CENTRAL UNIVERSITY OF KERALA

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 2024 batch onwards)

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	CENTRAL UNIVERSITY OF KERALA DEPARTMENT OF COMPUTER SCIENCE M.Sc. COMPUTER SCIENCE – PROGRAMME STRUCTURE					
COURSE CODE		**COURSE TITLE**	**CONTACT HRS/WEEK**			**CREDITS**
			LEC	LAB	TUT	
SEMESTER I						
Core	CSC5101	Computational Mathematics	1	2	1	3
Core	CSC5102	Programming Concepts Using Python	2	2	1	4
Core	CSC5103	Advanced Data Structures and Algorithms	2	2	1	4
Core	CSC5104	Digital Signal Processing	2	2	1	4
Core	CSC5105	Computational Intelligent Systems	2	2	0	3
Core	CSC5106	Artificial Intelligence and Machine Learning	2	2	0	3
Value added	CSC50XX	Value Added Course 1	1	2	0	0
		Total	**12**	**14**	**4**	**21**
SEMESTER II						
Core	CSC5201	Cryptography and Network Security	2	2	1	4
Core	CSC5202	Pattern Recognition	2	2	0	3
Core	CSC5203	Image Processing	2	2	0	3
Core	CSC5204	Data Mining	2	2	0	3
Core	CSC5205	Web Intelligence	2	2	0	3
Core Elective	CSC50XX	Core Elective 1	2	2	1	4
Open Elective	CSC50XX	Open Elective 1	2	2	1	4
		Total	**14**	**14**	**3**	**24**
During Summer Vacation						
Open Elective	CSC5391	Internship	0	0	0	4*
		Total				**4**
SEMESTER III						
Core	CSC5301	High Performance Computing	1	2	1	3
Core Elective	CSC5302	Minor Project	0	6	2	4
Core Elective	CSC50XX	Core Elective 2	2	2	1	4
Open elective	CSC50XX	Open Elective 2	2	2	1	4
Open elective	CSC50XX	Open Elective 3	2	2	1	4
Value added	CSC50XX	Value Added Course 2	1	2	0	0
Core Elective	CSC5392	Industrial Visit/Field Work	0	0	0	0
		Total	**8**	**16**	**7**	**19**
SEMESTER IV						
Core Elective	CSC5490	Dissertation	0	20	4	8
Open elective	CSC50XX	Open Elective 4	2	2	1	4
		Total	**2**	**22**	**5**	**12**

Exit:
- Those who would like to exit after 1 year must do an internship of 4 credits and they will get a PG diploma in Computer Science with specialization in Intelligent systems.

Entry:
- Candidates can opt for lateral entry to 3rd Semester if they have completed a minimum of 49 credits in first year

Open Elective:
- Open elective courses (interdisciplinary/skill based) must be either from the department or from other departments or from SWAYAM MOOCS courses.

Core Elective:
- Core Elective must be either from the department or from SWAYAM MOOCS courses.

Credits distribution:

Credits for Core Courses	:	40
Credits for Core Elective Courses (including Dissertation)	:	20
Credits for Open Elective Courses (including internship)	:	20
Total	:	80

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

	CORE ELECTIVES					
	COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
			LEC	LAB	TUT	
Interdisciplinary	CSC5001	Natural Language Processing	2	2	1	4
Skill based	CSC5002	Digital Speech Processing	2	2	1	4
Skill based	CSC5003	Wireless Sensor Networks	2	2	1	4
Skill based	CSC5004	Cloud Computing	2	2	1	4
Skill based	CSC5005	Nature Inspired Computing	2	2	1	4
Skill based	CSC5006	Web Mining and Social Networking	2	2	1	4
Skill based	CSC5007	Multimedia Database Systems	2	2	1	4
Interdisciplinary	CSC5008	Computational Biology	2	2	1	4
Interdisciplinary	CSC5009	Embedded Systems	2	2	1	4
Skill based	CSC5010	Computer Vision	2	2	1	4
Skill based	CSC5011	Biometrics	2	2	1	4
Skill based	CSC5012	Information Retrieval Systems	2	2	1	4
Interdisciplinary	CSC5013	Bioinformatics	2	2	1	4
Skill based	CSC5014	Algorithms for Big Data	2	2	1	4
Skill based	CSC5015	Deep Learning	2	2	1	4
Interdisciplinary	CSC5016	Internet of Things	2	2	1	4
Skill based	CSC5017	Cyber Security	2	2	1	4
Skill based	CSC5018	Blockchain Technology	2	2	1	4
Skill based	CSC5019	Big Data Analytics	2	2	1	4

AUDITED/VALUE ADDED COURSES*					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC5051	Operating Systems	1	2	0	Nil
CSC5052	Computer Networks	1	2	0	Nil
CSC5053	LATEX	1	2	0	Nil
CSC5054	Software Engineering	1	2	0	Nil
CSC5055	Operations Research	1	2	0	Nil
CSC5056	Cyber Security	1	2	0	Nil
CSC5057	R Programming	1	2	0	Nil
CSC5058	C# Programming	1	2	0	Nil
CSC5059	Internet of Things	1	2	0	Nil
CSC5060	Technical Writing	1	2	0	Nil
CSC5061	Research Methodology	1	2	0	Nil

*Syllabus may vary and will be customized based on the level of students. Credits will not be added to mark lists.

OPEN ELECTIVE COURSES *					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC5071	C Programming	2	2	1	4
CSC5072	C++ Programming	2	2	1	4
CSC5073	MATLAB	2	2	1	4
CSC5074	Python	2	2	1	4
CSC5075	Enjoyable programming	2	2	1	4
CSC5076	C # .NET Framework and Unity	2	2	1	4
CSC5077	Full Stack Development	2	2	1	4
CSC5078	Data Analytics with Python	2	2	1	4
CSC5079	Internet of Things	2	2	1	4
CSC5080	Web Technologies	2	2	1	4
CSC5081	Metaverse	2	2	1	4

*Syllabus may vary and will be customized based on the level of students.
Lec = Lecture, Tut = Tutorial, Lab = Practical

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

CSC5101 - Computational Mathematics

This is a participatory and problem solving skill development course.

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

By completing this course, students will obtain the following course outcomes:
1.   Knowledge to be gained:
   (i)   Fundamental concepts of computational mathematics
   (ii)   Representation of real world problems into computational algorithms
   (iii)   Skills in representation data and implementation of mathematical concepts on computers
   (iv)   Influence of data representation on computers on numerical algorithms.
2.   Skill to be gained:
   (v)   Skills in representation of data and implementation of mathematical concepts using AI related toolbox/packages in Python and MATLAB
   (vi)   Critical analyzing and logic skills in developing computational algorithms.
3.   Competency to be gained:
   (vii) Computational modelling of any real world problem

Prerequisites: Basic knowledge in mathematics

CSC5102 - Programming Concepts using Python

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: Basic knowledge in any programming languages/concepts

CSC5103 - 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

CSC5104 – Digital Signal Processing

This is a participatory and experimental learning course.

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

By completing this course, students will obtain the following course outcomes:
1. Knowledge to be gained:
    (i)   Develop methods for signal transformation.
    (ii) To address digital signal processing in wide application areas including speech processing, remote sensing etc.
2. Skill to be gained:
    (iii) Skills in representation of digital signal processing concepts using AI related toolbox/packages in Python and MATLAB
3. Competency to be gained:
    (iv) Computational modelling of digital signal processing in any real world problems

Prerequisites: Basic knowledge in mathematics.

CSC5105 - Computational Intelligence 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

CSC5106 - 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 and CNN.
   (v) Solve real life problems using appropriate machine learning models and evaluate the performance measures.

Prerequisites: Basic knowledge in programming

CSC5201 - 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.

CSC5202 – 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 and statistics.

CSC5203 – 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.

CSC5204 – 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.

CSC5205 – Web Intelligence

This is a participatory, experimental, problem solving 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 with web applications.

Prerequisites: Basic knowledge of Computer Programming.

CSC5301 – 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.

CSC5302 – Minor Project

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

Course Objective:
   The objective of the course is to enable the students to develop research prototypes/models.

By completing this course, students will obtain the following course outcomes:
1. Knowledge to be gained:
    (i) State of arts methods /algorithms /procedures for the specific project undertaken by the student.
2. Skill to be gained:
    (ii) Paper writing skills
3. Competency to be gained:
    (iii) Competency to model real world research problems related the mini project undertaken by the student

CSC5490 – 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.

CSC5391 – 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.

CSC5392 – Industrial Visit/Field Work

This is an industrial visit or field work for skill development.

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

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
    (i) Understanding the state of arts methods /algorithms /procedures used for the live projects.
2. Skill gained:
    (ii) Report writing skills
    (iii) Critically identifying the modelling of real world problems.
3. Competency gained:
    (iv) Competency to handle/model any real world research based problem.

Core Elective Courses

CSC5001 – 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

CSC5002 – Digital Speech Processing

This is a participatory and experimental based course.

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

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

Prerequisites: Basic knowledge in signal processing

CSC5003 – Wireless Sensor Networks

This is a participatory, experimental and skill based course.

Course Objective:
  The objective of the course is to provide theoretical and practical aspects of wireless sensor networks.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
    (i) State of art methods, challenges, architecture and applications of wireless sensor networks.
2. Skill gained:
    (ii) Skills in modelling wireless sensor application using Network Simulator and NetSim
    (iii) Skills in designing and performance analysis of various protocols for wireless sensor networks
3. Competency gained:
    (iv) Implementation and simulation of wireless sensor networks for various applications.

Prerequisites: Basic knowledge in computer networks

CSC5004 – Cloud Computing

This is a participatory and experimental course.

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

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
    (i) State of art methods, challenges, architecture and applications of cloud computing.
2. Skill gained:
    (ii) Skills in modelling and development of cloud based service using cloud technology.
3. Competency gained:
    (iii) Implementation/virtualization of cloud based service for various applications.

Prerequisites: Basic knowledge of understanding web technology

CSC5005 – Nature Inspired Computing

This is a participatory and problem solving course.

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

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) fundamental concepts of nature inspired computing
2. Skill gained:
   (ii) Skills in the development of algorithms for nature inspired computing
3. Competency gained:
   (iii) optimization of real world problems using nature inspired computing

Prerequisites: Basic knowledge of programming

CSC5006 – 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

CSC5007 – Multimedia Database Systems

This is an experimental and skill based course.

Course Objective:
   The objective of the course is to provide theoretical and practical aspects of multimedia database systems.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) State of art methods in multimedia database systems
2. Skill gained:
   (ii) Skills in developing algorithms and methods for multimedia databases
3. Competency gained:
   (iii) Developing multimedia systems for various applications

Prerequisites: Basic knowledge of databases

CSC5008 – Computational Biology

This is a participatory, experimentally and problem solving course.

Course Objective:
   The objective of the course is to provide theoretical and practical aspects of developing computational techniques needed for biology.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Mathematical concepts of computational biology
2. Skill gained:
   (ii) Critical analyzing and logic skills in developing computational algorithms.
3. Competency gained:
   (iii) Computational biology modelling and applications

Prerequisites: Basic knowledge of programming

CSC5009 – Embedded Systems

This is a participatory and experimental skill development course.

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

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Fundamental concepts of embedded systems.
2. Skill gained:
   (ii) Critical analyzing and logic skills in developing embedded codes.
3. Competency gained:
   (iii) Development of embedded systems for a variety of real world problems

Prerequisites: Basic knowledge of electronic components and programming

CSC5010 – Computer Vision

This is a participatory, experimental and problem solving course.

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

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Theoretical concepts of achieving computer vision
2. Skill gained:
   (ii) Critical analyzing and logic skills in developing computer vision related methods and algorithms.
3. Competency gained:
   (iii) Modelling and development of computer vision based applications.

Prerequisites: Basic knowledge of image processing

CSC5011 – Biometrics

This is a participatory and experimental course.

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

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
   (i) Theoretical concepts of developing methods and algorithms for biometrics
2. Skill gained:
   (ii) Critical analyzing and logic skills in developing biometrics related methods and algorithms.
3. Competency gained:
   (iii) Modelling and development of biometric applications.

Prerequisites: Basic knowledge of image processing

CSC5012 – Information Retrieval Systems

This is a theoretical and experimental course.

Course Objective:
   The objective of the course is to provide theoretical and practical aspects of information retrieval systems.

By completing this course, students will obtain the following course outcomes:
1.   Knowledge gained:
     (i)   Theoretical concepts for developing methods and algorithms for information retrieval systems
2.   Skill gained:
     (ii)   Critical analyzing and logic skills in developing methods and algorithms for information retrieval systems
3.   Competency gained:
     (iii) Modelling and development of information retrieval systems and applications.
Prerequisites: Nil

CSC5013 – Bioinformatics

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

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

By completing this course, students will obtain the following course outcomes:
1.   Knowledge gained:
     (i) Theoretical concepts for developing methods and algorithms for bioinformatics
2.   Skill gained:
     (ii) Critical analyzing and logic skills in developing methods and algorithms for bioinformatics
3.   Competency gained:
     (iii) Modelling and development of bioinformatics-based applications using MATLAB.

Prerequisites: Basic knowledge of programming

CSC5014 – Algorithms for Big Data

This is a participatory, experimental and problem solving course.

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

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
     (i)   Theoretical concepts for developing methods and algorithms for big data
2. Skill gained:
     (ii)   Critical analyzing and logic skills in developing methods and algorithms for big data
3. Competency gained:
     (iii) Modelling and development of big data based applications.

Prerequisites: Basic knowledge of algorithms.

CSC5015 – 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.

CSC5016 – 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.

CSC5017 – 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:
1. Knowledge gained:
    (i) cyber security issues, tools and techniques that are critical in solving problems in cyber 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 scenarois.

Prerequisites: Basic knowledge in computer networks

CSC5018 – 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

CSC5019 – 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.

Audited/Value Added Courses

CSC5051 – Operating Systems

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 principles of operating system design issues.

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
4. Competency gained:
    (iii) Utilization of inter-process communication strategies and access control in an operating system

Prerequisites: Nil

CSC5052 – Computer Networks

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 principles of computer networks.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
    (i) State of art functionalities of networks, Architecture, protocols, methods used for data transmission.
2. Skill gained:
    (ii) Deploying networking components and analyzing the network protocols.
4. Competency gained:
    (iii) Optimal usage of networks for communication by providing quality of service.

Prerequisites: Nil

CSC5053 – LATEX

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 principles of document preparation using LATEX.

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

(i) State of art of document preparation using LATEX
2. Skill gained:
(ii) Paper writing skill for international publisher
3. Competency gained:
(iii) Document preparation for all proposes using LATEX.

Prerequisites: Nil

CSC5054 – Software Engineering

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 principles of software development life cycle.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
(i) State of art software life cycle models
(ii) Software development process
2. Skill gained:
(iii) Modelling software applications
3. Competency gained:
(iv) Design and develop correct and robust software products.

Prerequisites: Nil

CSC5055 – Operations Research

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 principles of Operations Research.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
(i) State of art methods in Operations Researchs
2. Skill gained:
(ii) Formulation of linear programming models.
3. Competency gained:
(iii) Solving realife operations research problems.

Prerequisites: Nil

CSC5056 – Cyber Security

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

CSC5057 – 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

CSC5058 - C# 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 the basic principles of programming using C#.

By completing this course, students will obtain the following course outcomes:
1. Knowledge gained:
         (i) State of art of programming techniques using C#
2. Skill gained:
         (ii) Designing algorithms using object oriented programming concepts and to develop simple programs using OOPs concepts in C#
3. Competency gained:
         (iii) Development of real life applications using C#

Prerequisites: Nil

CSC5059 – Internet of Things

This is a participatory, experimental and flipped classroom skill development course. The credits will not be added to mark list.

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

CSC5060 – Technical Writing

This is a skill development course. The credits will not be added to mark list.

Course Objective:
  The objective of the course is to provide technical writing skills for preparing reports, research papers, documents for research funding and making presentations.

By completing this course, students will obtain the following course/learning outcomes:
1. Knowledge to be gained:
    (i)   Identifying the structure of a report
    (ii) Representation of technical content in the appropriate position in the report or presentation

2. Skill to be gained:
   (iii) Skills in collecting the relevant data pertaining to the problem and preparing the necessary contents or documents for oral presentation and publishing of the reports
3. Competency to be gained:
   (iv) Writing research papers/reports and making presentations for oral communications

Prerequisites: Nil

CSC5061 – Research Methodology

This is a research skill development course. The credits will not be added to mark list.

Course Objective:
   The objective of the course is to provide theoretical and practical aspects of formulating viable research questions and to prepare and execute a feasible research.

By completing this course, students will obtain the following course/learning outcomes:
1. Knowledge to be gained:
   (i)   Identifying the research problem
   (ii) Representation of research problems into computational algorithms
   (iii) Skills in representation of data and implementation of mathematical concepts
2. Skill to be gained:
   (iv) Skills in collecting relevant data pertaining to the problem
   (v) Skills in representation of data and implementation of concepts using programming languages and toolboxes
3. Competency to be gained:
   (vi) Computational modelling of data related to the problem
   (vii) Writing research papers and research reports

Prerequisites: Nil

Open Elective Courses

CSC5071 – 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

CSC5072 – 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

CSC5073 – 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

CSC5074 - Python

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

CSC5075 - 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

CSC5076 - 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

CSC5077 - Full Stack Development

This is a participatory and problem solving course.

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

CSC5078 - 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

CSC5079 - 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.

CSC5080 - Web Technologies

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

CSC5081 - 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:
    (i)   Familiarize multiple technologies used in Metaverse
    (ii) Understand the security threats and its countermeasures in metaverse
2. Skill to be gained:
    Skills to develop AR, VR and blockchain applications with Graphical User Interface
3. Competency to be gained:
    Analyse the applications and their performance in Metaverse

Prerequisites: Programming Skill

OVERALL COURSE OUTCOME MAPPING WITH PROGRAMME OUTCOME		PO1	PO2	PO3	PO4	PO5	PO6
SEMESTER I							
CSC5101	Computational Mathematics	H	H	H	L	L	L
CSC5102	Programming Concepts Using Python	H	M	H	M	L	L
CSC5103	Advanced Data Structures and Algorithms	M	H	H	L	M	M
CSC5104	Digital Signal Processing	M	H	H	L	M	M
CSC5105	Computational Intelligent Systems	H	H	H	M	H	H
CSC106	Artificial Intelligence and Machine Learning	H	H	H	M	H	H
SEMESTER II							
CSC5201	Cryptography and Network Security	M	L	H	L	H	M
CSC5202	Pattern Recognition	H	H	H	M	H	M
CSC5203	Computer Graphics and Visualization	L	L	M	L	H	L
CSC5204	Data Mining	M	H	H	H	H	M
CSC5205	Web Intelligence	H	M	M	M	H	M
During Summer Vacation							
CSC5391	Internship	M	H	H	H	H	M
SEMESTER III							
CSC5301	High Performance Computing	H	M	H	H	H	H
CSC5302	Minor Project	H	H	H	H	H	H
CSC5392	Industrial Visit/Field Work	H	H	H	H	H	H
SEMESTER IV							
CSC5490	Dissertation	H	H	H	H	H	H
Core Electives							
CSC5001	Natural Language Processing	M	H	H	M	H	M
CSC5002	Digital Speech Processing	M	M	H	M	H	M
CSC5003	Wireless Sensor Networks	L	L	H	M	H	H
CSC5004	Cloud Computing	L	L	H	L	H	H
CSC5005	Nature Inspired Computing	M	M	H	L	H	M
CSC5006	Web Mining and Social Networking	M	M	H	M	H	H
CSC5007	Multimedia Database Systems	L	L	H	L	H	L
CSC5008	Computational Biology	L	L	H	L	H	M
CSC5009	Embedded Systems	L	L	H	L	H	M
CSC5010	Computer Vision	M	M	H	M	H	M
CSC5011	Biometrics	M	M	H	M	H	M
CSC5012	Information Retrieval Systems	L	M	H	M	H	H
CSC5013	Bioinformatics	H	M	H	M	H	M
CSC5014	Algorithms for Big Data	H	H	H	M	H	H
CSC5015	Deep Learning	H	H	H	M	H	H
CSC5016	Internet of Things	L	L	H	L	H	H
CSC5017	Cyber Security	L	L	H	M	H	H
CSC5018	Blockchain Technology	L	L	H	L	H	H
CSC5019	Big Data Analytics	H	H	H	H	H	H
Open Electives							
CSC5071	C Programming	H	M	H	L	L	L
CSC5072	C++ Programming	H	M	H	L	L	L
CSC5073	MATLAB	H	M	H	L	L	L
CSC5074	Python	H	L	H	L	L	L
CSC5075	Enjoyable programming	H	L	H	L	M	L
CSC5076	C # .NET Framework and Unity	H	L	H	M	M	M
CSC5077	Full Stack Development	H	L	M	M	H	M
CSC5078	Data Analytics with Python	H	L	H	L	H	L
CSC5079	Internet of Things	L	L	H	L	H	H
CSC5080	Web Technologies	H	L	M	M	H	M
CSC5081	Metaverse	H	M	M	M	M	H

Audited/Value Added Courses							
CSC5051	Operating Systems	L	L	H	L	H	L
CSC5052	Computer Networks	L	L	H	L	H	L
CSC5053	LATEX	L	L	H	L	H	L
CSC5054	Software Engineering	M	L	H	L	H	L
CSC5055	Operations Research	H	L	H	L	H	L
CSC5056	Cyber Security						
CSC5057	R Programming	H	L	H	L	H	L
CSC5058	C# Programming	H	H	H	M	H	L
CSC5059	Internet of Things	L	L	H	L	H	H
CSC5060	Technical Writing	L	L	M	L	L	M
CSC5061	Research Methodology	L	L	M	M	L	M

		OVERALL COURSE OUTCOME MAPPING WITH PROGRAMME SPECIFIC OUTCOME									
		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
	SEMESTER I										
CSC5101	Computational Mathematics	H	M	M	M	L	M	H	H	H	L
CSC5102	Programming Concepts Using Python	M	M	M	M	L	M	H	H	M	L
CSC5103	Advanced Data Structures and Algorithms	H	H	H	H	M	M	H	H	M	M
CSC5104	Digital Signal Processing	H	H	H	H	M	M	H	H	H	H
CSC5105	Computational Intelligent Systems	H	H	H	H	H	M	H	H	H	H
CSC5106	Artificial Intelligence and Machine Learning	H	H	H	H	H	M	H	H	H	H
	SEMESTER II										
CSC5201	Cryptography and Network Security	H	H	H	H	H	M	H	H	H	H
CSC5202	Pattern Recognition	H	H	H	H	H	M	H	H	H	H
CSC5203	Computer Graphics and Visualization	M	H	H	H	H	M	H	H	H	H
CSC5204	Data Mining	H	H	H	H	H	M	H	H	H	H
CSC5205	Web Intelligence	M	M	H	H	M	H	H	H	H	H
	During Summer Vacation										
CSC5391	Internship	H	H	H	H	H	H	H	H	H	H
	SEMESTER III										
CSC5301	High Performance Computing	H	H	H	H	H	M	H	H	H	H
CSC5302	Minor Project	H	H	H	H	H	H	H	H	H	H
CSC5392	Industrial Visit/Field Work	H	H	H	H	H	H	H	H	H	H
	SEMESTER IV										
CSC5490	Dissertation	H	H	H	H	H	H	H	H	H	H
Core Electives											
CSC5001	Natural Language Processing	H	H	H	H	H	M	H	H	M	H
CSC5002	Digital Speech Processing	H	H	H	H	M	M	H	H	M	H
CSC5003	Wireless Sensor Networks	L	H	H	H	M	M	H	H	M	H
CSC5004	Cloud Computing	M	H	H	H	M	M	H	H	M	H
CSC5005	Nature Inspired Computing	N	H	H	H	M	L	H	H	M	H
CSC5006	Web Mining and Social Networking	H	H	H	H	H	M	H	H	H	H
CSC5007	Multimedia Database Systems	H	H	H	H	M	L	H	H	M	M
CSC5008	Computational Biology	L	H	H	H	M	L	H	H	H	H
CSC5009	Embedded Systems	M	H	H	H	M	L	H	H	H	H
CSC5010	Computer Vision	H	H	H	H	M	M	H	H	H	H
CSC5011	Biometrics	M	H	H	H	M	L	H	H	H	H
CSC5012	Information Retrieval Systems	M	H	H	H	H	M	H	H	H	H
CSC5013	Bioinformatics	M	H	H	H	M	M	H	H	H	H

CSC5014	Algorithms for Big Data	H	H	H	H	H	M	H	H	H	H
CSC5015	Deep Learning	H	H	H	H	H	M	H	H	H	H
CSC5016	Internet of Things	L	H	H	M	H	H	H	H	H	H
CSC5017	Cyber Security	H	H	H	H	H	M	H	H	H	H
CSC5018	Blockchain Technology	M	H	H	H	H	M	H	H	H	H
CSC5019	Big Data Analytics	H	H	H	H	H	M	H	H	H	H
	Open Electives										
CSC5071	C Programming	L	M	M	M	L	L	H	H	H	L
CSC5072	C++ Programming	L	M	M	M	L	L	H	H	H	L
CSC5073	MATLAB	L	M	M	M	L	L	H	H	H	L
CSC5074	Python	L	M	M	M	L	L	H	H	H	L
CSC5075	Enjoyable programming	L	M	M	M	L	L	H	H	H	L
CSC5076	C # .NET Framework and Unity	L	M	M	M	L	L	H	H	H	M
CSC5077	Full Stack Development	M	M	M	M	M	H	H	H	H	M
CSC5078	Data Analytics with Python	H	H	H	H	M	M	H	H	H	M
CSC5079	Internet of Things	L	H	H	M	H	H	H	H	H	H
CSC5080	Web Technologies	M	M	M	M	M	H	H	H	H	M
CSC5081	Metaverse	H	M	H	H	M	M	H	H	H	M
	Audited/Value Added Courses										
CSC5051	Operating Systems	L	M	M	M	L	M	H	H	H	H
CSC5052	Computer Networks	L	M	M	M	L	M	H	H	H	H
CSC5053	LATEX	L	L	L	L	L	L	H	H	H	L
CSC5054	Software Engineering	M	M	M	M	L	M	H	H	H	M
CSC5055	Operations Research	H	L	L	L	L	M	H	H	H	M
CSC5056	Cyber Security	H	H	H	H	H	M	H	H	H	H
CSC5057	R Programming	L	M	M	M	L	L	H	H	H	L
CSC5058	C# Programming	L	M	M	M	L	L	H	H	H	L
CSC5059	Internet of Things	L	H	H	M	H	H	H	H	H	H
CSC5060	Technical Writing	L	M	M	M	L	L	M	H	M	M
CSC5061	Research Methodology	L	H	H	M	M	M	H	H	H	M

SYLLABUS

CSC5101 - Computational Mathematics

Module 1

Mathematical Statistics – Concepts of Probability and Random Variables, Classical Relative Frequency and Axiomatic Definition of Probability, Addition Rule, Conditional Probability, Multiplication Rule, Bayes Rule, T Test, χ^2 Test

Module 2

Solution of Algebraic and Transcendental Equations **-** Bisection method, Regula – Falsi Method, Newton_ Raphson method, Solution of Linear System of Equations and Matrix Inversion – Gaussian Elimination Method, Jacobi's Method, Gauss – Seidel Iteration Method, Eigen Value Problems – Power Method.

Module 3

Interpolation – Lagrange's Interpolation Formulae, Newton's Forward Difference Interpolation Formula, Numerical Differentiation and Integration – Trapezoidal Rule, Simpson's Rules, Ordinary Differential Equations – Euler Method, Runge-Kutta Methods. Any one of the finite difference schemes for partial differential equations.

Module 4

Graph theory – Introduction to Graphs, Subgraphs, Trees and Traversals, Connectivity, Network Flows, Shortest Paths, Graph Applications.

Text Books/References:
1. Fundamentals of Computational Methods for Engineers, Md. Masud Rana, Wei Xu, Youguang Guo, Bentham Books, 2022
2. Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale, 7th Edition, Mc Graw Hill Education, 2015
3. An Introduction to MATLAB® Programming and Numerical Methods for Engineers, Timmy Siauw, Alexandre M. Bayen, Academic Press, Elsevier, 2014
4. Discrete Mathematics and Graph Theory – A Concise Study Companion and Guide, K. Erciyes, Springer, 2021.

CSC5102 - Programming Concepts using Python

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.

Module 5

Any one case study based on Machine Learning, IoT, Data Analysis and Visualization, Web development, Robot programming, Multithreading and Networking concepts.

Text Books/References:
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.
4. James Payne, Beginning Python using Python 2.6 and Python 3, Wrox publishing, 2010.

5. Paul Gries, Practical Programming: An Introduction to Computer Science using Python the Pragmatic Bookshelf, 2nd edition 2013.
6. Charles Dierach, Introduction to Computer Science using Python, Wiley, 2015.

CSC5103 - Advanced Data Structures and Algorithms

Module 1:
Tree structures and its operations: - Min-max heaps, deaps, binomial heaps, Fibonacci heaps. Binary search trees, AVL trees, 2-3-4 trees, red-black trees, b-trees.

Module 2:
Introduction to algorithms: Role of Algorithms in computing, growth of functions: asymptotic notations, functions and running times, asymptotic notations in equalities and inequalities. Practical complexities, performance measurement. Randomized algorithms: Basics of probability theory, an Informal description, primality testing

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.

CSC5104 – Digital Signal Processing

Module 1
Signals and Signal Processing- Characterization and Classification of Signals, Typical Signal Processing Operations, Typical Signal Processing Applications, Advantages of Digital Signal Processing, Sampling and reconstruction of Signals.

Module 2
Time Domain Representation of Signals and Systems- Discrete Time Signals, Operations on sequences, Discrete time Systems, Linear Time Invariant Discrete Time Systems.

Module 3
z-Transform, Properties of the z-Transform, Rational z-Transform, Inversion of the z-Transform, Pole – Zero Analysis.

Module 4
Frequency Analysis of Signals- Frequency Analysis of Continuous Time Signals, Frequency Analysis of Discrete Time Signals, Frequency domain and Time Domain Signal Properties.

Module 5
Case study in any one of the following: Discrete Fourier Transform, Discrete Cosine Transform, Analog-to-Digital and Digital-to-Analog Converters.

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

CSC5105 - Computational Intelligence 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.

Module 5
Latest literature review and case studies.

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

CSC5106 - Artificial Intelligence and Machine Learning

Module 1

Artificial Intelligence -Introduction - Problem-solving -Solving Problems by Searching - Uninformed Search Strategies -Informed (Heuristic) Search Strategies, Intelligent Systems, 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 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).

Module 4

Introduction to Neural Networks: Perceptron, Multilayer perceptron, activation functions, architecture design, Loss functions- various types, introduction to optimization-Gradient descent based algorithms. Convolutional Neural Networks: convolution and pooling operations, Convolutional layers in neural network. Case study: Alexnet and VGG16 architecture.

Module 5

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. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016.
5. Yuxi (Hayden), Liu and Savansh Mehta, "Hands -on Deep Learning Architectures with Python", Packt, 2019.
6. Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995
7. 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.

CSC5201 - 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: Intruders, Intrusion detection, Malicious software, firewalls.

Module 5
Case Studies on Cryptography and Security: Cryptographics 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.

CSC5202 – 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

CSC5203 – 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 Rosenfeld, Avinash C. Kak, "*Digital Picture Processing*", Morgan Kaufmann, 2nd Ed., 1982.
5. Bernd Jahne, "*Digital Image Processing*", Springer, 6th Ed., 1997

CSC5204 – 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.

Module 3

Mining Image data: Color feature extraction: Color space, image clustering and segmentation, 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 and annotation

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, classification, clustering, 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

CSC5205 – 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.

CSC5301 – 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*

CSC5302 – Minor Project

Students should undertake research based real time minor project work to get an exposure in developing applications related to Intelligent Systems as the field of specialization. Each student will be allotted to one or more Internal Guide (Faculty Member) who will guide the students in the successful implementation of the minor project. A detailed project report should be submitted by each student at the end of the semester. At least two internal evaluation and end semester evaluation will be conducted and marks will be awarded based on demonstration, presentation and report.

CSC5490 – 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 presentation of the project work at the end of the semester in front of examiners based on the work done and the dissertation submitted.

CSC5391 – Internship

Each student is required to carry out an internship 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 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.

CSC5392 – Industrial Visit/Field Work

Each student is required to carry out an industrial visit/field work under the supervision of two faculties in the Department. Industrial visit/field work to be done before the completion of third semester. There is no credit for the industrial visit/field work. The consent of the parent to be submitted to the Department before going to industrial visit/field work. The mentor or Head of the Department can get willingness letter from the Industry/Institute for allowing the students for industrial visit/field work. A report to be submitted to the Department after industrial visit/field work.

Core Elective Courses

CSC5001 – 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.

CSC5002 – Digital Speech Processing

Module 1

Introduction to Speech Recognition: Introduction-The Paradigm for Speech Recognition-History of Speech Recognition Research, The Speech Signal: Speech Production Mechanism, perception-Acoustic Phonetic Characterization and classification -The Speech Production Process-Representing speech in Time Frequency Domains-Speech Sounds and Features-Approaches to Automatic Speech Recognition by Machine

Module 2

Signal Processing and Analysis Methods for Speech Recognition: Introduction-The Bank of Filters Front End Processor, Linear Predictive Coding for Speech Recognition, Vector Quantization.

Module 3

Pattern Comparisons Techniques: Speech Detection, Distortion Measures – mathematical and perceptual consideration, Spectral Distortion Measures- Log Spectral Distance, Cepstral Distances, Spectral Distortion using a Warped Frequency Scale, Alternative Spectral Representations and Distortion Measures.

Module 4

Speech Recognition System Design and Implementation Issues: Template Training Methods – Casual Training, Robust Training, Clustering, Performance Analysis and Recognition Enhancements – Choice of Distortion Measures, Choice of clustering methods and k-NN Decision Rule, Incorporation of Energy Information, Effects of signal Analysis Parameters, Performance of Isolated Word Recognition System.

Text Books/References:
1. Lawrence Rabiner, Biing-Hwang Juang, B Yegnanarayana, Fundamentals of Speech Recognition, Pearson, 2009.
2. L.R. Rabiner and R.E Schafer, *Digital processing of speech signals*, Prentice Hall, 1978 (Digitized 2007)
3. John G. Proakis, Dimitris G. Manolakis, *Digital Signal Processing* Principles, Pearson, 2006.

CSC5003 – Wireless Sensor Networks

Module 1
Introduction and basic overview of wireless sensor network, Challenges and hurdles, Basic sensor network architectural elements, Sensor node technology, Available wireless technologies. Range of applications, Examples of category 1 WSN applications and Examples of category 2 WSN applications.

Module 2
Introduction of Medium access control protocols for wireless sensor networks, Fundamentals of MAC protocols, MAC protocol for WSNs, Sensor MAC case study, IEEE 802.15.4 LR-WPANs standard case study. Introduction of routing protocols, Data dissemination and gathering, Routing challenges and design issues in wireless sensor networks, Routing strategies in wireless sensor networks, Geographical routing.

Module 3
Traditional transport control protocol for WSN, Transport protocol design issues, Examples of existing transport control protocols, Performance of transport control protocols. Network management requirements for WSN, Traditional network management models, Network management design issues.

Module 4
Sensor network Platform, Tools and Operating Systems for WSN: Sensor node hardware, Sensor network programming challenges, Node-level software platforms, Operating system design issues, Examples of operating systems. Performance and Traffic management: Introduction, WSN design issues, Performance modeling of WSNs, Case study: Simple computation of the system life span.

Text books and References:
1. Kazem Sohraby, Daniel Minoli, Taieb F. Znati, Wireless Sensor Networks: technology, protocols and application, Wiley, 2015.
2. Feng Zhao and Leonidas Guibas, *Wireless Sensor Networks*, Morgan Kaufmann, San Francisco, 2004.
3. H. Karl, A. Willing, Protocols and Architectures for Wireless Sensor Networks, Wiley, 2017.
4. A. Swami, Q. Zhao, Y.-W. Hong, L. Tong, Wireless Sensor Networks: Signal Processing and Communication Perspectives, Wiley, 2007.

CSC5004 – Cloud Computing

Module 1
Introduction to Cloud Computing– Definition, Characteristics, Cloud architecture - Layers – Deployment models - Cloud provider, SAAS, PAAS, IAAS and Others, Organizational scenarios of clouds, Administering & Monitoring cloud services, Benefits and limitations, Deploy application over cloud, Comparison among SAAS, PAAS, IAAS, Cloud computing platforms: Infrastructure as service; Amazon EC2, Platform as Service; Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing.

Module 2
Introduction to Cloud Technologies- Study of Hypervisors. Compare SOAP and REST, Virtualization Technology: Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization, Multitenant software: Multi-entity support, Multi-schema approach, Multi-tenance using cloud data stores, Data access control

for enterprise applications, Data in the cloud: Relational databases, Cloud file systems: GFS and HDFS, BigTable,HBase and Dynamo. Map-Reduce and extensions: Parallel computing, The map-Reduce model, Parallel efficiency of Map-Reduce, Relational operations using Map-Reduce, Enterprise batch processing using Map-Reduce, Introduction to cloud development.

Module 3
Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud, Cloud computing security architecture: Cloud computing security challenges: Virtualization security management- virtual threats, VM Security Recommendations, VM-Specific Security techniques, Secure Execution Environments and Communications in cloud.

Module 4
Issues in cloud computing, implementing real time application over cloud platform, Issues in Intercloud environments, QOS Issues in Cloud, Dependability, data migration, streaming in Cloud. Quality of Service (QoS), monitoring in a cloud computing environment. Cloud Middleware. Mobile Cloud Computing. A grid of clouds, Sky computing, load balancing, resource optimization, resource dynamic reconfiguration.

Text Books/References:
1. Frederic Magoules, *Fundamentals of Grid Computing: Theory, Algorithms and Technologies*, Chapman and Hall, 2010
2. B. Wilkinson, *GRID Computing, Techniques and Applications*, Chapman, 2009
3. Antonopoulos, Nick; Gillam, Lee, *Cloud Computing Principles, Systems and Applications*, Springer, 2010.
4. G. Reese, *Cloud Application Architecture*, O'Reilly, 2009

CSC5005 – Nature Inspired Computing

Module 1
Natural to Artificial Systems – Biological Inspirations in problem solving – Behavior of Social Insects: Foraging - Division of Labor - Task Allocation – Cemetery Organization and Brood Sorting – Nest Building - Cooperative transport.

Module 2
Ant Colony Optimization: Ant Behavior - Towards Artificial Ants - Ant Colony Optimization – Problem solving using ACO - Extensions of Ant Systems - Applications.

Module 3
Swarm Intelligence: Introduction to Swarm Intelligence – Working of Swarm Intelligence - Optimization – Particle Swarms - Applications

Module 4
Introduction to Genetic Algorithms - population initialization - choosing a fitness function - selection - crossover - mutation - reinsertion - applications of genetic algorithms - evolutionary algorithms.

Module 5
Case studies in Immune System Algorithms, Simulated Annealing.

Text Books:
1. Stephan Olariu and Albert Zomaya, *Hanbook of Bioinspired Algorithms and Appl.*, Chapman and Hall, 2006
2. Marco Dorigo, Thomas Stutzle, *Ant Colony Optimization*, MIT Press, 2004.
3. E. Bonabeau, Marco Dorigo, Guy Theraulaz, *Swarm Intelligence: From Natural to Artificial Systems*, Oxford University press, 2000.
4. Mitchell, Melanie, *Introduction to genetic algorithms*, ISBN: 0262133164, MIT Press, 1996
5. Nunes de Castro, Leandro, *Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications*, Chapman & Hall, 2006

References:
1. Nunes de Castro, Leandro and Fernando J. Von Zuben, *Recent Developments in Biologically Inspired Computing,* MIT Press, 2005
2. D. Floreano and C. Mattiussi, *Bio-Inspired Artificial Intelligence*, MIT Press, 2008
3. Camazine, Scott et al, *Self-organization in biological systems*, ISBN: 9780691116242, Princeton Univ. Press, 2001
4. Nancy Forbes, *Imitation of Life - How Biology Is Inspiring Computing*, MIT Press, 2004.

5. Christian Blum, Daniel Merkle (Eds.), *Swarm Intelligence: Introduction and Applications*, Springer Verlag, 2008.
6. Leandro N De Castro, Fernando J Von Zuben, *Recent Developments in Biologically Inspired Computing*, Idea Group Inc., 2005.

CSC5006 – 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.

CSC5007 – Multimedia Database Systems

Module 1
Basics: Architecture of Multimedia Database System, Performance Measures for evaluating Multimedia Database System – Accuracy, Precision, Recall, F-Measure, R-Norm. Multidimensional Data Structures: k-d Trees, Quadtrees, R-Trees, G-Tree, comparison of Different Data Structures.

Module 2
Image Databases: Image Formats, overview of image processing steps, feature extraction techniques for images – Color, Shape, Texture and Spatial features. Study on archival and retrieval of images for exact and similarity retrieval. Indexing techniques for archival of images using B-Tree, R-Tree, G-Tree for both conventional as well as spatial layout representation. Text/Document Databases: Stop Lists, Word Stems, and Frequency Tables. Study on text representation using Vector Space Model, Term Document Frequency representation, Latent Semantic Indexing, Other Retrieval Techniques. Recent research development in text database management system.

Module 3
Video Databases: Organizing Content of a Single Video, video segmentation, Keyframe extraction, video summarization, video archival and retrieval using conventional representation schemes. Introduction to semantic based video archival and retrieval systems. Recent developments in video database system. Audio Databases A General Model of Audio Data, Capturing Audio Content through Discrete Transformation, Indexing Audio Data.

Module 4
Design and Architecture of a Multimedia Database, Organizing Multimedia Data Based on The Principle of Uniformity, Media Abstractions, Query Languages for Retrieving Multimedia Data, Indexing SMDSs with Enhanced Inverted Indices, Query Relaxation/Expansion, Web-based multimedia applications.

Text Books/References:
1. V.S. Subrahmanian, *Principles of Multimedia Database Systems*, Morgan Kauffman, 2nd Edition, 2013.
2. Shashi Shekhar, Sanjiv Chawla, *Spatial Databases*, Pearson Education, 2002.

3. Lynne Dunckley, *Multimedia Databases- An object relational approach*, Pearson Education, 2003.
4. B. Prabhakaran, *Multimedia Database Systems*, Kluwer Academic,1997

CSC5008 – Computational Biology

Module 1
Introductory Molecular Biology, DNA Analysis, Regulatory Motifs in DNA Sequences, Finding Motifs, Greedy Approach to Motif finding, Longest Common Subsequences, Global and Local Sequence Alignments, Multiple Alignment

Module 2
Gene Prediction, Constructing Algorithms in sub quadratic time, Shortest Superstring Problem

Module 3
Sequencing by Hybridization, Protein Sequencing and Hybridization, Spectrum Graphs, Spectral Convolution, Repeat Finding, Hash Tables, Keyword Trees, Suffix Trees and its Applications

Module 4
Approximate Pattern Matching, Hierarchical Clustering, Evolutionary Trees, Parsimony Problem, Hidden Markov Models, Applications of HMM.

Text books/References:
1. N. C. Jones, P. A. Pevzner, An Introduction to Bioinformatics Algorithms, MPI Press, 2004.
2. D. W. Mont, Bioinformatics: Sequence and Genome Analysis, CSHL Press, 2004.
3. D. Gusfield, Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology, Cambridge University Press, 1997.

CSC5009 – Embedded Systems

Module 1
Introduction to Embedded Systems: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software, Complex System Design, Design Process in Embedded System, Formalization of System Design, Classification of Embedded Systems

Module 2
8051 and Advanced Processor Architecture: 8051 Architecture, 8051 Micro controller Hardware, Input/output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/output, Interrupts, Introduction to Advanced Architectures, Real World Interfacing, Processor and Memory organization - Devices and Communication Buses for Devices Network: Serial and parallel Devices & ports, Wireless Devices, Timer and Counting Devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Internet Enabled Systems, Wireless and Mobile System protocols.

Module 3
Real – Time Operating Systems: OS Services, Process and Memory Management, Real – Time Operating Systems, Basic Design Using an RTOS, Task Scheduling Models, Interrupt Latency, Response of Task as Performance Metrics - RTOS Programming: Basic functions and Types of RTOSES, RTOS VxWorks, Windows CE.

Module 4
Embedded Software Development Process and Tools: Introduction to Embedded Software Development Process and Tools, Host and Target Machines, Linking and Locating Software, Getting Embedded Software into the Target System, Issues in Hardware-Software Design and Co-Design - Testing, Simulation and Debugging Techniques and Tools: Testing on Host Machine, Simulators, Laboratory Tools.

Text Book:
1. Raj Kamal, *Embedded Systems*, Second Edition TMH, 2008
References:
1. K.V.K.K.Prasad, *Embedded/Real-Time Systems*, dreamTech press, 2003
2. Muhammad Ali Mazidi, *The 8051 Microcontroller and Embedded Systems*, Pearson, 2007
3. Kenneth J. Ayala, Thomson, *The 8051 Microcontroller*, Third Edition, 1997
4. David E. Simon, *An Embedded Software Primer*, Pearson Education, 2005
5. Ajay V Deshmukhi, *Micro Controllers*, TMH, 2005
6. Raj kamal, *Microcontrollers*, Pearson Education, 2009
7. Shibu K.V, *Introduction to Embedded Systems*, TMH, 2009

CSC5010 – Computer Vision

Module 1
Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems. Recognition Methodology: Conditioning, Labeling, Grouping, Extracting, Matching, Edge detection, Gradient based operators, Morphological operators, Spatial operators for edge detection. Thinning, Region growing, region shrinking, Labeling of connected components.

Module 2
Binary Machine Vision: Thresholding, hierarchical segmentation, spatial clustering, split & merge, rule-based segmentation, motion-based segmentation. Area Extraction: Concepts, Data-structures, Edge, Line-Linking, Hough transform, Line fitting, Curve fitting (Least-square fitting). Region Analysis: Region properties, External points, Spatial moments, Mixed spatial gray-level moments, Boundary analysis: Signature properties, Shape numbers.

Module 3
Motion Estimation: Regularization theory, Optical computation, Stereo Vision, Motion estimation, Structure from motion, Shape Representation and Segmentation: Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multiresolution analysis, Tracking-basic concepts, kalman filter-particle filter.

Module 4
Object recognition: Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition. Labeling lines, understanding line drawings, Classification of shapes by labeling of edges, Photogrammetry - from 2D to 3D. Classifiers.

Text books/References:
1. David A. Forsyth, Jean Ponce, *Computer Vision: A Modern Approach*, Prentice Hall, US Ed., 2002.
2. Ramesh Jain, Rangachar Kasturi, Brian G. Schunck, *Machine Vision*, McGraw Hill, 1st Ed., 1995.
3. Berthold K. P. Horn, *Robot Vision*, MIT Press, 1986.
4. Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis, and Machine Vision*, CL-Engineering, 3rd Ed., 2007.
5. Robert M. Haralick, Linda G. Shapiro, *Computer and Robot Vision*, Vol. I, Addison Wesley, 1991.
6. Robert M. Haralick, Linda G. Shapiro, *Computer and Robot Vision*, Vol. II, Prentice Hall, 2002.
7. Trucco, Alessandro Verri, *Introductory Techniques for 3-D Computer Vision*, Prentice Hall, 1998

CSC5011 – Biometrics

Module 1: Introduction to biometrics
Introduction, operation of a biometric system, types of biometrics, benefits of biometrics, verification versus identification, performance of a biometric system, biometric characteristics, Applications of biometrics.

Module 2: Fingerprint recognition and verification
Introduction, Fingerprint sensing and database creation, Fingerprint segmentation, Feature extraction -Local ridge orientation and frequency, Minutiae extraction, matching -Correlation-based techniques, Minutiae-based methods, finger print classification, Finger print recognition and verification, performance evaluation. challenges in fingerprint biometric, current literatureon fingerprint.

Module 3: Face recognition and verification
Introduction, face sensing and database creation, face detection, feature extraction -subspace techniques-Eigen faces, Fisher faces and Laplacian faces and their variants, face recognition and verification, performance evaluation, challenges in face biometric, current literatureon face recognition.

Module 4: Signature recognition and verification
Introduction, Types of signatures -offline and online signature. Feature extraction –Parameter and function based features, signature matching schemes, Signature recognition and verification, performance evaluation, challenges in signature biometric, current literatureon signature.

Text Books/References:
1. Jain A. K., Flynn P and Ross A. A. Handbook of biometrics. Springer, 2008.
2. Wayman J., Jain A. K., Maltoni D and Maio D. Biometric Systems –Technology, Design and Performance evaluation. Springer, 2005.
3. Gregory P and Simon M A. Biometrics for dummies. Wiley Publishing Inc, 2008.

CSC5012 – Information Retrieval Systems

Module 1
Introduction: Definition, Objectives, Functional Overview, Relationship to DBMS, Digital libraries and Data Warehouses. Information Retrieval System Capabilities: Search, Browse, Miscellaneous

Module 2
Cataloging and Indexing: Objectives, Indexing Process, Automatic Indexing, Information Extraction. Data Structures: Introduction, Stemming Algorithms, Inverted file structures, N-gram data structure, PAT data structure, Signature file structure, Hypertext data structure.

Module 3
Automatic Indexing: Classes of automatic indexing, Statistical indexing, Natural language, Concept indexing, Hypertext linkages Document and Term Clustering: Introduction, Thesaurus generation, Item clustering, Hierarchy of clusters.

Module 4
User Search Techniques: Search statements and binding, Similarity measures and ranking, Relevance feedback, Selective dissemination of information search, Weighted searches of Boolean systems, Searching the Internet and hypertext. Information Visualization: Introduction, Cognition and perception, Information visualization technologies. Text Search Algorithms: Introduction, Software text search algorithms, Hardware text search systems. Information System Evaluation: Introduction, Measures used in system evaluation, Measurement example –TREC results.

Text Books/References:
1. Kowalski, Gerald, Mark T Maybury: Information Retrieval Systems: Theory and Implementation, Kluwer Academic Press, 1997.
2. Frakes, W.B., Ricardo Baeza-Yates: Information Retrieval Data Structures and Algorithms, Prentice Hall, 1992.
3. Yates, Modern Information Retrieval, Pearson Education, 1999.
4. Robert Korfhage, Information Storage &Retrieval, John Wiley & Sons, 1997.

CSC5013 – Bioinformatics

Module 1
MATLAB fundamentals, toolboxes, Introduction to Bioinformatics and molecular biology, Biological databases, Genome viewer, Applications of Bioinformatics, Processing biological sequences with MATLAB.

Module 2
Information retrieval from biological databases: Sequence homology, protein alignments, multiple sequence alignment, alignment tools, bio-linguistic methods.

Module 3
Biological sequence analysis: Sequence models, subsequence pattern models, gene models.

Module 4
Phylogenetics and system biology: phylogenetic reconstruction, distance-based methods, character-based methods, probabilistic methods, microarrays.

Text Books/References:

1. Bioinformatics: Sequence & Genome Analysis, by David W. Mount, Cold spring Harbor press, 2004.
2. Introduction to Bioinformatics, by T K Attwood & D J Parry-Smith Addison Wesley Longman, 1999
3. Fundamentals of bioinformatics and computational biology, by Gautam B. Singh, Springer, 2015
4. Bioinformatics- A Beginner's Guide, Jean-Michel Claverie, Cerdric Notredame, WILEY Dreamtech India Pvt. Ltd, 2006
5. Bioinformatics- Basics, Algorithms and Applications, Ruchi Singh, Richa Sharma, University Press, 2010
6. Bioinformatics- Databases, Tools, and Algorithms, Orpita Bosu, S K Thukral, Oxford University Press, 2007
7. Fundamentals of Bioinformatics and Computational Biology - Methods and Exercises in MATLAB, Gautam B. Singh, Springer International Publishing Switzerland 2015

CSC5014 – Algorithms for Big Data

Module 1
Intro to Probability Theory: Basic definitions, conditional probability, karger's min cut algorithm, random variables, Bernoulli, Binomial, and Geometric distributions, Tail bounds with Applications: application of chernoff bound, application of chebyshev's inequality.

Module 2
Introduction to Big Data Algorithms, SAT problem, classification of States, Stationary distribution of Markov Chain, random walks on undirected graphs, introduction to streaming, Morris algorithm, reservoir sampling, approximate median. Overview of data storage, balls and bins, hashing, chain hashing, bloom filter, pair wise independence, universal hashing functions, perfect hashing.

Module 3
Heavy hitters in data stream, Random walks on linear structures, lollipop graph, cats and mouse. Estimating frequency moments, property testing frame work, testing connectivity, enforce and test introduction, testing bicyclic graph, testing bipartiteness.

Module 4
Property testing and random walk algorithms, testing if graph is bipartite using random walks, graph streaming algorithms: introduction, matching, graph sparsification. Map reduce, K-machine (aka pregel model) model.

Text Books/References:
1. Michael Mitzenmacher, Eli Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis, Cambridge University Press, Second edition, ISBN-13: 978-1107154889, ISBN-10: 9781107154889, 2017.
2. Dana Ron, Algorithmic and Analysis Techniques in Property Testing, now publishers Inc., 2010, ISBN: 978-1-60198-318-3
3. Graham Cormode, Minos Garofalakis, Peter J. Haas and Chris Jermaine. Synopses for Massive Data: Samples, Histograms, Wavelets, Sketches. now publishers Inc., 2011, ISBN: 978-1-60198-516-3

CSC5015 – 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, GAN, 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.

CSC5016 – 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

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CSC5017 – Cyber Security

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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.

CSC5018 – 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.

CSC5019 – Big Data Analytics

Module 1
Introduction to Big Data, challenges of conventional systems, characteristics of Big Data-Volume, Variety, Velocity, Veracity, etc., 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 (Machine Learning), overview of Big Data Machine Learning, Mahout introduction, Big Data Machine Learning algorithms in Mahout- kmeans, Naïve Bayes etc.

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

Audited/Value Added Courses

CSC5051 – Operating System

Module I

Introduction: Functions of Operating System, Operating System Structure
Process Management: Process Concept – States – Process Control Block, Context Switching– Threads.
CPU Scheduling – Scheduling Criteria, Scheduling Algorithms.

Module II

Memory Management: Main Memory – Background– Swapping – Contiguous Memory allocation –Segmentation – Paging – Structure of Page table – Virtual Memory.
Storage Management: Overview of mass storage structure- disk structure – disk attachment. Disk scheduling and management. Swap Space. RAID and different RAID levels.

Module III

Process Synchronization: Critical Section-Peterson's solution. Synchronization Hardware. Locks, Semaphores, Monitors, Classical Problems.
Deadlocks – System Model, Characterization –Prevention – Avoidance – Detection- Recovery.
Inter Process Communication: Shared Memory, Message Passing, Sockets, Pipes, RPC, Threads.

Module IV

File System Interface: File Concepts – Attributes –operations – types – structure – access methods. File system mounting. File System structure –File system implementation. Directory implementation– allocation methods. Free space Management.
Protection– Goals, Principles, Domain. Access Matrix

Text Book/References:

1. Abraham Silberschatz, Peter B Galvin, Gerg Gagne, Operating System Concepts, 9/e,
Wiley India, 2015.
2. Garry Nut, Operating Systems: 3/e, Pearson Education, 2004
3. Bhatt P. C. P., An Introduction to Operating Systems: Concepts and Practice, 3/e,
Prentice Hall of India, 2010.
4. Madnick S. and J. Donovan, Operating Systems, McGraw Hill, 2001.
5. Hanson P. B., Operating System Principle, Prentice Hall of India, 2001.
6. Deitel H. M., An Introduction to Operating System Principles, Addison-Wesley, 1990.

CSC5052 – Computer Networks

Module 1

Network Architecture, Reference models of OSI, TCP/IP and ATM, Physical address, Logical address, Internet Protocol, Packet Format (IPV4 and IPV6), Features of IPv6, Fragmentation of IP packets, Packet Switching, Cell switching in ATM, CIDR notation, DHCP, Subnetting, Supernetting.

Module 2

Internetworking devices: Repeaters, Hubs, Bridges, LAN switches, Routers and Gateway Router functions, Features of IP Routers, Network Address Translation (NAT), TCP Protocol, TCP connection establishment and termination, Nagle's algorithm, Silly Window Syndrome, TCP timer Management, Karn's algorithm, UDP protocol, UDP Services and protocol operation, Stream and Datagram Sockets, Socket Programming.

Module 3

Congestion Management, Congestion control in Data Networks and Internet, Random Early Detection (RED), TCP congestion control: Additive increase/Multiplicative decrease, Slow start, Fast retransmit and Fast recovery, Wireless Transmission, Wireless systems, Bluetooth architecture and protocol stack.

Module 4

Overview of generations of cell phone technologies, Wireless Ad-hoc networks, Routing in Ad-hoc networks, Quality of Service: Requirements and parameters of Quality of Service, Integrated Services, Resource Reservation Protocol (RSVP), Differentiated Services, Peer to Peer Networks: Gnutella, BitTorrent, Node Lookup in Peer to Peer Networks, Virtual Private Networks.

Text Books/References:
1. Andrew S. Tanenbaum, Computer Networks, PHI (Prentice Hall India).
2. Behrouz A Forouzan, Data Communication and Networking, Tata McGraw Hill
3. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, Morgan Kaufmann.
4. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach.
5. Keshav, An Engineering Approach to Computer Networks, Addison Wesley.
6. Richard Stevens. TCP/IP Illustrated Volume 1, Addison-Wesley.
7. William Stallings, High-Speed Networks and Internets, Performance and Quality of Service, Prentice-Hall.

CSC5053 – LATEX

Module 1
Installation of the software LaTeX, Understanding Latex compilation, Basic Syntex, Writing equations, Matrix, Tables.

Module 2
Page Layout – Titles, Abstract Chapters, Sections, Referrences, Equation references, citation. List making environments. Table of contents, Generating new commands, Figure handling, numbering, List of figures, List of tables, Generating index

Module 3
Packages: Geometry, Hyperref, amsmath, amssymb, algorithms, algorithmic graphic, color, tilez listing. Classes: article, book, report, beamer, slides. Writing question paper, Writing articles/ research papers, Presentation using beamer.

Text Books/References:
1. A Document Preparation System: LaTeX, by Leslie Lamport, ISBN 0-201-52983-1, published jointly by the American Mathematical Society and Addison-Wesley Publishing Company. The 2nd edition, 1994, describes LaTeX2e, the second widely distributed version of LaTeX. The first edition of this book, which appeared in 1985, described LaTeX 2.09.
2. The TeXbook by Donald E. Knuth, ISBN 0-201-13448-9, published jointly by the American Mathematical Society and Addison-Wesley, 1984.
3. M. Goossens, F. Mittelbach, and A. Samarin, The LaTeX Companion, published by Addison-Wesley, ISBN 0-

201-54199-8 (essential for the serious LaTeX hackers), 1993.
4. L. Botway and C. Biemesderfer, LaTeX Command Summary, published by the TeX Users Group, Providence, RI is a good companion, 2019.
5. A. Diller, LaTeX Line by Line, published by Wiley, 1999.

CSC5054 – SOFTWARE ENGINEERING

Module 1
Software Engineering-Software Process- Generic process model-Prescriptive process model-specialized, unified process-Agile development-Agile Process- Extreme Programming- Other agile Process models-Software engineering Knowledge-core Principles

Module 2
Requirements Engineering-Establishing the Groundwork-Eliciting Requirements-Developing use cases-Building the requirements model-Negotiating, validating, Requirements-Requirements Analysis-Requirements Modeling Strategies.

Module 3
Modeling, Implementation, Testing, Maintenance and case studies.

TEXT BOOKS
1. Roger S, "Software Engineering – A Practitioner's Approach", seventh edition, Pressman, 2010.
2. Ian sommerville, "Software Engineering by", Pearson Edu, 9th edition, 2010.

CSC5055 – OPERATIONS RESEARCH

Module 1
Basics of Operational Research: Origin & Development of Operational Research, Definition and Meaning of Operational Research, Different Phases of an Operational Research Study, Scope and Limitations of Operational Research, Mathematical Modeling of Real Life Problems.

Module 2
Linear Programming: Introduction to Linear algebra. Solution of a system of Linear Equations, Linear independence and dependence of vectors, Concept of Basis, Basic Feasible solution, Convex sets. Extreme points, Hyperplanes and Halfspaces, Convex cones, Polyhedral sets and cones.

Module 3
Linear Programming Problem Formulation, solution by Graphical Method, Theory of Simplex Method, Simplex Algorithm, Two phase Method, Charnes-M Method, Degeneracy, Theory of Duality, Dual-simplex method.

Text Books/References:
1. G. Hadley: Linear Programming. Narosa, Reprint, 2002.
2. G. Hadley: Linear Algebra, Narosa, Reprint, 2002.
3. Hamdy A. Taha: Operations Research-An Introduction, Prentice Hall, 9th Edition, 2010.
4. A. Ravindran, D. T. Phillips and James J. Solberg: Operations Research- Principles and Practice, John Wiley & Sons, 2005.
5. F.S. Hillier. G.J. Lieberman: Introduction to Operations Research- Concepts and Cases, 9th Edition, Tata Mc-Graw Hill, 2010

CSC5056 – CYBER SECURITY

Module 1
Information Security Concepts: Information security issues, goals, architecture, Security Services and Mechanisms, Network security model, Security Threats and Vulnerabilities: Overview of Security Threats and Vulnerability, Types of attacks on Confidentiality, Integrity and Availability.

Module 2
Malware: Types of Malware, Worms, Viruses, Spyware, Trojan horses. Cyber Security Breaches: Phishing, Identity Theft, Harassment, Cyberstalking.   Cyber security Fundamentals: Cyberspace, Cyber Security, Cyber security Importance, Hackers, Cyber Crime and Cyber Terrorism

Module 3

Types of Cyber Attacks: Password Attacks, Denial of Service Attacks, Man-in-the-middle attack, Social engineering attacks, Spoofing, E-mail threats.   Security Counter Measures: Antivirus Software, Anti-Spyware, Firewalls, Virtual Private Networks, Intrusion Detection Systems, Secure Computing Tips.

References:
1. https://heimdalsecurity.com/pdf/cyber_security_for_beginners_ebook.pdf
2. http://docshare04.docshare.tips/files/21900/219006870.pdf
3. https://www.uou.ac.in/sites/default/files/slm/FCS.pdf

CSC5057 – 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.

CSC5058 - C# Programming

Module I
Introduction to .NET framework, Basics of C#: Variables, Data Types, Operators, Expressions, Branching, Looping, Methods, Arrays, Strings, Structures, Enumerations.

Module 2
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.
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

CSC5059 - 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/

CSC5060 – Technical Writing

Module 1

Report writing, types of reports, significance of technical paper, components of a research report, different steps in the preparation, layout, structure and language of typical reports.

Module 2

Oral presentation, making presentation, answering questions, use of visual aids, quality and proper usage, importance of effective communication with illustrations. Proposal writing for research funding.

Module 2

Writing of research proposal, report and research paper using LaTeX with the help of reference management software like Zotero/Mendeley and plagiarism/self-plagiarism detection.

Module 4

Evaluation of research papers, publishing of research papers, quality of research publications, citation, Impact factor, H-index, i10 index, SCOPUS and SCI indexed journals, Publication ethics: introduction and importance. Best practices / standards setting initiatives and guidelines: COPE, WAME etc.

Text Books/References:

1. Gerald J. Alred, Charles T. Brusaw, Walter E. Oliu, Handbook of Technical Writing, St. Martin's Press, 2012
2. Alan S. Pringle, Sarah S. O'Keefe , Technical Writing, Scriptorium Publishing Services, 2009
3. Krista Van Laan, The Insider's Guide to Technical Writing, XML Press, 2012
4. Mike Markel , Stuart A Selber Technical Communication, Bedford/St. Martin's, 2017
5. Soraya M. Coley, Cynthia A. Scheinberg, Yulia A. Levites Strekalova, Proposal Writing Effective Grantsmanship for Funding, SAGE Publications, 2021

CSC5061 – Research Methodology

Module 1

Introduction, motivation in research, significance of research, research methods, steps in research process, selection of a research topic, literature review, importance of literature review in defining a problem, critical literature review, identifying gap areas from literature review, statement of the problem.

Module 2

Primary data, secondary data, hypothesis, research structure, types of research: pure or basic research, applied research, descriptive research, exploratory research, experimental research, action research, historical research, analytical research, survey, deductive reasoning, inductive reasoning, qualitative and quantitative research.

Module 3:

Research design, different types: descriptive, exploratory, experimental and diagnostic design, developing a research plan, method of data collection: observation method, interview method, questionnaire method; sampling, processing and analyzing data, types of analysis, interpretations of results.

Module 4

Ethical reasoning, ethical issues in research, Intellectual Property rights: Copyrights, Patents, Trade Secrets, Trademarks; Copyleft, Openness.

Text Books/References:

1. R. Panneerselvam, Research Methodology, PHL Learning Private Ltd. New Delhi, 2014.
2. C.R. Kothari, Research Methodology: Methods and Techniques, New Age International (P) Limited Publishers, New Delhi, 2013.
3. Dr. Shanti Bhushan Mishra, Dr. Shashi Alok, Handbook of Research Methodology, EDUCREATION PUBLISHIN, 2017.
4. Leedy PD, Practical Research -Planning and Design, MW Mac Millan Publishing Co., 1980.
5. Earl Babbie, The Practice of Social Research, Wordsworth Publishing Company, 1994.

Open Elective Courses

CSC5071 – 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.

CSC5072 – 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
Classes, objects, user defined types, constructors/destructors, object oriented design, streams, cout/cin, operator overloading, class conversion, class scope, static data, static member functions.

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

Module 4
Exception handling, overloaded constructors/functions/operators. Case Studies

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.

CSC5073 – 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.

CSC5074 - Python

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.

Module 5
Any one case study based on Machine Learning, IoT, Data Analysis and Visualization, Web development, Robot programming, 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.

CSC5075 – 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
2. Computer Coding for Kids: A unique step-by-step visual guide, from binary code to building games, Carol Vorderman, DK Children, 2017

CSC5076 - C # .NET Framework and Unity

Module I
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 II
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 III
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 IV
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

CSC5077 - Full Stack Development

Module 1

World Wide Web, browsers, web servers and websites, Introduction to Web Development, Web Hosting, HTML Basics, Structure of an HTML page, Common tags and their usage in HTML, CSS Basics, Styling with CSS: Selectors, properties and values, Box model and layout basics.

Module 2

Introduction to responsive design and media queries, JavaScript: variables, data types, operators, data structures, control structures, loops and functions, Introduction to the Document Object Model, DOM Manipulation, Introduction to Front-end Framework, Front-end Basics using ReactJS: UI, forms, Component Lifecycle and Event Handling, Front-end development based on User Interface designs.

Module 3

Back-end technologies, PHP: Embedding PHP in HTML, Embedding HTML in PHP, Conditional Statements, Loops, Reading and Writing Files, Introduction to database, SQL vs. NoSQL, XML- DTD & XSLT, Database connectivity, PhpMyAdmin, Building database applications using PHP and MySQL, MongoDB: Create database, Insert, Find, Update, indexing/searching query operations.

Module 4

Full-stack application development: Setting up the development environment, Web Application development using Django/MEAN/MERN stack, Development of both front end and back end of web application with Database integration, Front-end and Back-end optimization techniques.

Text Books/References:
1. Richard Blum, PHP, MySQL & JavaScript All-in-One for Dummies, Wiley, ISBN: 978-8126576005,
   2018.
2. Anthony O. O, React.js Design Patterns: Learn how to build scalable React apps with ease,
   ISBN: 978-9355513649, 2023.
3. Alex Banks, Eve Porcello, Learning React: Functional Web Development with React and Redux,
   Oreilly, 2017.
4. Antonio Mel, Django 4 By Example, Packt Publishing, ISBN: 978-1801813051, 2022.
5. 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.
6. Colin J Ihrig, Adam Bretz, Full Stack JavaScript Development With MEAN: MongoDB, Express,
    AngularJS, and Node.JS, Shroff Publishers and Distributors Pvt. Ltd., 2015
7. 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.

CSC5078 - Data Analytics with Python

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

Module II
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 III

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

Module IV

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.

CSC5079 - 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/

CSC5080 - Web Technologies

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.

CSC5081 - Metaverse

Module I
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 II
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 III
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 IV
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.