthony O’Dowd, Venkatraman Ramakrishna, “Hands-On Block Chain with Hyperledger: Building Decentralized Applications with Hyperledger Fabric and Composer”, Packt Publishing, 2019.
8. Rogen Wattenhofer, “Blockchain Science: Distributed Ledger Technologies”, Inverted Forest Publishing, 2019.

25CSCPG4DSE06 – Cloud Computing Security

Module 1

Introduction to Cloud and Cloud Concepts: Definition of cloud computing, characteristics (elasticity, scalability, on-demand), deployment models (Public, Private, Hybrid), Cloud Architecture, Service Models, and Design: IaaS, PaaS, SaaS; architectural components (compute, storage, networking); designing for scalability and resilience
Cloud Security Concepts: Shared Responsibility Model, Confidentiality, Integrity, Availability (CIA Triad), security principles in cloud environments, Security Challenges: Common threats (misconfigurations, data breaches, API vulnerabilities, insider threats); CSP-specific risks (AWS, Azure, Google Cloud).

Module 2

Introduction to Identity and Access Management: Core IAM concepts (users, roles, permissions); importance in cloud security. Cloud Infrastructure Security: Securing compute, storage, and networking components; overview of CSP-specific security models. Securing hybrid cloud environments; challenges of integrating on-prem and

cloud systems. During Migration: Data encryption during transfer, secure migration tools (e.g., AWS Migration Hub, Azure Migrate), access control during migration. Cloud Configuration & Patch Management: Automating configurations with IaC (e.g., Terraform); patch management tools (e.g., AWS Systems Manager). Cloud Change Management: Change control processes; tracking and auditing changes in cloud environments.

Module 3
Cloud Data Security: Overview of data protection strategies in cloud environments; CSP-specific data security models. Data Protection (Rest, In Transit, In Use): Securing data at rest (e.g., S3 encryption), in transit (e.g., TLS), and in use (e.g., homomorphic encryption). Cloud Data Security Foundational Strategies: Core principles (e.g., defense-in-depth, least privilege); tools like Data Loss Prevention (DLP). Encryption: Symmetric and asymmetric encryption; client-side vs. server-side encryption; use cases in AWS, Azure, Google Cloud. Masking, Obfuscation, Anonymization & Tokenization: Techniques for protecting sensitive data; use cases (e.g., PCI-DSS compliance). Key Management: Managing cryptographic keys using AWS KMS, Azure Key Vault, Google Cloud KMS; key rotation policies.

Module 4
Cloud Application Challenges & Development Basics: Unique challenges in cloud apps (e.g., multi-tenancy, scalability); basics of cloud-native development (e.g., microservices, serverless), Cloud Applications Access to Resources: Managing app permissions with IAM roles; securing access to APIs, databases, and storage. Common Pitfalls & Vulnerabilities: Injection flaws, broken authentication, misconfigured cloud resources; real-world examples.

Textbooks

1. Practical Cloud Security: A Guide for Secure Design and Deployment by Chris Dotson, 2019.
2. Cloud Security: Concepts, Applications and Practices by Jamuna S. Murthy and Siddesh G. M., 2024.

Reference Books

1. A Hands-On Approach by Arshdeep Bahga and Vijay Madisetti, 2014.
2. A Comprehensive Guide to Secure Cloud Computing by Ronald L. Krutz and Russell Dean Vines, 2010.
3. AWS Certified Security – Specialty Exam Guide by Adam Book, 2021.
4. Identity and Access Management: Controlling Your Network by Michael Howard, 2020.
5. AWS Certified Solutions Architect – Associate Guide by Gabriel Ramirez and Stuart Scott, 2021.
6. Data Security in Cloud Computing by Vimal Kumar et al., 2017.
7. Cloud Security: A Comprehensive Guide to Secure Cloud Computing by Ronald L. Krutz and Russell Dean Vines, 2010.
8. Securing DevOps: Safe Services in the Cloud by Julien Vehent, 2018.
9. Web Application Security: Exploitation and Countermeasures for Modern Web Applications by Andrew Hoffman, 2020.

Open Elective Courses

25CSCPG1OPE01 – Enjoyable Programming

Module 1
Introduction to programming, conditional statements, loops

Module 2
Introduction to Alice, programming constructs available in Alice, modelling using Alice, case studies.

Module 3
Introduction to Scratch, programming constructs available in Scratch, modelling using scratch, case studies.

Module 4
Working with Blockly, CoderZ, Tynker. Case studies.

Reference

1. Alice Programming, Harold L Rogler, Kendall/Hunt Publishing Co ,U.S.; Second edition, 2016.
Computer Coding for Kids: A unique step-by-step visual guide, from binary code to building games, Carol Vorderman, DK Children, 2017.

25CSCPG1OPE02 – C Programming

Module 1
Introduction: Introduction to C, structure of C program, C programming, data types, storage classes, constants, keywords and operators: precedence and associativity, expressions, input/output statements, assignment statements, decision making statements, switch statement, looping statements.

Module 2
Arrays: Introduction to arrays, declaration, initialization one-dimensional array, operations on one-dimensional arrays, two dimensional arrays, operations on two-dimensional arrays, example programs on arrays.
Strings: Introduction to strings, string operations: length, compare, concatenate, copy, etc., programs on strings, programs on strings and arrays, selection sort, linear-search, binary-search.

Module 3
Functions: Introduction to functions, function prototype, function definition, function call, Built-in functions (string functions, math functions), recursion, example Programs: Computation of Sine series, Scientific calculator using built-in functions, Binary Search using recursive functions.
Pointers: Introduction to pointers, operators, pointer arithmetic, arrays and pointers, array of pointers, example programs, parameter passing: pass by value, pass by reference, example programs: Swapping of two numbers and changing the value of a variable using pass by reference.

Module 4
Structures: Introduction to structures, operations on structures, nested structures, array of structures, example Program using structures, self-referential structures, dynamic memory allocation, singly linked list, type-definition.

Text Books/References:

1. E Balagurusamy, Programming in ANSI C, 8/e, McGraw Hill Education, 2019.
2. Kernighan, B.W and Ritchie,D.M, The C Programming language, Second Edition, Pearson Education, 2006
3. Paul Deitel and Harvey Deitel, C How to Program, Seventh edition, Pearson Publication
4. Juneja, B. L and Anita Seth, Programming in C, CENGAGE Learning India pvt. Ltd., 2011
5. Pradip Dey, Manas Ghosh, Fundamentals of Computing and Programming in C, First Edition, Oxford University Press, 2009.

25CSCPG1OPE03 – MATLAB

Module 1
The MATLAB environment and getting touch/help, MATLAB search path, advantages and disadvantages of MATLAB, applications.

Module 2
MATLAB basics: variables and arrays, initializing variables in MATLAB, multidimensional arrays, sub arrays, end function, disp function, fprintf function, load and save commands, scalar operations, array and matrix operations, built-in MATLAB functions, Introduction to plotting, 2-D plots and 3-D plots.

Module 3
Program design techniques: logical data type, relational operators, logic operators, logical functions. Branching statements: if...else, switch, Loops: while, for, break, continue, nesting loops, complex data, string functions, user defined functions, familiarization of some tool boxes.

Text Books/References:

1. Stephen J. Chapman, Essentials of MATLAB Programming, Wadsworth Publisher, 2008
2. Stormy Attaway, A Practical Introduction to Programming and Problem Solving, 4th edition, Elsevier, 2016
3. Ram N. Patel, Ankush Mittal, Programming in MATLAB a Problem Solving Approach, Person Publication, 2014.

4. Manoj Khanna, Geeta Bhatt, Pawan Kumar. MATLAB Essentials for Problem Solving, PHI Learning Publisher, 2016.

25CSCPG1OPE04 – R PROGRAMMING

Module 1
Overview: Feature of R, basic syntax, data types, variables, operators, conditional statements, loops, functions, and strings.

Module 2
Data structures: Vectors, lists, matrices, arrays, factors, data frames, packages. Data handling: CSV files, excel files.
Data Visualizations: Pie charts, bar charts, box plots, histograms, etc.

Module 3
Data Analysis: Mean, median, mode, linear regression, multiple regression, logistic regression, data distribution functions, covariance, decision trees, random forest, chi-square test.

Text Books/References:
1. Hadley Wickham, Garrett Grolemund. R for data science: Import, Tidy, Transform, Visualize, And Model Data, O′Reilly; 1st edition, 2017.
2. Peter Dalgaard. Introductory Statistics with R. Springer, 2nd edition, 2008.
3. Brian Everitt and Torsten Hothorn. A Handbook of Statistical Analyses Using R. Chapman & Hall/CRC, Boca Raton, FL, 2006.
4. Benjamin M. Bolker. Ecological Models and Data in R. Princeton University Press, 2008.
5. John Maindonald and John Braun. Data Analysis and Graphics Using R. Cambridge University Press, Cambridge, 2nd edition, 2007.

25CSCPG1OPE05 - Internet of Things

Module 1
Introduction to IoT, History and evolution of IoT, societial benefits of IoT, Risks, Privacy and Security

Module 2
Understanding Arduino microcontroller, what can Arduino do?, setting up and testing Ardunio, Understanding Arduino programming environment, programming with Arduino. Experiments with Arduino: Blinking an LED/ RGB LED, PWM pin for varying the brightness of an LED, usage of push button, potentiometer, Photoresistor, temperature sensor, buzzer, servo, motor and LCD screen,

Module 3
Understanding Raspberry pi, what can Raspberry pi do?, setting up Raspberry pi. Understanding Raspberry pi programming environment, programming with Raspberry pi. Experimenting with Raspberry Pi.

Module 4
Case study in any one of the following: Opensource IoT platform, Amazon IoT cloud, IR sensor, Gas sensor, fire sensor, GSM shield, Bluetooth shield, PIR sensor, line tracking robot, Tensorflow on raspherry Pi, Home automation

References:
1. University of Cambridge lab experiments. https://www.cl.cam.ac.uk/projects/raspberrypi/
2. https://courses.ideate.cmu.edu/99-355/s2016a4/text/syllabus.html
3. https://courses.ideate.cmu.edu/99-355/s2017/text/syllabus.html
4.https://www.tu-berlin.de/menue/summer_university/summer_university_term_2/arduino_for_interactive_design/

25CSCPG1OPE06 - Fundamentals of Generative AI

Module 1
Generative AI: Definition and scope of Generative AI. Overview of generative models and their applications.

Importance of Generative AI in various domains. Brief discussion on ethical considerations and challenges. Supervised, Unsupervised and Reinforcement Learning.

Module 2
Introduction to Neural Networks, Recurrent Neural Networks (RNN), Classification and Clustering algorithms, Long Short-Term Memory (LSTM)**,** Bidirectional Long Short-Term Memory**,** Attention Mechanism.

Module 3
Prompt Engineering, Generative AI Models, Text Generation Models: GPT-3, GPT-4, Large Language Model Meta AI (LLaMA), Claude, Gemini, Grok. Generative Adversarial Networks (GAN), Multimodal AI models: CLIP, Flamingo.

Text Books/References:
1. David Foster , Generative Deep Learning, O'Reilly Media, 2019.
2. Ian Goodfellow, Yoshua Bengio, and Aaron Courville , Deep Learning, MIT Press, 2016.
3. Yoav Goldberg, Morgan & Claypool Publishers, Neural Network Methods for Natural Language Processing, 2017.
4. Cathryn van Kessel, Christopher H. Clark, AI in Social Studies Education, Teachers College Press, 2025.
5. Arokiaraj David, Jeganathan Gomathi Sankar, Generative AI and Implications for Ethics, Security, and Data Management, IGI Global, 2024.

25CSCPG2OPE01 – C++ Programming

Module 1
Introduction to C++: Introduction to C++, structure of C++ program, Compiling and Executing C++ Program. Selection control statements in C++. Data types, expressions and control statements. Scope and Visibility of variables in Functions.

Module 2
Object Oriented Concepts, Classes, objects, user defined types, constructors/destructors, object oriented design, IO streams, cout/cin, operator overloading, class conversion, class scope, static member function.

Module 3
Class inheritance, private/public/protected, polymorphism, virtual functions, abstract classes. Overloading vs. overriding, multiple inheritance, friend function, Object Oriented Design and Patterns. Structures, records, dynamic allocation, new/delete, linked lists

Module 4
Exception handling, overloaded constructors/functions/operators. File Operations: Read, Write, Update, Ftell, Fseek.

Text Books/References:
1. C++ common knowledge : essential intermediate programming / C++ (Computer program language) , Dewhurst, Stephen C. Addison-Wesley, Upper Saddle River, N. J.: 2005.
2. C++ programming cookbook Herb Schildt's C++ programming cookbook / C++ (Computer program language), Schildt, Herbert. McGraw-Hill, New York: c2008.
3. Problem solving with C++: The object of programming/ C++ (Computer program language). Savitch, Walter. Pearson Addison Wesley, Boston: 2005. Fifth Edition (International ed.)
4. C++ programming: From Problem Analysis to Program Design / C plus plus programming. : Malik, D S. Course Technology, Boston, MA : c2009. Fourth Edition.
5. Problem solving with C++ / Savitch, Walter J, 1943- Pearson/Addison-Wesley, Boston : c2006. Sixth Edition.

25CSCPG2OPE02 – Python Programming

Module 1
Introduction to Python, Basic Syntax, Variables, Data Types, Operators, Understanding python blocks. Conditional Statements, Looping, and Control Statements.

Module 2
Introduction to Files, Processing files and records, Exceptions, Functions. Local Variables, Global Variables and Global Constants. Generating Random Numbers. The math Module, Storing Functions in Modules.

Module 3
Strings and Number System, String Methods, Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings. Introduction to Lists, List slicing, Copying Lists, Processing Lists, List Methods and Useful Built-in Functions.

Module 4
Classes and Objects, Classes and Functions, Classes and Methods, Working with Instances, Constructor, class attributes and destructors, Inheritance and Polymorphism. Any one case study based on Machine Learning, Web development, Multithreading and Networking concepts.

Text Books:
1. Kenneth A. Lambert, The Fundamentals of Python: First Programs, Cengage Learning, 2011.
2. Think Python Second Edition, by Allen B. Downey, Orielly publishing, 2015
3. Introduction to Computation and Programming Using Python. John V. Guttag, The MIT Press,2016.

25CSCPG2OPE03 - Data Analytics with Python

Module 1
Python fundamentals, data analysis, and data visualization libraries.

Module 2
Introduction to data analytics, data visualization, exploratory data analysis, measures of central tendency, outlier detection, probability distribution functions, and probability density functions, histogram. Hypothesis testing.

Module 3
Machine learning, sci-kit learn library, types of machine learning, data preprocessing, data transformation, dimensionality reduction.

Module 4
Classification, regression, time series forecasting, clustering, model evaluation techniques, confusion matrix, and ROC. Introduction to deep learning.

Text Books/References:
1. "Python for Data Analysis: Data Wrangling with pandas, NumPy, and Jupyter", 3rd edition, Wes McKinney, O'REILLY.
2. "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking", 1st edition, Foster Provost, and Tom Fawcett, O'RELLY.
3. "Data Science from Scratch: First Principles with Python", 2nd edition, Joel Grus, O'REILLY.
4. "Data Mining: Concepts and Techniques" by Jiawei Han, Micheline Kamber, and Jian Pei, 2nd edition, MORGAN KAUFMANN.
5. Machine Learning For Absolute Beginners, Oliver Theobald, 3rd edition.

25CSCPG2OPE04 - Machine Learning

Module 1
Machine Learning, supervised and unsupervised learning, Classification, Regression - Linear and Logistic regression, Review of supervised learning methods- support vector machines, Decision Tree and Random Forest.

Module 2
Types of error calculations and evaluation measures, confusion table, cross validations-LOOCV, 5fold and 10-fold. Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve (ROC), Area Under Curve (AUC).

Module 3
Introduction to Neural Networks: Perceptron, Multilayer perceptron, activation functions, architecture design, Loss functions, Introduction to optimization-Gradient descent-based algorithms. Convolutional Neural Networks:

convolution and pooling operations, Convolutional layers in neural network.

Module 4

Autoencoders: Introduction, Stacked autoencoders, Variational Autoencoders. Case Study: Develop a classifier for object detection.

Text Books/References:

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill, 2010
2. Ethem Alpaydin, (2004) "Introduction to Machine Learning (Adaptive Computation and Machine Learning)", The MIT Press.
3. N.P.Padhy:Artificial Intelligence and Intelligent Systems, Oxford University Press, 2009.
4. J S.N. Sivanandam, S.N. Deepa, Introduction to genetic algorithms, Springer, 2008
5. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.
6. Yuxi (Hayden), Liu and Savansh Mehta, "Hands-on Deep Learning Architectures with Python", Packt, 2019.
7. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995
8. Kevin P. Murphy, "Machine Learning, a probabilistic perspective", The MIT Press Cambridge, Massachusetts, 2012.
8. Shalev-Shwartz,S., Ben-David,S., (2014), Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press.

25CSCPG2OPE05 - Web Technology

Module 1

World Wide Web, Web Browsers, Web Servers, Uniform Resource Locators, Basic Syntax of HTML, Standard HTML Document Structure, Basic Text Markup, Images, Hypertext links, Lists, Tables and Forms, Span and Div Tags. Cascading Style Sheets: Style Specification Formats, Selector Forms, Property Value Forms, Font Properties, List Properties, Alignment of Text, Colour, Box Model, Background Image.

Module 2

Overview of JavaScript, General Syntactic Characteristics, Primitives, Operations and Expressions, Control Statements, Arrays, Functions, Callback Functions, Document Object Model.

Module 3

MongoDB: Create database, Insert, Find, Update, indexing/searching query operations. XML: Syntax of XML, XML Document Structure, Namespaces, XML Schemas, Displaying Raw XML Documents, Displaying XML Documents with CSS, XSLT Style Sheets.

Module 4

PHP: General Syntactic Characteristics, Primitives, Operations, Expressions, Control Statements, Arrays, Functions, Form handling, Database connectivity with MySQL, Development of Web Applications with database integration.

Text Books/References:

1. Richard Blum, PHP, MySQL & JavaScript All-in-One for Dummies, Wiley, ISBN: 978-8126576005, 2018.
2. Brad Dayley, Bredan Dayley, Caleb Dayley, Node.Js, Mongodb and Angular Web Development: The Definitive Guide to Using the Mean Stack to Build Web Applications, ISBN: 978-0134655536, 2018.
3. Menal Dahiya, Nikita Malik, Sargam Gupta, Getting Started with Web Technologies : HTML, CSS, BOOTSTRAP, JAVASCRIPT AND XML, ISBN: 979-8888333174, 2022.
4. Akshi Kumar, Web Technology, Theory and Practice, CRC Press, 2018.
5. Kogent Learning Solutions, Web Technologies: HTML, JAVASCRIPT, PHP, JAVA, JSP, ASP.NET, XML and Ajax, Black Book: HTML, Javascript, PHP, Java, Jsp, XML and Ajax, Black Book, 2009.

25CSCPG2OPE06 - Metaverse

Module 1

Fundamentals of metaverse, phases of development of the metaverse, characteristics, components and architecture of metaverse, metaverse engine, recognition and rendering, content creation modes in metaverse, technologies of metaverse, metaverse challenges and limitation. Ubiquitous computing.

Module 2

Security threats and corresponding security countermeasures in metaverse, threats and countermeasures to data

management in metaverse, sybil attack and DDOS attack in metaverse, economy-related threats and countermeasures in metaverse, threats to digital forensics, digital governance in metaverse, endogenous security empowered metaverse, cloud-edge-end orchestrated secure metaverse.

Module 3

Overview of Blockchain, Structure of Blockchain, Cryptocurrency, Bitcoin, Security aspects of Blockchain, Hash pointer and Merkle tree, Distributed Ledger Technology, Smart Contracts in Blockchain, Operation of Smart Contracts, Remix IDE, Solidity syntax and semantics, solidity data types, Smart Contract creation using solidity. Truffle frame work, DAPP architecture, DAPP development framework.

Module 4

Augmented Reality, Methods used for Augmented Reality, Virtual worlds, Virtual reality, VR/AR integration, User experience on mobile pedestrian navigation between digital map interface and location-based augmented reality, VRTK, Mixed Reality and Extended Reality.

Text Books/References:

1. Park, Sang-Min, and Young-Gab Kim, "A metaverse: Taxonomy, components, applications, and open challenges", IEEE access, 2022.
2. Chen, Shu-Ching, "Multimedia research toward the metaverse", IEEE MultiMedia, 2022.
3. C. Hacki, “Navigating the Metaverse: A Guide to Limitless Possibilities in a Web 3.0 World”, 2022, Wiley.
4. Terry Winters, “The Metaverse: Prepare Now for the Next Big Thing”, 2021.
5. Terry, Quharrison and Scott Keeney, The metaverse handbook: Innovating for the internet's next tectonic shift, John Wiley & Sons, 2022.
6. Rostami, Sajjad, and Martin Maier, "The metaverse and beyond: implementing advanced multiverse realms with smart wearables", IEEE Access, 2022.
7. Sara Abdelghafar, Dalia Ezzat, Ashraf Darwish, Aboul Ella Hassanien, Metaverse for Brain Computer Interface: Towards New and Improved Applications, Springer, 2023.
8. Aboul Ella Hassanien, Ashraf Darwish, Mohamed Torky, “The Future of Metaverse in the Virtual Era and Physical World”, Springer, 2023.
9. Lacity, Mary C., and Steven C. Lupien. Blockchain Fundamentals for Web 3.0, University of Arkansas Press, 2022.

25CSCPG2OPE07 - C # Programming

Module I

Introduction to .NET framework, .NET frame work Architecture, Features of .NET framework, Common Language Runtime, Basics of C#: Variables, Data Types, Operators, Expressions.

Module 2

Branching, Looping, Methods, Arrays, Strings, Structures, Enumerations. Object Oriented Aspects: Classes, Objects, Inheritance, Polymorphism, Interfaces, Delegates. Handling of Events.

Module 3

Application Development on .NET: Building Windows Applications, Accessing, searching and storing files. Application development using forms and threads, ADO.NET, Programs for inserting, retrieving and searching data from the database.

Module 4

Network Programming in C#: Basic concepts required for data transmission through Network, Socket Programming, Building simple client and server applications using Multithreading.

Text Books/References:

1. Programming in C#, E Balagurusamy, Tata Mcgraw Hill Publishing Co Ltd.

2. C# The Complete Reference , Herbert Schildt, Tata Mcgraw Hill Publishing Co Ltd.
3. Programming C# - Best-Selling Guide to Building Windows and Web Applications with C#, Jesse Liberty, Donald Xie, O'Reilly Media.
4. Network programming in .NET, Fiach Reid, Publisher: Digital Press.

25CSCPG2OPE08 – Cyber Security Essentials

Model 1
Cyber Security Fundamentals: Network and Security Concepts- Information Assurance Fundamentals, Basic Cryptography, Symmetric Encryption, Public Key Encryption, The Domain Name System (DNS), Firewalls, Virtualization, Radio-Frequency Identification
Microsoft Windows Security Principles: Windows Tokens, Window Messaging, Windows Program, The Windows firewalls
Module 2
Attacker Techniques and Motivations: How Hackers Cover Their Tracks (Antiforensics) How and Why Attackers Use Proxies, Tunneling Techniques, Fraud Techniques, Threat Infrastructure
Module 3
Exploitation: Techniques to Gain a Foothold, Misdirection- Shellcode, Integer Overflow Vulnerabilities, Stack-Based Buffer Overflows, Format String Vulnerabilities, SQL Injection, Malicious PDF Files, Race Conditions, Web Exploit Tools, DoS Conditions, Brute Force and Dictionary Attacks, Reconnaissance, and Disruption Methods- Cross-Site Scripting (XSS), Social Engineering, WarXing, DNS Amplification Attacks
Module 4
Defense and Analysis Techniques: Memory Forensics, Honeypots, Malicious Code Naming, Automated Malicious Code Analysis Systems, Intrusion Detection Systems.

Text Books/References:

1. James Graham, Richard Howard, Ryan Olson, “Cyber Security Essentials” CRC Press, Taylor & Francis Group, 2011.
2. Mayank Bhusan, Rajkumar Singh Rathore, Aatif Jamshed, “Fundamental of Cyber Security (Principles, Theory and Practices) BPB Publications 2018.
3. Charles J. Brooks, Christopher Grow, Philip Craig & Donald Short, “Cyber Security Essentials” John Wiley & Sons, Inc. 2018

25CSCPG2OPE09 – Natural Language Processing

Module 1: Morphology and Finite-State Transducers
Survey of (Mostly) English Morphology, Finite-State Morphological Parsing, Combining FST Lexicon and Rules, Lexicon-free FSTs: The Porter Stemmer, Human Morphological Processing.

Module 2: Probabilistic Models of Pronunciation and Spelling
Dealing with Spelling Errors, Spelling Error Patterns, Detecting Non-Word, Probabilistic Models, Applying the Bayesian method to spelling, Minimum Edit Distance, English Pronunciation Variation, The Bayesian method for pronunciation, Weighted Automata, Pronunciation in Humans.

Module 3: N-grams
Counting Words in Corpora, Simple (Unsmoothed) N-grams, Smoothing, Backoff , Deleted Interpolation, N-grams for Spelling and Pronunciation, Entropy.

Module 4: HMMs and Speech Recognition
Speech Recognition Architecture, Overview of Hidden Markov Models, The Viterbi Algorithm Revisited, Advanced Methods for Decoding, Acoustic Processing of Speech, Computing Acoustic Probabilities, Waveform Generation for Speech Synthesis, Human Speech Recognition.

Text Books and References:
4. Daniel Jurafsky and James H. Martin, *Speech and language processing: an introduction to natural language processing, computational linguistics, and speech recognition*, Pearson Education Series in Artificial Intell., 2008.

5. Allen, James, *Natural Language Understanding*, Second Edition, Benjamin/Cumming, 1995.
6. Manning, Christopher and Heinrich, Schutze, *Foundations of Statistical Natural Language Proc.*, MIT Press, 1999.

25CSCPG2OPE10 – JAVA Programming

Module 1

Overview of Object oriented programming, Basics of JAVA, Variables, Constants, Keywords, Datatypes, Operators, Type Conversion and Casting, Enumerated Types, Control Statements, Loops, Arrays.

Module 2

Class, Object, Methods, Overloading, Constructors, Static Members, this Keyword, Access Control, Garbage Collection, String Class, String Tokenizer.

Module 3

Inheritance, Types, Method Overriding, Super, Final, Abstract Classes, Interfaces, Extending and Implementing Interfaces, Applying Interfaces, Accessing Interface Variables, Packages, Creating, Defining and Accessing Packages, Importing Packages.

Module 4

Concepts of Exception, Types, Exception Handling Techniques, Built-in Exceptions, User Defined Exception, Concepts of thread, Creating a thread, Thread Life Cycle, Multithreading, Synchronizing Threads.

Text Books/References:

- E. Balagurusamy, Programming with Java, McGraw Hill Education, 2019.
- Herbert Schildt, Java the Complete Reference, McGraw Hill, Education, 2024.
- Herbert Schildt, Coward Danny, Java: A Beginner's Guide, 2024.
- Bruce Eckel, Thinking in Java, Prentice Hall, 2006.
- Kathy Sierra, Bert Bates, Head First Java, O'REILLY, 2009.