CENTRAL UNIVERSITY OF KERALA
केरल केन्द्रीय विश्वविद्यालय
DEPARTMENT OF COMPUTER SCIENCE
SCHOOL OF PHYSICAL SCIENCES

Minutes of BOS in Computer Science
held on 28/01/2021 at 10.30 AM

Agenda:

(i) To introduce new elective courses
(ii) To introduce value added courses
(iii) To analyse the feedbacks
(iv) To relook into the Program outcome (PO), Program specific outcome (PSO) and Course outcome (CO)

The following members were present during the meeting.

1. Dr. Rajesh R, Head, Department of Computer Science
2. Prof. (Dr.) C. Chandrasekhar, IIT Madras
3. Prof. (Dr.) Arunkumar T., Professor, School of Computer Science and Engineering, VIT, Vellore
4. Dr. K.A. Germina, Associate Professor, Department of Mathematics
5. Mr. Kumar V, Assistant Professor, Dept. of Computer Science
6. Mr. Ragesh N.K., DSP & Multimedia Specialist, Tata Elxsi Ltd.
7. Mr. Sagar Padmanabhan, TechLead, Infosys
8. Dr. Thasleema T.M., invited member by the Chair
9. Dr. Manohar N.S. invited member by the Chair

The BOS meeting started with a welcome address by Dr. Rajesh R.

The BOS members have gone through the syllabus of the two elective course (Cyber security and Block Chain) and two value added courses (R programming and Introduction to Cyber Security) and approved the same. The suggestions from the experts were considered and included in the syllabus.

The consolidated suggestions made by Faculty council based on the feedback of the students of 2015-17, 2016-18, 2017-19, 2018-20 batches, parents and industrial experts were discussed in the BOS meeting. Most of the suggestions are positive and provide hands to go forward with the syllabus.

The BOS members had a discussion and a relook on the Program outcome (PO), Program specific outcome (PSO) and Course outcome (CO). The BOS approved the same.

The suggestions for decreasing the number of tutorial hours as specified by Prof. Chandrasekar was considered by the BoS to be included in the next major revision to be held during the new academic year.

The meeting ended with vote of thanks by Dr. Thasleema T.M.

Dr. Rajesh R. | Prof. C. Chandrasekhar | Prof. (Dr.) Arunkumar T. | Dr. K.A. Germina

Dr. Kumar V | Mr. Ragesh N.K. | Mr. Sagar Padmanabhan | Dr. Thasleema T.M. | Dr. Manohar N.S.

केरल केन्द्रीयविश्वविद्यालय
CENTRAL UNIVERSITY OF KERALA
TEJASWINI HILLS, PERIYE P.O, KASARGOD- 671 316

MINUTES OF THE 21ST MEETING OF THE ACADEMIC COUNCIL OF CENTRAL UNIVERSITY OF KERALA HELD AT 02.30 PM ON 23RD FEBRUARY, 2021

The Honorable Vice Chancellor welcomed all the members of the Academic Council to the meeting.

Before the agenda items were taken up for discussion, the Honorable Vice Chancellor briefed the following developments:

The Central University will be launching a 4 years BS Finance Programme. Further there will be an integrated programme on BS or MS data programme. It was further pointed out the need for an expert either at the national or global level in each Department to improve upon the functioning of the Department. The Academic Council should be the builder of the mission and every faculty of this University should be aware of where we stand and where we should be. It was further observed that the last date for NAAC showcasing is 10th of March and there will be an Academic and Administrative Audit between 17/3/21 to 19/3/21 at the CUK as aprelude to NAAC visit. This will be followed by NAAC rehearsal.

The external expert, Prof.(Dr.) R.K Mishra deliberated the necessity to work in the dimensions of quality, multidisciplinary, research progress and global disciplines.

With this introduction, agenda items were taken up.

AC 21:01	*TO CONFIRM the Minutes of the meeting of the Academic Council held on 15.09.2020.*

CONFIRMED the Minutes of the meeting of the Academic Council held on 15.09.2020.

AC 21:02	*TO APPROVE the Action Taken Report .*

The Action Taken Report (ATR) of the last Academic Council Meeting held on 15.09.2020 was approved.

AC 21:03	TO APPROVE the Minutes of the meeting of Board of Studies and Syllabus of various Departments.

On this agenda, the Honorable Vice Chancellor urged the need for an eminent and an accessible person in the BoS of each Department. He also stressed the need for skill component in each Department Syllabus. Regarding the age limit for PG admissions which is differing from professional to other PG courses, it was decided to leave the matter to the faculty council concerned based on whose decision, the age limit may be reviewed. The Academic Council perused the following Departments' BoS conducted, The Minutes of the BoS for revision of syllabus are received from the following Deaprtments.

(1.) **Dept. of Linguistics: -**

Approved the Minutes of the meeting of the Board of Studies of Department of Linguistics held on 24.08.2020.

(2.) **Dept. of Zoology: -**

Approved the Minutes of the meeting of the Board of Studies of Department of Zoology held on 07.10.2020.

(3). **Dept. of Public Health and Community Medicine: -**

Approved the Minutes of the meeting of the Board of Studies of the Department of Public Health and Community Medicine held on 08.01.2021.

(4). **Dept. of Mathematics: -**

Approved the Minutes of the meeting of the Board of Studies of Department of Mathematics held on 23.01.2021.

(5). **Dept. of Commerce and International Business**

Approved the Minutes of the meeting of the Board of Studies of Department of Commerce and International Business held on 07.07.2020.

(6). **Dept. of Computer Science: -**

Approved the Minutes of the meeting of the Board of Studies of Department of Computer Science held on 28.01.2021.

CENTRAL UNIVERSITY OF KERALA

DEPARTMENT OF COMPUTER SCIENCE

M.Sc. (Computer Science)

Specialization: Intelligent Systems

Programme Structure

(Applicable for 2020 batch onwards)

.

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					
CSC5101	Computational Mathematics	2	2	1	4
CSC5102	Programming Concepts Using Python	2	2	1	4
CSC5103	Advanced Data Structures and Algorithms	2	2	1	4
CSC5104	Digital Signal Processing	2	2	1	4
CSC5105	Computational Intelligent Systems	2	2	1	4
	Total	**10**	**10**	**5**	**20**
SEMESTER II					
CSC5201	Cryptography and Network Security	2	2	1	4
CSC5202	Pattern Recognition	2	2	1	4
CSC5203	Computer Graphics and Visualization	2	2	1	4
CSC5204	Data Mining	2	2	1	4
CSC50XX	Elective 1	2	2	1	4
CSC50XX	Elective 2 *	2	2	1	4
	Total	**12**	**12**	**6**	**24**
SEMESTER III					
CSC5301	Big Data Analytics	2	2	1	4
CSC5302	Image Processing	2	2	1	4
CSC5303	High Performance Computing	2	2	1	4
CSC5304	Minor Project	-	4	1	4
CSC50XX	Elective 3	2	2	1	4
	Total	**8**	**12**	**5**	**20**
SEMESTER IV					
CSC5490	Dissertation	-	20	4	8
	Total	**-**	**20**	**4**	**8**

*Students have the flexibility to choose elective 2 either from the department or from other departments or from SWAYAM MOOCS courses.

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

Lec = Lecture, Tut = Tutorial, Lab = Practical

Credits for Core Courses	:	48
Credits for Elective Courses	:	12
Minor Project	:	04
Dissertation	:	08
Total	:	72 (Minimum Credits Required is72)

AUDITED/VALUE ADDED COURSES*					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC5051	Operating Systems	2	1	1	Nil
CSC5052	Computer Networks	2	1	1	Nil
CSC5053	MATLAB	2	1	1	Nil
CSC5054	LATEX	2	1	1	Nil
CSC5055	Software Engineering	2	1	1	Nil
CSC5056	Operations Research	2	1	1	Nil
CSC5057	Introduction to Cyber Security	2	1	1	Nil
CSC5058	R Programming	2	1	1	Nil

*Syllabus may slightly vary and will be customized based on the level of students. No Credits added to marklists.

OPEN ELECTIVE COURSES (for other departments)*					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC5071	C	2	1	1	4
CSC5072	C++	2	1	1	4
CSC5073	MATLAB	2	1	1	4
CSC5074	LATEX	2	1	1	4
CSC5075	Python	2	1	1	4
CSC5076	Enjoyable programming	2	1	1	4

*Syllabus may slightly vary and will be customized based on the level of students.

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 modeling and design of computational intelligent systems in a way that demonstrates comprehension of the tradeoffs 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/learning 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

Grading:

Lab implementation	– 12%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 8%
Class Test	– 10%
Final Exam	– 60%

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/learning outcomes:
1. Knowledge to be gained:
   (i) Interpret the fundamental Python syntax and semantics and be fluent in the use 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:
   (i) Design and implement a program using python to solve a real world problem

Prerequisites: Basic knowledge in any programming languages/concepts

Grading:

Lab implementation	– 30%
Assignment/Quiz/presentation	– 5%
Class Test	– 5%
Final Exam	– 60%

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/learning 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

Grading:

Lab implementation	– 15%
Assignment/Quiz/presentation	– 5%
Mini project (individual)	– 8%
Class Test	– 12%
Final Exam	– 60%

CSC5104 – Digital Signal Processing

This is a participatory, experimental learning and skill development 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/learning 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.

Grading:

Lab implementation	– 12%
Participatory based group Project	– 8%
Assignment/Quiz/presentation	– 8%
Class Test	– 12%
Final Exam	– 60%

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/learning 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

Grading:

Lab experiments and implementation	– 12%
Participatory based group Project	– 10%
Mini project (individual)	– 8%
Class Test/Assignment/Quiz/presentation	– 10%
Final Exam	– 60%

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/learning 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.

Grading:

Lab experiments and implementation	– 15%
Participatory based group Project	– 10%
Class Test/Assignment/Quiz/presentation	– 5%
Lab Test	- 10%
Final Exam	– 60%

CSC5202 – Pattern Recognition

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 pattern recognition.

By completing this course, students will obtain the following course/learning 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.

Grading:

Lab experiments and implementation	– 15%
Class Test	- 10%
Assignment/Quiz/presentation	– 5%
Lab Test	- 10%
Final Exam	– 60%

CSC5203 - Computer Graphics and Visualization

This is an experimental and problem solving skill development course.

Course Objective

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

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

1. Knowledge gained:
   - (i) Mathematical concepts of computer graphics and visualization
2. Skill gained:
   - (ii) modelling of 2D and 3D transformations.
   - (iii) Projection from 3D to 2D
   - (iv) Implementing Clipping algorithms.
3. Competency gained:
   - (v) Development of algorithms for various techniques in computer graphics

Prerequisites: Basic knowledge in mathematics.

Grading:

Lab experiments and implementation	– 15%
Participatory based group Project	– 10%
Mini project (individual)	– 5%
Class Test/Assignment/Quiz/presentation	– 10%
Final Exam	– 60%

CSC5204 – Data Mining

This is an experimental, problem solving, 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/learning 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.

Grading:

Lab experiments and implementation	– 15%
Mini project (individual)	– 10%
Class Test	- 10%
Assignment/Quiz/presentation	– 5%
Final Exam	– 60%

CSC5301 – Big Data Analytics

This is an experimental, problem solving, skill development and employability based 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/learning 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.

Grading:

Lab experiments and implementation	– 15%
Mini project (individual)	– 10%
Class Test	- 10%
Assignment/Quiz/presentation	– 5%
Final Exam	– 60%

CSC5302 - 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/learning 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.

Grading:

Lab experiments and implementation	– 15%
Mini project (individual)	– 10%
Class Test	- 10%
Assignment/Quiz/presentation	– 5%
Final Exam	– 60%

CSC5303 – High Performance Computing

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 implementing high performance computing.

By completing this course, students will obtain the following course/learning 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.

Grading:

Lab implementation	– 12%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 8%
Class Test	– 10%
Final Exam	– 60%

CSC5304 – Mini Project

Students should undertake research based real time mini 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 mini project. A detailed project report should be submitted by each student at the end of the semester. Evaluation of the mini-project is fully internal based on demonstration, presentation and report.

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 research prototypes/models.

By completing this course, students will obtain the following course/learning 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

Grading:

Lab implementation	– 30%
Presentation	– 10%
Final Exam (based on presentation, novelty, implementation, understanding)	– 60%

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 bases 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 internal and external examiners based on the work done and the dissertation submitted.

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/learning 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.

Grading:

Lab implementation	– 30%
Presentation	– 10%
Final Exam (based on presentation, novelty, implementation, understanding)	– 60%

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/learning 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

Grading:

Lab implementation	– 12%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 8%
Class Test	– 10%
Final Exam	– 60%

CSC5002 – Digital Speech Processing

This is a participatory and experimental based skill development 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/learning 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

Grading:

Lab implementation	– 12%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 8%
Class Test	– 10%
Final Exam	– 60%

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/learning 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

Grading:

Lab implementation	– 20%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Class Test	– 5%
Final Exam	– 60%

CSC5004 – Cloud Computing

This is a participatory and experimental skill development 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/learning 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

Grading:

Lab implementation	– 10%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 10%
Class Test	– 10%
Final Exam	– 60%

CSC5005 – Nature Inspired Computing

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 implementing nature inspired computing.

By completing this course, students will obtain the following course/learning 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

Grading:

Lab implementation	– 15%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Class Test	– 10%
Final Exam	– 60%

CSC5006 – Web Mining and Social Networking

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 techniques for data mining applied on Internet related data and social networking.

By completing this course, students will obtain the following course/learning outcomes:
1. Knowledge gained:
(i) Modeling 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

Grading:

Lab implementation	– 10%
Assignment/Quiz/presentation	– 10%
Class Test	– 10%
Lab test	- 10%
Final Exam	– 60%

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/learning 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

Grading:

Lab implementation	– 10%
Assignment/Quiz/presentation	– 10%
Class Test	– 10%
Lab test	- 10%
Final Exam	– 60%

CSC5008 – Computational Biology

This is a participatory, experimentally and problem solving skill development 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/learning 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

Grading:

Lab implementation	– 15%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Class Test	– 10%
Final Exam	– 60%

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/learning 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

Grading:

Lab implementation	– 15%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Class Test	– 10%
Final Exam	– 60%

CSC5010 – Computer Vision

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 computer vision.

By completing this course, students will obtain the following course/learning 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

Grading:

Lab implementation	– 15%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Class Test	– 10%
Final Exam	– 60%

CSC5011 – Biometrics

This is a participatory and experimental skill development 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/learning 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

Grading:

Lab implementation	– 15%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Class Test	– 10%
Final Exam	– 60%

CSC5012 – Information Retrieval Systems

This is a theoretical and experimental skill development 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/learning 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

Grading:

Lab implementation	– 5%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 15%
Class Test	– 10%
Final Exam	– 60%

CSC5013 – Bioinformatics

This is a participatory, experimental, problem solving and employability based skill development 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/learning 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.

Prerequisites: Basic knowledge of programming

Grading:

Lab implementation	– 15%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Class Test	– 10%

Final Exam – 60%

CSC5014 – Algorithms for Big Data

This is a participatory, experimental, problem solving and employability based skill development 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/learning 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.

Grading:

Lab implementation	– 15%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Class Test	– 10%
Final Exam	– 60%

CSC5015 – Deep Learning

This is an experimental, problem solving and employability based skill development 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/learning 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.

Grading:

Lab implementation	– 15%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Class Test	– 10%
Final Exam	– 60%

CSC5016 – Internet of Things

This is a participatory, experimental, flipped classroom, and employability based 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/learning 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.

Grading:

Lab implementation	– 20%
Participatory based group Project	– 10%

Assignment/Quiz/presentation	– 5%
Lab Test	– 5%
Final Exam	– 60%

CSC5017 – Cyber Security

This is a participatory, problem solving, experimental and employability based 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/learning 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

Grading:

Lab implementation	– 20%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 5%
Lab Test	– 5%
Final Exam	– 60%

CSC5018 – Block Chain

This is a theoretical, participatory, experimental and employability based skill development 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/learning outcomes:
1. Knowledge gained:
   (i) State of art methods for developing block chain
   (ii) Equipping design principles of bitcoin and ethereum
2. Skill gained:
   (iii) Investigating the need and necessity of block chain various applications
3. Competency gained:
   (iv) Development of prototypes for various applications using block chain technology.

Prerequisites: Nil

Grading:

Lab implementation	– 10%
Participatory based group Project	– 10%
Assignment/Quiz/presentation	– 10%
Lab Test	– 10%
Final Exam	– 60%

CSC5051 – Operating Systems

This is an audited/value added skill development course and the credits will not be added to marklist.

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/learning outcomes:
1. Knowledge gained:
   (i) Management of operating system functionalities (CPU, Memory, File management)
2. Skill gained:
   (ii) Modelling software based on memory requirements
3. Competency gained:
   (iii) Optimal utilization of Operating System.

Prerequisites: Nil

Grading:

Lab implementation	– 25%
Participatory based group Project	– 25%
Assignment/Quiz/presentation	– 25%
Individual project	- 25%

CSC5052 – Computer Networks

This is an audited/value added skill based course and the credits will not be added to marklist.

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/learning outcomes:
1. Knowledge gained:
   (i) State of art functionalities of networks
2. Skill gained:
   (ii) Deploying networking components
3. Competency gained:
   (iii) Optimal usage of networks for communication.

Prerequisites: Nil

Grading:

Lab implementation	– 25%
Participatory based group Project	– 25%
Assignment/Quiz/presentation	– 25%
Individual project	- 25%

CSC5053 – MATLAB

This is an audited/value added skill based course and the credits will not be added to marklist.

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/learning 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

Grading:

Lab implementation	– 25%
Participatory based group Project	– 25%
Assignment/Quiz/presentation	– 25%
Individual project	- 25%

CSC5054 – LATEX

This is an audited/value added skill based course and the credits will not be added to marklist.

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/learning 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

Grading:

Lab implementation	– 25%
Participatory based group Project	– 25%
Assignment/Quiz/presentation	– 25%
Individual project	- 25%

CSC5055 – Software Engineering

This is an audited/value added skill based course and the credits will not be added to marklist.

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/learning 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

Grading:

Lab implementation	– 25%
Participatory based group Project	– 25%
Assignment/Quiz/presentation	– 25%
Individual project	- 25%

CSC5056 – Operations Research

This is an audited/value added skill based course and the credits will not be added to marklist.

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/learning 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

Grading:

Lab implementation	– 25%
Participatory based group Project	– 25%
Assignment/Quiz/presentation	– 25%
Individual project	- 25%

CSC5057 – Introduction to Cyber Security

This is an audited/value added employability based skill development course and the credits will not be added to marklist.

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/learning outcomes:

1. Knowledge gained:
   (i) All cyber security threats
2. Skill gained:
   (ii) Handling cyber security threats.
3. Competency gained:
   (iii) To be secured from all future threats.

Prerequisites: Nil

Grading:

Lab implementation	– 25%
Participatory based group Project	– 25%
Assignment/Quiz/presentation	– 25%
Individual project	- 25%

CSC5058 – R Programming

This is an audited/value added employability based skill development course and the credits will not be added to marklist.

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/learning 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

Grading:

Lab implementation	– 25%
Participatory based group Project	– 25%
Assignment/Quiz/presentation	– 25%
Individual project	- 25%

CSC5071 – C

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/learning 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

Grading:

Lab implementation	– 20%
Assignment/Quiz/presentation	– 10%
Class Test	– 10%
Final Exam	– 60%

CSC5072 – C++

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/learning 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

Grading:

Lab implementation – 20%
Assignment/Quiz/presentation – 10%
Class Test – 10%
Final Exam – 60%

CSC5073 – MATLAB

This is a practical and 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/learning 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

Grading:
Lab implementation – 25%
Participatory based group Project – 25%
Assignment/Quiz/presentation – 25%
Individual project - 25%

CSC5074 – LATEX

This is a practical and skill development course.

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/learning 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

Grading:
Lab implementation – 25%
Participatory based group Project – 25%
Assignment/Quiz/presentation – 25%
Individual project - 25%

CSC5075 - 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/learning outcomes:
1. Knowledge to be gained:
   (i) Interpret the fundamental Python syntax and semantics and be fluent in the use 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

Grading:

Lab implementation	– 30%
Assignment/Quiz/presentation	– 5%
Class Test	– 5%
Final Exam	– 60%

CSC5076 - 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/learning 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

Grading:

Lab implementation	– 30%
Assignment/Quiz/presentation	– 5%
Class Test	– 5%
Final Exam	– 60%

OVERALL COURSE OUTCOME MAPPING WITH PROGRAMME OUTCOME							
		PO1	PO2	PO3	PO4	PO5	PO6
SEMESTER I							
CSC5101	Computational Mathematics	H	H	H	L	H	L
CSC5102	Programming Concepts Using Python	H	L	H	L	H	L
CSC5103	Advanced Data Structures and Algorithms	M	H	H	L	H	L
CSC5104	Digital Signal Processing	M	H	H	H	H	H
CSC5105	Computational Intelligent Systems	H	H	H	H	H	H
SEMESTER II							
CSC5201	Cryptography and Network Security	M	L	H	L	H	H
CSC5202	Pattern Recognition	H	H	H	H	H	H
CSC5203	Computer Graphics and Visualization	L	L	M	L	H	L
CSC5204	Data Mining	M	H	H	H	H	H
SEMESTER III							
CSC5301	Big Data Analytics	H	H	H	H	H	H
CSC5302	Image Processing	M	H	H	H	H	H
CSC5303	High Performance Computing	H	M	H	H	H	H
CSC5304	Minor Project	H	H	H	H	H	H
SEMESTER IV							
CSC5490	Dissertation	H	H	H	H	H	H
CSC5001	Natural Language Processing	M	H	H	H	H	H
CSC5002	Digital Speech Processing	M	M	H	H	H	H
CSC5003	Wireless Sensor Networks	L	L	H	H	H	H
CSC5004	Cloud Computing	L	L	H	L	H	H
CSC5005	Nature Inspired Computing	M	M	H	H	H	H
CSC5006	Web Mining and Social Networking	M	M	H	H	H	H
CSC5007	Multimedia Database Systems	L	L	H	L	H	L
CSC5008	Computational Biology	L	L	H	H	H	H
CSC5009	Embedded Systems	L	L	H	L	H	H
CSC5010	Computer Vision	M	M	H	H	H	H
CSC5011	Biometrics	M	M	H	H	H	H
CSC5012	Information Retrieval Systems	L	M	H	H	H	H
CSC5013	Bioinformatics	H	M	H	H	H	H
CSC5014	Algorithms for Big Data	H	H	H	H	H	H
CSC5015	Deep Learning	H	H	H	H	H	H
CSC5016	Internet of Things	L	L	H	L	H	H
CSC5017	Cyber Security	L	L	H	H	H	H
CSC5018	Block Chain	L	L	H	L	H	H
CSC5071	C	H	M	H	L	H	L
CSC5072	C++	H	M	H	L	H	L
CSC5073	MATLAB	H	M	H	L	H	L
CSC5074	LATEX	L	L	H	L	H	L
CSC5075	Python	H	L	H	L	H	L
CSC5076	Enjoyable programming	H	L	H	L	H	L
CSC5051	Operating Systems	L	L	H	L	H	L
CSC5052	Computer Networks	L	L	H	L	H	L
CSC5053	MATLAB	H	L	H	L	H	L
CSC5054	LATEX	L	L	H	L	H	L
CSC5055	Software Engineering	M	L	H	L	H	L
CSC5056	Operations Research	H	L	H	L	H	L
CSC5057	Introduction to Cyber Security	L	L	H	L	H	H
CSC5058	R Programming	H	L	H	L	H	L

OVERALL COURSE OUTCOME MAPPING WITH PROGRAMME SPECIFIC OUTCOME											
		PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
SEMESTER I											
CSC5101	Computational Mathematics	H	H	H	H	H	H	H	H	H	H
CSC5102	Programming Concepts Using Python	H	H	H	H	H	H	H	H	H	L
CSC5103	Advanced Data Structures and Algorithms	H	H	H	H	H	H	H	H	H	M
CSC5104	Digital Signal Processing	H	H	H	H	H	H	H	H	H	H
CSC5105	Computational Intelligent Systems	H	H	H	H	H	H	H	H	H	H
SEMESTER II											
CSC5201	Cryptography and Network Security	H	H	H	H	H	H	H	H	H	H
CSC5202	Pattern Recognition	H	H	H	H	H	H	H	H	H	H
CSC5203	Computer Graphics and Visualization	M	H	H	H	H	H	H	H	H	H
CSC5204	Data Mining	H	H	H	H	H	H	H	H	H	H
SEMESTER III											
CSC5301	Big Data Analytics	H	H	H	H	H	H	H	H	H	H
CSC5302	Image Processing	H	H	H	H	H	H	H	H	H	H
CSC5303	High Performance Computing	H	H	H	H	H	H	H	H	H	H
CSC5304	Minor Project	H	H	H	H	H	H	H	H	H	H
SEMESTER IV											
CSC5490	Dissertation	H	H	H	H	H	H	H	H	H	H
CSC5001	Natural Language Processing	H	H	H	H	H	H	H	H	H	H
CSC5002	Digital Speech Processing	H	H	H	H	H	H	H	H	H	H
CSC5003	Wireless Sensor Networks	H	H	H	H	H	H	H	H	H	H
CSC5004	Cloud Computing	H	H	H	H	H	H	H	H	H	H
CSC5005	Nature Inspired Computing	H	H	H	H	H	H	H	H	H	H
CSC5006	Web Mining and Social Networking	H	H	H	H	H	H	H	H	H	H
CSC5007	Multimedia Database Systems	H	H	H	H	H	H	H	H	H	H
CSC5008	Computational Biology	H	H	H	H	H	H	H	H	H	H
CSC5009	Embedded Systems	H	H	H	H	H	H	H	H	H	H
CSC5010	Computer Vision	H	H	H	H	H	H	H	H	H	H
CSC5011	Biometrics	H	H	H	H	H	H	H	H	H	H
CSC5012	Information Retrieval Systems	H	H	H	H	H	H	H	H	H	H
CSC5013	Bioinformatics	H	H	H	H	H	H	H	H	H	H
CSC5014	Algorithms for Big Data	H	H	H	H	H	H	H	H	H	H
CSC5015	Deep Learning	H	H	H	H	H	H	H	H	H	H
CSC5016	Internet of Things	H	H	H	H	H	H	H	H	H	H
CSC5017	Cyber Security	H	H	H	H	H	H	H	H	H	H
CSC5018	Block Chain	H	H	H	H	H	H	H	H	H	H
CSC5071	C	H	H	H	H	H	H	H	H	H	L
CSC5072	C++	H	H	H	H	H	H	H	H	H	L
CSC5073	MATLAB	H	H	H	H	H	H	H	H	H	L
CSC5074	LATEX	L	L	L	L	H	H	H	H	H	L
CSC5075	Python	H	H	H	H	H	H	H	H	H	L
CSC5076	Enjoyable programming	H	H	H	H	H	H	H	H	H	L
CSC5051	Operating Systems	L	H	H	H	H	H	H	H	H	H
CSC5052	Computer Networks	L	H	H	H	H	H	H	H	H	H
CSC5053	MATLAB	H	H	H	H	H	H	H	H	H	H
CSC5054	LATEX	L	L	L	L	H	H	H	H	H	L
CSC5055	Software Engineering	H	H	H	H	H	H	H	H	H	H
CSC5056	Operations Research	H	H	H	H	H	H	H	H	H	H
CSC5057	Introduction to Cyber Security	H	H	H	H	H	H	H			
CSC5058	R Programming	H	H	H	H	H	H	H			

MAPPING OF THE COURSES TO EMPLOYABILITY/ ENTREPRENEURSHIP / SKILL DEVELOPMENT				
		Employability	**Entrepreneurship**	**Skill Development**
SEMESTER I				
CSC5101	Computational Mathematics			**Y**
CSC5102	Programming Concepts Using Python	**Y**		**Y**
CSC5103	Advanced Data Structures and Algorithms			**Y**
CSC5104	Digital Signal Processing			**Y**
CSC5105	Computational Intelligent Systems			**Y**
SEMESTER II				
CSC5201	Cryptography and Network Security			**Y**
CSC5202	Pattern Recognition			**Y**
CSC5203	Computer Graphics and Visualization			**Y**
CSC5204	Data Mining			**Y**
SEMESTER III				
CSC5301	Big Data Analytics	**Y**		**Y**
CSC5302	Image Processing			**Y**
CSC5303	High Performance Computing			**Y**
CSC5304	Minor Project			**Y**
SEMESTER IV				
CSC5490	Dissertation			**Y**
CSC5001	Natural Language Processing			**Y**
CSC5002	Digital Speech Processing			**Y**
CSC5003	Wireless Sensor Networks			**Y**
CSC5004	Cloud Computing			**Y**
CSC5005	Nature Inspired Computing			**Y**
CSC5006	Web Mining and Social Networking			**Y**
CSC5007	Multimedia Database Systems			**Y**
CSC5008	Computational Biology			**Y**
CSC5009	Embedded Systems			**Y**
CSC5010	Computer Vision			**Y**
CSC5011	Biometrics			**Y**
CSC5012	Information Retrieval Systems			**Y**
CSC5013	Bioinformatics	**Y**		**Y**
CSC5014	Algorithms for Big Data	**Y**		**Y**
CSC5015	Deep Learning	**Y**		**Y**
CSC5016	Internet of Things	**Y**		**Y**
CSC5017	Cyber Security	**Y**		**Y**
CSC5018	Block Chain	**Y**		**Y**
CSC5071	C			**Y**
CSC5072	C++			**Y**
CSC5073	MATLAB			**Y**
CSC5074	LATEX			**Y**
CSC5075	Python	**Y**		**Y**
CSC5076	Enjoyable programming	**Y**		**Y**
CSC5051	Operating Systems			**Y**
CSC5052	Computer Networks			**Y**
CSC5053	MATLAB			**Y**
CSC5054	LATEX			**Y**
CSC5055	Software Engineering			**Y**
CSC5056	Operations Research			**Y**
CSC5057	Introduction to Cyber Security	**Y**		**Y**
CSC5058	R Programming	**Y**		**Y**

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
Introduction to Graph theory.

References:

1. K Sankara Rao, *Numerical Methods for Scientists and Engineers*, PHI Publication, Eastern Economy edition, 2009.
2. Laurene V Fausett, *Applied Numerical Analysis using MATLAB,* Pearson Edition, 2011.
3. V Rajaraman, *Computer Oriented Numerica Methods,* PHI Publication, Eastern Economy edition, 2009
4. Kreyszig E, *Advanced Engineering Mathematics,* Wiley India edition, 2008.

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:

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

Reference:
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: Introduction and Analysis of Algorithm
Introduction to algorithms, Role of Algorithms in computing, asymptotic notations: big O, omega, theta notations– properties of asymptotic notations. Divide and Conquer: General method, Maximum sub array problem, Convex hull problem. Greedy Method: The General Method, Knapsack problem, Minimum Cost Spanning Trees.

Module 2: Algorithm Design
Dynamic Programming: The General Method, Matrix chain multiplication, Rod cutting problem. Back Tracking: The General method, 8-queens problem, Knapsack problem. NP-Hard and NP-Complete problems.

Module 3: Selection and Search Structures
Heap 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 4: Multimedia Structures
Segment trees – k-d trees – Point Quad trees – MX-Quad trees – R-trees TV trees. Analysis and complexity of all above topics. Hash list- Hash table- Hash tree- Applications: Huffman coding

References:

1. Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest, *Introduction to Algorithms*, Third Edition, PHI 2009.
2. Adam Drozdex, *Data Structures and Algorithms in C++,* Second Edition, Thomson learning – Vikas publishing house, 2001.
3. E. Horowitz, S. Sahni and Dinesh Mehta, *Fundamentals of Data structures in C++,* Galgotia, 1999.
4. G. Brassard and P. Bratley, *Algorithmics: Theory and Practice*, Printice –Hall,1988.
5. V.S. Subrahmanian, *Principles of Multimedia Database systems*, Morgan Kaufman, 1998.
6. 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.

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 biological neurons - Introduction to artificial neurons - types of transfer functions - architecture of feedforward neural networks - backpropagation learning algorithm - applications of neural network

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

Reference

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

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:
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

Reference:
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.

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 - Computer Graphics and Visualization

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

Module 2
Geometric transformation in 2D space – translation, rotation, scaling, reflection. Homogenous co-ordinates and Composite transformation. Affine transformation. Two Dimensional Viewing transformation – Line/Polygon Clipping.

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

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

Reference:

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

CSC5204 – Data Mining

Module 1
Introduction: Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Data Preprocessing: Needs Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation. Some Considerations in Multi-Source Data Fusion.

Module 2
Data Mining Primitives, Languages, and System Architectures: Data Mining Primitives, Data Mining Query Languages, Architectures of Data Mining Systems. 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 Association Rules in Large Databases: Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases, Dynamic Itemset Counting Algorithm, FP-Tree Growth Algorithm, Constraint-Based Association Mining. Handling large datasets in main memory, the limited pass algorithm, Counting frequent item sets in a stream.

Module 4
Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Other Classification Methods, Prediction, Classifier Accuracy. Uncertain Knowledge Association Through Information Gain. Cluster Analysis Introduction: Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Density-Based Methods, Clustering High-Dimensional data, Constraint-based cluster analysis, Outlier Analysis, Mining Complex Types of Data: Mining Time-Series and Sequence Data, Mining Text Databases, Mining the World Wide Web.

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. Da Ruan, Guoqing Chen, Etienne E. Kerre, Geert Wets, *Intelligent Data Mining: Techniques and Applications* (Studies in Computational Intelligence), Springer, 1st Ed., 2010.
5. M. Mohammadian, *Intelligent Agents for Data Mining and Information Retrieval*, Idea Group Publishing, 2004.

CSC5301 – 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.

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

CSC5302 - 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 book:

1. Rafael C. Gonzalez, Richard E. Woods, "*Digital Image Processing*", 3rd Ed., PHI, 2007.

References:

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

CSC5303 – 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.

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*

CSC5304 – Mini Project

Students should undertake research based real time mini 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 mini project. A detailed project report should be submitted by each student at the end of the semester. Evaluation of the mini-project is fully internal 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 bases 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 internal and external examiners based on the work done and the dissertation submitted.

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 Book:

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.

References:

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 Book:
1. Lawrence Rabiner, Biing-Hwang Juang, B Yegnanarayana, Fundamentals of Speech Recognition, Pearson, 2009.

References
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:
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.

Reference books:
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.

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

Reference Books
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.

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.

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:

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.

Reference Books:
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
Reference:
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.

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.

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.

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
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:
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*

Reference:
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.

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
History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, FeedForward Neural Networks, Backpropagation

Module 2
Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalues and eigenvectors, Eigenvalue Decomposition, Principal Component Analysis and its interpretations, Singular Value Decomposition, Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders

Module 3
Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization, Learning Vectorial Representations of Words

Module 4
Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks, Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs, Encoder Decoder Models, Attention Mechanism, Attention over images

References:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, An MIT Press book, 2016
2. http://www.deeplearningbook.org

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 raspberry 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/

CSC5017 – Cyber Security

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

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

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

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

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

Module-4
Cyber Laws: Introduction, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013.

Cyber Forensics: Introduction to Cyber Forensics, Need of Cyber Forensics, Cyber Evidence, Documentation and Management of Crime Sense, Image Capturing and its importance, Partial Volume Image, Web Attack Investigations, Denial of Service Investigations, Internet Crime Investigations, Internet Forensics, Steps for Investigating Internet Crime, Email Crime Investigations.

Open Source/ Free/ Trial Tools: Case Studies related to Cyber Law, Common Forensic Tools like dd, md5sum, sha1sum, Ram dump analysis, USB device

Text Book/References

1. William Stallings, ―Cryptography and Network Security, Pearson Education, 7th Edition, 2017.
2. V.K. Jain, ―Cryptography and Network Security, Khanna Publishing House, 1st Edition, 2020.
3. Sarika Gupta, Gaurav Gupta ―Information Security and Cyber Laws, Khanna Publishing House, 2019
4. Atul Kahate, ―Cryptography and Network Security, McGraw Hill, 4th Edition, 2019.
5. V.K. Pachghare, ―Cryptography and Information Security, PHI Learning, 3rd Edition, 2019.
6. Nina Godbole, Sunit Belapure ―Cyber Security, Wiley India Pvt Ltd, 2011.
7. Bothra Harsh, ―Mastering Hacking, Khanna Publishing House, Delhi, 2019.
8. Rajeev Alur, ―Principles of Cyber-Physical Systems, MIT Press, 2015.

CSC5018 – Block Chain

Module 1
Introduction: Overview of Blockchain, Public Ledgers, Bitcoin, Smart Contracts, Block in a Blockchain, Transactions, Distributed Consensus, Public vs. Private Blockchain, Understanding Cryptocurrency to Blockchain, Permissioned Model of Blockchain, Overview of Security aspects of Blockchain.

Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency.

Module 2
Bitcoin and Blockchain: Creation of coins, Payments and double spending, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay.

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 and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time, The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.

Module 3
Permissioned Blockchain: Permissioned model and use cases, Design issues for Permissioned blockchains, Execute contracts, State machine replication, Overview of Consensus models for permissioned blockchain-Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem, Byzantine fault tolerant system, Lamport-Shostak-Pease BFT Algorithm, BFT over Asynchronous systems.

Enterprise application of Blockchain: Cross border payments, Know Your Customer (KYC), Food Security, Mortgage over Blockchain, Blockchain enabled Trade, We Trade –Trade Finance Network, Supply Chain Financing, Identity on Blockchain.

Module 4
Blockchain Application Development: Hyperledger Fabric- Architecture, Identities and Policies, Membership and Access Control, Channels, Transaction Validation, Writing smart contract using Hyperledger Fabric, Writing smart contract using Ethereum, Overview of Ripple and Corda.

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.

CSC5051 – Operating System

Module 1
Introduction to Operating System (OS): History of OS, functionalities of OS, different types of OS.

Module 2
File Management, Memory Management, virtual memory, CPU Management

Module 3
Interprocess communications, Synchronization, Working with Windows, Linux, Mac OS

Text Books/References:

1. Operating Systems: Principles and Practice, 2nd Edition (2014), by Anderson and Dahlin, Recursive Books, ISBN 978-0985673529
2. Operating System Concepts, 8th Edition (2008), by Silberschatz, Galvin and Gagne, Wiley, ISBN 978-0470128725
3. Understanding the Linux Kernel, 3rd Edition (2008), by Bovet, O’Reilly, ISBN 978-0596005658, (good for projects)
4. Modern Operating Systems, 4th Edition (2014), by Tanenbaum and Bos, Pearson, ISBN 978-0133591620

CSC5052 – Computer Networks

Module 1
Introduction to Computer Networks: Topologies, categories of networks, ISO & TCP/IP Reference Model.

Module 2
Transmission media, LAN, switching and other devices

Module 3
Details of all layers and their functionalities. Case studies.

Text Books/References:

1. Andrew S. Tanenbaum, ―Computer Networks‖, PHI, 5th Edition, 2013
2. Behrouz A. Forouzan, ―Data communication and Networking‖, TataMcGrawHill,4thEdition,2006
3. TeerawatUssaruyakul, Ekram Hossain, Introduction to Network Simulator NS2, Springer, 2009
4. William Stallings, ―Data and ComputerCommunication‖,7th Edition, Pearson Education, 2007

CSC5053 – 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, case study

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.

CSC5054 – 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. IEEtran. Applications to: Writing Resumae, 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

CSC5055 – 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.

CSC5056 – 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.

References /Suggested Readings:

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

CSC5057 – INTRODUCTION TO 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

CSC5058 – 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.

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.

CSC5071 – C

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.

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++

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, 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

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, case study

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 – 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. IEEtran. Applications to: Writing Resumae, 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

CSC5075 - 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.

CSC5076 – 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

CENTRAL UNIVERSITY OF KERALA
केरल केन्द्रीय विश्वविद्यालय
DEPARTMENT OF COMPUTER SCIENCE
SCHOOL OF PHYSICAL SCIENCES

कंप्यूटर विज्ञान विभाग
केरल केंद्रीय विश्वविद्यालय
CENTRAL UNIVERSITY OF KERALA
कासरगोड / KASARAGOD
पेरिया / Periye - 671316
Department of Computer Science

Minutes of BOS in Computer Science
held on 09/07/2020 at 11.30 AM

Agenda:

(i) To move the course Data Mining from 3rd to the 2nd semester in the place of ADBMS
(ii) To introduce a course Big Data Analytics in the 3rd semester in the place of Data Mining
(iii) To move the elective from 4th semester to the second semester
(iv) any other discussion

The following members were present during the meeting.

1. Dr. Rajesh R, Head, Department of Computer Science
2. Dr. K.A. Germina, Associate Professor, Department of Mathematics
3. Mr. Kumar V, Assistant Professor, Dept. of Computer Science
4. Prof. (Dr.) Vineeth Paleri, Professor, Dept. of Computer Science, NITC, Calicut
5. Prof. (Dr.) Arunkumar T., Professor, School of Computer Science and Engineering, VIT, Vellore
6. Prof. (Dr.) Manjaiah D.H., Professor, Dept. of Computer Science Application, Mangalore University
7. Mr. Ragesh N.K., DSP & Multimedia Specialist, Tata Elxsi Ltd.
8. Mr. Sagar Padmanabhan, TechLead, Infosys

The BOS meeting started with a welcome address by Dr. Rajesh R.

The BOS members have gone through the previous course structure and the current course structure of M.Sc Computer Science.

There was a very good discussion regarding the entry criteria (eligibility) by Prof. (Dr.) Manjaiah D.H, whether industry or research oriented syllabus Prof. (Dr.) Vineeth Paleri, availability of bridge on course for other discipline students by Prof. (Dr.) Manjaiah D.H., industry relevance by Prof. (Dr.) Arunkumar T., Mr. Ragesh N.K. and Mr. Sagar Padmanabhan.

The BOS chairman conveyed that the syllabus is research oriented with main focus on intelligent systems and the same was supported by Prof. (Dr.) Vineeth Paleri. The BOS chairman conveyed the availability of bridge course and audited course as part of the course curriculum and the same was supported by Prof. (Dr.) Manjaiah D.H. The BOS chairman clarified the non-necessity of DBMS as the students are learning it during the UG course and the same was supported by Prof. (Dr.) Arunkumar T. The need of industry linkage was specified by Mr. Ragesh N.K. and Mr. Sagar Padmanabhan were also considered positively for further improvement of the curriculum.

The following were approved in the BOS

1. Moving the course Data Mining from 3rd Semester in the place of Data Mining
2. Introduction of Big Data Analytics course in the 3rd Semester in the place of Data mining
3. Moving the elective from the 4th Semester to the second semester.

The meeting ended with vote of thanks.

Dr. Rajesh R. Dr. K.A.Germina Mr. Kumar V Prof. (Dr.) Vineeth Paleri

Head / Head
Department of Computer Science
School of Physical Sciences

Prof. (Dr.) Arunkumar T. Prof. (Dr.) Manjaiah D.H. Mr. Ragesh N.K. Mr. Sagar Padmanabhan

CENTRAL UNIVERSITY OF KERALA
केरल केन्द्रीय विश्वविद्यालय
DEPARTMENT OF COMPUTER SCIENCE
SCHOOL OF PHYSICAL SCIENCES

Minutes of BOS in Computer Science held on 09/07/2020 at 11.30 AM

Agenda:

(i) To move the course Data Mining from 3rd to the 2nd semester in the place of ADBMS
(ii) To introduce a course Big Data Analytics in the 3rd semester in the place of Data Mining
(iii) To move the elective from 4th semester to the second semester
(iv) any other discussion

The following members were present during the meeting.

1. Dr. Rajesh R, Head, Department of Computer Science
2. Dr. K.A. Germina, Associate Professor, Department of Mathematics
3. Mr. Kumar V, Assistant Professor, Dept. of Computer Science
4. Prof. (Dr.) Vineeth Paleri, Professor, Dept. of Computer Science, NITC, Calicut
5. Prof. (Dr.) Arunkumar T., Professor, School of Computer Science and Engineering, VIT, Vellore
6. Prof. (Dr.) Manjaiah D.H., Professor, Dept. of PG Studies and Research in Computer Science, Mangalore University
7. Mr. Ragesh N.K., DSP & Multimedia Specialist, Tata Elxsi Ltd.
8. Mr. Sagar Padmanabhan, TechLead, Infosys

The BOS meeting started with a welcome address by Dr. Rajesh R.

The BOS members have gone through the previous course structure and the current course structure of M.Sc Computer Science.

The was a very good discussion regarding the entry criteria (eligibility) by Prof. (Dr.) Manjaiah D.H, whether industry or research oriented syllabus Prof. (Dr.) Vineeth Paleri, availability of bridge on course for other discipline students by Prof. (Dr.) Manjaiah D.H., industry relevance by Prof. (Dr.) Arunkumar T., Mr. Ragesh N.K. and Mr. Sagar Padmanabhan.

The BOS chairman conveyed that the syllabus is research oriented with main focus on intelligent systems and the same was supported by Prof. (Dr.) Vineeth Paleri. The BOS chairman conveyed the availability of bridge course and audited course as part of the course curriculum and the same was supported by Prof. (Dr.) Manjaiah D.H. The BOS chairman clarified the non-necessity of DBMS as the students are learning it during the UG course and the same was supported by Prof. (Dr.) Arunkumar T. The need of industry linkage was specified by Mr. Ragesh N.K. and Mr. Sagar Padmanabhan were also considered positively for further improvement of the curriculum.

The following were approved in the BOS

1. Moving the course Data Mining from 3rd Semester in the place of Data Mining
2. Introduction of Big Data Analytics course in the 3rd Semester in the place of Data mining
3. Moving the elective from the 4th Semester to the second semester.

The meeting ended with vote of thanks.

Dr. Rajesh R | Dr. K.A.Germina | Mr. Kumar V | Prof. (Dr.) Vineeth Paleri

Prof. (Dr.) Arunkumar T. | Prof. (Dr.) Manjaiah D.H. | Mr. Ragesh N.K. | Mr. Sagar Padmanabhan

CENTRAL UNIVERSITY OF KERALA
केरल केन्द्रीय विश्वविद्यालय
DEPARTMENT OF COMPUTER SCIENCE
SCHOOL OF PHYSICAL SCIENCES

Minutes of BOS in Computer Science
held on 09/07/2020 at 11.30 AM

Agenda:

(i) To move the course Data Mining from 3rd to the 2nd semester in the place of ADBMS
(ii) To introduce a course Big Data Analytics in the 3rd semester in the place of Data Mining
(iii) To move the elective from 4th semester to the second semester
(iv) any other discussion

The following members were present during the meeting.

1. Dr. Rajesh R, Head, Department of Computer Science
2. Dr. K.A. Germina, Associate Professor, Department of Mathematics
3. Mr. Kumar V, Assistant Professor, Dept. of Computer Science
4. Prof. (Dr.) Vineeth Paleri, Professor, Dept. of Computer Science, NITC, Calicut
5. Prof. (Dr.) Arunkumar T., Professor, School of Computer Science and Engineering, VIT, Vellore
6. Prof. (Dr.) Manjaiah D.H., Professor, Dept. of Computer Science Application, Mangalore University
7. Mr. Ragesh N.K., DSP & Multimedia Specialist, Tata Elxsi Ltd.
8. Mr. Sagar Padmanabhan, TechLead, Infosys

The BOS meeting started with a welcome address by Dr. Rajesh R.

The BOS members have gone through the previous course structure and the current course structure of M.Sc Computer Science.

The was a very good discussion regarding the entry criteria (eligibility) by Prof. (Dr.) Manjaiah D.H, whether industry or research oriented syllabus Prof. (Dr.) Vineeth Paleri, availability of bridge on course for other discipline students by Prof. (Dr.) Manjaiah D.H., industry relevance by Prof. (Dr.) Arunkumar T., Mr. Ragesh N.K. and Mr. Sagar Padmanabhan.

The BOS chairman conveyed that the syllabus is research oriented with main focus on intelligent systems and the same was supported by Prof. (Dr.) Vineeth Paleri. The BOS chairman conveyed the availability of bridge course and audited course as part of the course curriculum and the same was supported by Prof. (Dr.) Manjaiah D.H. The BOS chairman clarified the non-necessity of DBMS as the students are learning it during the UG course and the same was supported by Prof. (Dr.) Arunkumar T. The need of industry linkage was specified by Mr. Ragesh N.K. and Mr. Sagar Padmanabhan were also considered positively for further improvement of the curriculum.

The following were approved in the BOS

1. Moving the course Data Mining from 3rd Semester in the place of Data Mining
2. Introduction of Big Data Analytics course in the 3rd Semester in the place of Data mining
3. Moving the elective from the 4th Semester to the second semester.

The meeting ended with vote of thanks.

Dr. Rajesh R. Dr. K.A.Germina Mr. Kumar V Prof. (Dr.) Vineeth Paleri

Prof. (Dr.) Arunkumar T. Prof. (Dr.) Manjaiah D.H. Mr. Ragesh N.K. Mr. Sagar Padmanabh

CENTRAL UNIVERSITY OF KERALA
केरल केन्द्रीय विश्वविद्यालय

DEPARTMENT OF COMPUTER SCIENCE
SCHOOL OF PHYSICAL SCIENCES

Minutes of BOS in Computer Science
held on 09/07/2020 at 11.30 AM

Agenda:

(i) To move the course Data Mining from 3rd to the 2nd semester in the place of ADBMS
(ii) To introduce a course Big Data Analytics in the 3rd semester in the place of Data Mining
(iii) To move the elective from 4th semester to the second semester
(iv) any other discussion

The following members were present during the meeting.

1. Dr. Rajesh R, Head, Department of Computer Science
2. Dr. K.A. Germina, Associate Professor, Department of Mathematics
3. Mr. Kumar V, Assistant Professor, Dept. of Computer Science
4. Prof. (Dr.) Vineeth Paleri, Professor, Dept. of Computer Science, NITC, Calicut
5. Prof. (Dr.) Arunkumar T., Professor, School of Computer Science and Engineering, VIT, Vellore
6. Prof. (Dr.) Manjaiah D.H., Professor, Dept. of Computer Science Application, Mangalore University
7. Mr. Ragesh N.K., DSP & Multimedia Specialist, Tata Elxsi Ltd.
8. Mr. Sagar Padmanabhan, TechLead, Infosys

The BOS meeting started with a welcome address by Dr. Rajesh R.

The BOS members have gone through the previous course structure and the current course structure of M.Sc Computer Science.

The was a very good discussion regarding the entry criteria (eligibility) by Prof. (Dr.) Manjaiah D.H, whether industry or research oriented syllabus Prof. (Dr.) Vineeth Paleri, availability of bridge on course for other discipline students by Prof. (Dr.) Manjaiah D.H., industry relevance by Prof. (Dr.) Arunkumar T., Mr. Ragesh N.K. and Mr. Sagar Padmanabhan.

The BOS chairman conveyed that the syllabus is research oriented with main focus on intelligent systems and the same was supported by Prof. (Dr.) Vineeth Paleri. The BOS chairman conveyed the availability of bridge course and audited course as part of the course curriculum and the same was supported by Prof. (Dr.) Manjaiah D.H. The BOS chairman clarified the non-necessity of DBMS as the students are learning it during the UG course and the same was supported by Prof. (Dr.) Arunkumar T. The need of industry linkage was specified by Mr. Ragesh N.K. and Mr. Sagar Padmanabhan were also considered positively for further improvement of the curriculum.

The following were approved in the BOS

1. Moving the course Data Mining from 3rd Semester in the place of Data Mining
2. Introduction of Big Data Analytics course in the 3rd Semester in the place of Data mining
3. Moving the elective from the 4th Semester to the second semester.

The meeting ended with vote of thanks.

Dr. Rajesh R. Dr. K.A.Germina Mr. Kumar V
Prof. (Dr.) Vineeth Paleri

Prof. (Dr.) Arunkumar T. Prof. (Dr.) Manjaiah D.H. Mr. Ragesh N.K. Mr. Sagar Padmanabhan

MINUTES OF THE 20TH MEETING OF THE ACADEMIC COUNCIL OF CENTRAL UNIVERSITY OF KERALA HELD ONLINE AT 10.30 AM ON 15TH SEPTEMBER 2020

Dr. A. Radhakrishnan Nair, Registrar & Secretary, welcomed the Vice-Chancellor and Chairman and all the members of the Academic Council. The Registrar also introduced the newly nominated expert member, Prof. Dr. Raj Kumar Mishra, Senior Professor and Director, Institute of Public Enterprise, Osmania University, Hyderabad.

The Vice-Chancellor, Prof. H. Venkateswaralu, started the meeting welcoming all the members. In his introductory remarks, the Vice-Chancellor pointed out that the Academic Council is the main body of a University by which the total academic plan of a university is formulated. He called upon all Deans to forward proposals for the future development of the University in consultation with faculty members of the School. The proposals of the faculty members, if any, to University should be through the HoDs Deans. The Vice-Chancellor also informed that except administrative issues the entire governance of students and faculty would be resolved at Dean's level. He also urged to focus on attaining the top 10 position among Central Universities during the next year. This objective could not be attained without the help of faculty members. After the introductory remarks, the agenda items were taken into consideration.

The Academic Council noted that the following Departments conducted their meetings of BoS for revision of syllabus:

(1.) **Dept. of Mathematics: -**

Approved the Minutes of the meeting of Board of Studies of Department of Mathematics held on 06.07.2020.

(2). **Dept. of Public Health and Community Medicine: -**

APPROVED the Minutes of the meeting of Board of Studies of Department of Public Health and Community Medicine held on 08.07.2020.

(3.) **Dept. of English and Comparative Literature:** -

The Academic Council noted that a meeting of Board of Studies Dept. of English and Comparative Literature was held on 07.07.2020, and the recommendation item No. 1 is against CBCS guidelines, hence the Vice-Chancellor rejected the recommendation of the BoS. However, Item No. 2 Film Appreciation Course (online) with three credits and two exit systems has been recommended to place before Academic Council for its consideration and approval.

APPROVED the Minutes of the meeting of Board of Studies of Dept. of English and Comparative Literature held on 07.07.2020 except the recommendation of Item No.1 as it is against CBCS guidelines.

(4.) **Dept. of Chemistry**

APPROVED the Minutes of the meeting of Board of Studies of Department of Chemistry held on 08.07.2020.

(5.) **Dept. of Computer Science**

APPROVED the Minutes of the A meeting of Board of Studies of Dept. of Computer Science held on 09.07.2020.

(6.) **Dept. of Law**

APPROVED the Minutes of the meeting of Board of Studies of Department of Law held on 18.08.2020.

(7.) **Dept. of Education**

APPROVED the Minutes of the meeting of Board of Studies of Department of Education held on 06.07.2020,

(8) Department of Geology

APPROVED the Minutes of the Board of Studies of Department of Geology held on 17.07.2020.

AC 20:09 TO CONSIDER starting of offline classes as per Academic Calendar 2020-2021.

The item deferred.

AC 20:10 TO CONSIDER the Proposal for Online Certificate and PG Diploma Course in Life Skills Education.

The Academic Council noted that Prof. (Dr.). M. N Mohamedunni Alias Musthafa, Dean, School of Education and Coordinator, Centre for Life Skill Education, submitted a proposal for an Online Certificate Course (6 months, 1 - Semester) and PG Diploma Course (12 months, 2- Semester)

CENTRAL UNIVERSITY OF KERALA

DEPARTMENT OF COMPUTER SCIENCE

M.Sc. (Computer Science)

Specialization: Intelligent Systems

Programme Structure

For 2020 Admission Onwards

CENTRAL UNIVERSITY OF KERALA DEPARTMENT OF COMPUTER SCIENCE M.Sc. COMPUTER SCIENCE – PROGRAMME STRUCTURE (2020 Admission Onwards)					
COURSE CODE	**COURSE TITLE**	**CONTACT HRS/WEEK**			**CREDITS**
		LEC	**LAB**	**TUT**	
SEMESTER I					
CSC5101	Computational Mathematics	2	2	1	4
CSC5102	Programming Concepts Using Python	2	2	1	4
CSC5103	Advanced Data Structures and Algorithms	2	2	1	4
CSC5104	Digital Signal Processing	2	2	1	4
CSC5105	Computational Intelligent Systems	2	2	1	4
	Total	**10**	**10**	**5**	**20**
SEMESTER II					
CSC5201	Cryptography and Network Security	2	2	1	4
CSC5202	Pattern Recognition	2	2	1	4
CSC5203	Computer Graphics and Visualization	2	2	1	4
CSC5204	Data Mining	2	2	1	4
CSC50XX	Elective 1	2	2	1	4
CSC50XX	Elective 2 *	2	2	1	4
	Total	**12**	**12**	**6**	**24**
SEMESTER III					
CSC5301	Big Data Analytics	2	2	1	4
CSC5302	Image Processing	2	2	1	4
CSC5303	High Performance Computing	2	2	1	4
CSC5304	Minor Project	-	4	1	4
CSC50XX	Elective 3	2	2	1	4
	Total	**8**	**12**	**5**	**20**
SEMESTER IV					
CSC5490	Dissertation	-	20	4	8
	Total	**-**	**20**	**4**	**8**

*Students have the flexibility to choose elective 2 either from the department or from other departments or from SWAYAM MOOCS courses.

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

Lec = Lecture, Tut = Tutorial, Lab = Practical

Credits for Core Courses	:	48
Credits for Elective Courses	:	12
Minor Project	:	04
Dissertation	:	08
Total	:	72 (Minimum Credits Required is72)

AUDITED COURSES*					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC5051	Operating Systems	1	1	1	2
CSC5052	Computer Networks	1	1	1	2
CSC5053	MATLAB	1	1	1	2
CSC5054	LATEX	1	1	1	2
CSC5055	Software Engineering	1	1	1	2
CSC5056	Operations Research	1	1	1	2

*Syllabus may vary and will be customized based on the level of students. These credits will not be added to marklists.

OPEN ELECTIVE COURSES (for other departments)*					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC5071	C	2	1	1	4
CSC5072	C++	2	1	1	4
CSC5073	MATLAB	2	1	1	4
CSC5074	LATEX	2	1	1	4
CSC5075	Python	2	1	1	4
CSC5076	Enjoyable programming	2	1	1	4

*Syllabus may vary and will be customized based on the level of students.

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
Introduction to Graph theory.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:

1. K Sankara Rao, *Numerical Methods for Scientists and Engineers*, PHI Publication, Eastern Economy edition, 2009.
2. Laurene V Fausett, *Applied Numerical Analysis using MATLAB,* Pearson Edition, 2011.
3. V Rajaraman, *Computer Oriented Numerica Methods,* PHI Publication, Eastern Economy edition, 2009
4. Kreyszig E, *Advanced Engineering Mathematics,* Wiley India edition, 2008.

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:

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

Reference:

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
6. Pragmatic Bookshelf, 2nd edition 2013.
7. Charles Dierach, Introduction to Computer Science using Python, Wiley, 2015.

CSC5103 - Advanced Data Structures and Algorithms

Module 1: Introduction and Analysis of Algorithm
Introduction to algorithms, Role of Algorithms in computing, asymptotic notations: big O, omega, theta notations– properties of asymptotic notations. Divide and Conquer: General method, Maximum sub array problem, Convex hull problem. Greedy Method: The General Method, Knapsack problem, Minimum Cost Spanning Trees.

Module 2: Algorithm Design
Dynamic Programming: The General Method, Matrix chain multiplication, Rod cutting problem. Back Tracking: The General method, 8-queens problem, Knapsack problem. NP-Hard and NP-Complete problems.

Module 3: Selection and Search Structures
Heap 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 4: Multimedia Structures
Segment trees – k-d trees – Point Quad trees – MX-Quad trees – R-trees TV trees. Analysis and complexity of all above topics. Hash list- Hash table- Hash tree- Applications: Huffman coding

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:

1. Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest, *Introduction to Algorithms*, Third Edition, PHI 2009.
2. Adam Drozdex, *Data Structures and Algorithms in C++,* Second Edition, Thomson learning – Vikas publishing house, 2001.
3. E. Horowitz, S. Sahni and Dinesh Mehta, *Fundamentals of Data structures in C++,* Galgotia, 1999.
4. G. Brassard and P. Bratley, *Algorithmics: Theory and Practice*, Printice –Hall,1988.
5. V.S. Subrahmanian, *Principles of Multimedia Database systems*, Morgan Kaufman, 1998.
6. 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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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 biological neurons - Introduction to artificial neurons - types of transfer functions - architecture of feedforward neural networks - backpropagation learning algorithm - applications of neural network

Module 5
Latest literature review and case studies.

Lab Work
This course is basically a case study oriented course and everything taught in the class must be applied to solve some problems in the Lab and the same must be submitted for internal assessment.

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

Reference

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

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:

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

Reference:

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.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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 - Computer Graphics and Visualization

Module 1

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

Module 2

Geometric transformation in 2D space – translation, rotation, scaling, reflection. Homogenous co-ordinates and Composite transformation. Affine transformation. Two Dimensional Viewing transformation – Line/Polygon Clipping.

Module 3

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

Module 4

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

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Reference:

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

CSC5204 – Data Mining

Module 1

Introduction: Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Data Preprocessing: Needs Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation. Some Considerations in Multi-Source Data Fusion.

Module 2

Data Mining Primitives, Languages, and System Architectures: Data Mining Primitives, Data Mining Query Languages, Architectures of Data Mining Systems. 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 Association Rules in Large Databases: Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases, Dynamic Itemset Counting Algorithm, FP-Tree Growth Algorithm, Constraint-Based Association Mining. Handling large datasets in main memory, the limited pass algorithm, Counting frequent item sets in a stream.

Module 4

Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Other Classification Methods, Prediction, Classifier Accuracy. Uncertain Knowledge Association Through Information Gain. Cluster Analysis Introduction: Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Density-Based Methods, Clustering High-Dimensional data, Constraint-based cluster analysis, Outlier Analysis, Mining Complex Types of Data: Mining Time-Series and Sequence Data, Mining Text Databases, Mining the World Wide Web.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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. Da Ruan, Guoqing Chen, Etienne E. Kerre, Geert Wets, *Intelligent Data Mining: Techniques and Applications* (Studies in Computational Intelligence), Springer, 1st Ed., 2010.
5. M. Mohammadian, *Intelligent Agents for Data Mining and Information Retrieval*, Idea Group Publishing, 2004.

CSC5301 – 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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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. Leskovec, Rajaraman, Ullman, Mining of Massive Datasets, Cambridge University Press, ISBN: 978-1-107-07723-2.
5. Arshdeep Bahga, Vijay Madisetti, "Big Data Science & Analytics: A Hands On Approach",VPT,2016,ISBN: 978-0996025539

CSC5302 - 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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text book:

1. Rafael C. Gonzalez, Richard E. Woods, "*Digital Image Processing*", 3rd Ed., PHI, 2007.

References:

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

CSC5303 – 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.

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*

CSC5304 – Mini Project

Students should undertake a mini 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 mini project. A detailed project report should be submitted by each student at the end of the semester. Evaluation of the mini-project is fully internal based on demonstration, presentation and report.

CSC5490 – Dissertation

Each student is required to carry out a project work 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 bases 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 internal and external examiners based on the work done and the dissertation submitted.

CSC5001 – Natural Language Processing Dissertation

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

Lab Work
Everything taught in the class and its extended exercises must be implemented in the Lab using NLTK Toolkit and the same must be submitted for internal assessment during the lab hours.

Text Book:
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.

References:
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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text Book:
1. Lawrence Rabiner, Biing-Hwang Juang, B Yegnanarayana, Fundamentals of Speech Recognition, Pearson, 2009.

References
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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text books:
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.

Reference books:
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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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

Reference Books

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text books:

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.

Reference Books:
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

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text Book:
1. Raj Kamal, *Embedded Systems*, Second Edition TMH, 2008

Reference:
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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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.

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.

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
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:

1. *Bioinformatics: Sequence & Genome Analysis, by David W. Mount, Cold spring Harbor press.*
2. *Introduction to Bioinformatics, by T K Attwood & D J Parry-Smith Addison Wesley Longman*
3. *Fundamentals of bioinformatics and computational biology, by Gautam B. Singh, Springer, 2015*

Reference:

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.

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.
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
History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, FeedForward Neural Networks, Backpropagation

Module 2
Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalues and eigenvectors, Eigenvalue Decomposition, Principal Component Analysis and its interpretations, Singular Value Decomposition, Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders

Module 3
Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization, Learning Vectorial Representations of Words

Module 4
Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks, Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs, Encoder Decoder Models, Attention Mechanism, Attention over images

References:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, An MIT Press book, 2016
2. http://www.deeplearningbook.org

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 raspberry Pi, Home automation

Lab Work
This course is basically a lab oriented flipped classroom learning course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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/

केरल केन्द्रीय विश्वविद्यालय
CENTRAL UNIVERSITY OF KERALA
(संसद के अधिनियम, वर्ष 2009 द्वारा स्थापित / *Established under the Act of Parliament in 2009*)

Minutes of BOS in Computer Science Held on 05/01/2019 at 11 AM

Agenda:
(i) To discuss about the Syllabus
(ii) To discuss about the feedback of students
(iii) To start Centre for Computational Intelligence
(iv) To decide about the eligibility criteria for M.Sc. Computer Science
(v) To discuss about the panel of examiners and question paper setting

The following members were present during the meeting.

1. Dr. Arunkumar Thangavelu, Professor, Dept. of Computer Science and Engineering, VIT
2. Dr. K.A. Germina, Associate Professor, Department of Mathematics
3. Dr. Rajesh R, Head, Department of Computer Science
4. Mr. Kumar V.

(i) The BOS members have gone through the previous syllabus and current syllabus proposed by FC based on brainstorming workshop on curriculum development held on 04/01/2019. The BOS observes the improvement in the new curriculum/syllabus and approves the same.

(ii) The BOS has gone through the feedback of the students of 2016-18 batch and considered the suggestions. Two exemplary students cleared the NET exam and two students got placed in TCS.

(iii) The BOS recommends for starting of a Centre for Computational Intelligence based on the recommendations from the FC. Initially, Dr. Rajesh R. will serve as the Director for the centre.

(iv) Based on the recommendation of FC, the BOS recommends to amend the eligibility conditions for M.Sc. Computer Science admission as

BCA or B.Sc (Computer Science/electronics/commuincations/IT/Bioinformatics) or B.Tech/BE (Computer Science/electronics/communications/IT/electrical/ECE) or B.Sc. in Physics/Mathematics/Statistics (with computer science as a subject or having a certificate/diploma in computer related areas) or B.Voc (computer science/IT/electronics/electrical/ECE)

(v) The BOS recommends the panel of examiners/question paper setters suggested by the FC.

The meeting ended with vote of thanks.

5th Jan 2019
Dr. Arunkumar Thangavelu

5/1/2019
Dr. K.A. Germina

Dr. Rajesh R.

Mr. Kumar V.

केरल केंद्रीय विश्वविद्यालय
CENTRAL UNIVERSITY OF KERALA
(संसद के अधिनियम, वर्ष 2009 द्वारा स्थापित / *Established under the Act of Parliament in 2009)*

Ref: No.CUK/ACA/IIIrd AC/5th Meeting/736/2019-20/ Dated, 15th July 2019

MINUTES OF THE 5TH MEETING OF THE 3RD ACADEMIC COUNCIL HELD AT 10.30 AM ON 28TH JUNE 2019 AT CUK.

AC 03:05:01 ***Approval of the minutes of the last Academic Council-Reg:-***

The Minutes of the Academic Council meeting held on 12.12.2018 was placed before the Academic Council for approval.

Decision: Minutes approved

AC 03:05:02 ***Approval of the Action Taken Report - Reg:-***

The Action Taken Reports (ATR) of the Academic Council Meeting held on 12.12.2018 was placed before the Academic Council for approval.

Decision: ATR approved

AC 03:05:03 ***CUCET be made mandatory for NET Qualified candidates - Reg:-***

As per clause 1 of Regulations No.1/2018 for the award of the degree of Doctor of Philosophy (PhD) of the Central University of Kerala 2018 dated 06.08.2018, application for admission to the PhD programme will be invited twice in a year i.e. June-July and December –January. The June – July admission is done through the CUCET. Only JRF and similar fellowship holders are exempted from the CUCET score. However they are required to register through the CUCET if they are seeking admission during this round. The December- January admission is exclusively reserved for to JRF and similar fellowship holders.

It is often creating confusion with the UGC-JRF and UGC-NET (Only) qualifications as an exemption for appearing for CUCET for Ph.D. Admission.

ii. **Dept. of Mathematics:-**

The BoS Meeting of Dept. of Mathematics held on 07.02.2019 has approved the revised syllabus of M.Sc. Mathematics to be implemented from 2019 onwards.

Decision: The Academic Council approved the proposal (72 credits)

iii. **Dept. of Plant Science:-**

The BoS Meeting of Dept. of Plant Science held on 15.04.2019 has proposed a revised syllabus of M.Sc. Plant Science. This is to be made effective from 2019- onwards.

Decision: The Academic Council approved the proposal in principle. The AC suggested 8 credits for both dissertation and viva voce together. The AC further pointed out to have Continuous Assessment of 40 marks and it is to be moderated by guide. Dissertation requires to be treated as a Core Course with double valuation.

iv. **Dept. of Environmental Science:-**

The BoS Meeting of Dept. of EVS held on 03.06.2019 has proposed a modified syllabus (Skeleton) and scheme of Evaluation for M.Sc. Environmental Science effective from 2019 onwards. **(Annexure V-D)**

Decision: Resolved to approve the syllabus with retrospective effect 2018-19. AC directed the department to change the Credits for core courses from the existing 3 to 4 credits.

AC resolved to have only one external evaluation and one internal evaluation for each core course.

v. **Dept. of Computer Science:-**

The BoS Meeting of Dept. of Computer Science held on 05.01.2019 (Minutes Enclosed) has proposed the following. **(Annexure V-E)**

i. Revised programme Structure for M.Sc. Computer Science(2019 Onwards).

ii. Establishment of Computational Intelligence

iii. Amendment on the Eligibility conditions for M.Sc. Computer Sciences(from next year onwards)

Decision: AC approved the proposal.

The Academic Council also constituted a committee to revisit the issue of credits to be assigned to Elective courses with Controller of Examinations, Dr. Govinda Rao, Dr. Rajendra Pilankatta and AR (Academic) to finalise the credit matter.

AC 03:05:08 New Departments – Commencement -Reg.

The UGC vide letter No. F.No.1-1/2013(CU) Vol-XVII dated 06.03.2019 has conveyed the approval of the University Grants Commission for commencing 4 New Department and also confirmed the establishment of Dept. of International Relations (UG). Accordingly**(ANNEXURE X)**.

1. **Dept. of Management Studies:-** A meeting of the duly constituted Consultative Committee for **MBA** Programme was held on 8.05.2019 and 29-30 May 2019 for deliberation on implementation of MBA Scheme, Regulation, Syllabus and qualification for faculty recruitment. Proceeding of the Committee is placed at **(Annexure VI)** for perusal please. The total credit will be 100 with 4 semesters.

   The Committee recommended commencing of the MBA Programme at the Central University of Kerala during the Academic year 2019-20 in accordance with UGC guidelines /AICTE regulations.

   The regulations framed by the Consultative Committee may be adopted in the University for Commencement of MBA Programme.

2. **Dept. of Tourism Studies:- MBA in T&TM**. The Consultative Committee of Tourism and Travel Management met on 16.05.2019 and 06.06.2019 at CUK Periya and finalized the MBA as MBA (Tourism and Travel Management). The total credit will be 100 with 4 semesters. **(Annexure VII)**

CENTRAL UNIVERSITY OF KERALA

DEPARTMENT OF COMPUTER SCIENCE

M.Sc. (Computer Science)

Specialization: Intelligent Systems

Programme Structure

For 2019 Admission Onwards

CENTRAL UNIVERSITY OF KERALA DEPARTMENT OF COMPUTER SCIENCE M.Sc. COMPUTER SCIENCE – PROGRAMME STRUCTURE (2019 Admission Onwards)					
COURSE CODE	**COURSE TITLE**	**CONTACT HRS/WEEK**			**CREDITS**
		LEC	**LAB**	**TUT**	
SEMESTER I					
CSC5101	Computational Mathematics	2	2	1	4
CSC5102	Programming Concepts Using Python	2	2	1	4
CSC5103	Advanced Data Structures and Algorithms	2	2	1	4
CSC5104	Digital Signal Processing	2	2	1	4
CSC5105	Computational Intelligent Systems	2	2	1	4
	Total	**10**	**10**	**5**	**20**
SEMESTER II					
CSC5201	Cryptography and Network Security	2	2	1	4
CSC5202	Pattern Recognition	2	2	1	4
CSC5203	Computer Graphics and Visualization	2	2	1	4
CSC5204	Advanced Data Base Management System	2	2	1	4
CSC50XX	Elective 1	2	2	1	4
	Total	**10**	**10**	**5**	**20**
SEMESTER III					
CSC5301	Data Mining	2	2	1	4
CSC5302	Image Processing	2	2	1	4
CSC5303	High Performance Computing	2	2	1	4
CSC50XX	Elective 2	2	2	1	4
CSC5304	Minor Project	-	4	1	4
	Total	**8**	**12**	**5**	**20**
SEMESTER IV					
CSC5490	Dissertation	-	16	4	8
CSC50XX	*Elective 3	2	2	1	4
	Total	**2**	**18**	**5**	**12**

***** Elective 3 is focused on increasing the self-reading, self-understanding and self-implementing of a research subject and hence contact hours are not mandatory for students who do the projects outside the University. Class tests, assignment, and end semester exams will be conducted as usual with other elective courses.

Those who are interested can also do MOOCS course for elective 2 and 3.

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

Lec = Lecture, Tut = Tutorial, Lab = Practical

Credits for Core Courses	:	48
Credits for Elective Courses	:	12
Minor Project	:	04
Dissertation	:	08
Total	:	72 (Minimum Credits Required is72)

AUDITED COURSES*					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC5051	Operating Systems	1	1	1	2
CSC5052	Computer Networks	1	1	1	2
CSC5053	MATLAB	1	1	1	2
CSC5054	LATEX	1	1	1	2
CSC5055	Software Engineering	1	1	1	2
CSC5056	Operations Research	1	1	1	2

*Syllabus may vary and will be customized based on the level of students. These credits will not be added to marklists.

OPEN ELECTIVE COURSES (for other departments)*					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC5071	C	2	1	1	4
CSC5072	C++	2	1	1	4
CSC5073	MATLAB	2	1	1	4
CSC5074	LATEX	2	1	1	4
CSC5075	Python	2	1	1	4
CSC5076	Enjoyable programming	2	1	1	4

*Syllabus may vary and will be customized based on the level of students.

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
Introduction to Graph theory.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:

1. K Sankara Rao, *Numerical Methods for Scientists and Engineers*, PHI Publication, Eastern Economy edition, 2009.
2. Laurene V Fausett, *Applied Numerical Analysis using MATLAB,* Pearson Edition, 2011.
3. V Rajaraman, *Computer Oriented Numerica Methods,* PHI Publication, Eastern Economy edition, 2009
4. Kreyszig E, *Advanced Engineering Mathematics,* Wiley India edition, 2008.

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:

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

Reference:

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
6. Pragmatic Bookshelf, 2nd edition 2013.
7. Charles Dierach, Introduction to Computer Science using Python, Wiley, 2015.

CSC5103 - Advanced Data Structures and Algorithms

Module 1: Introduction and Analysis of Algorithm
Introduction to algorithms, Role of Algorithms in computing, asymptotic notations: big O, omega, theta notations– properties of asymptotic notations. Divide and Conquer: General method, Maximum sub array problem, Convex hull problem. Greedy Method: The General Method, Knapsack problem, Minimum Cost Spanning Trees.

Module 2: Algorithm Design
Dynamic Programming: The General Method, Matrix chain multiplication, Rod cutting problem. Back Tracking: The General method, 8-queens problem, Knapsack problem. NP-Hard and NP-Complete problems.

Module 3: Selection and Search Structures
Heap 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 4: Multimedia Structures
Segment trees – k-d trees – Point Quad trees – MX-Quad trees – R-trees TV trees. Analysis and complexity of all above topics. Hash list- Hash table- Hash tree- Applications: Huffman coding

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:

1. Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest, *Introduction to Algorithms*, Third Edition, PHI 2009.
2. Adam Drozdex, *Data Structures and Algorithms in C++,* Second Edition, Thomson learning – Vikas publishing house, 2001.
3. E. Horowitz, S. Sahni and Dinesh Mehta, *Fundamentals of Data structures in C++,* Galgotia, 1999.
4. G. Brassard and P. Bratley, *Algorithmics: Theory and Practice*, Printice –Hall,1988.
5. V.S. Subrahmanian, *Principles of Multimedia Database systems*, Morgan Kaufman, 1998.
6. 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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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 biological neurons - Introduction to artificial neurons - types of transfer functions - architecture of feedforward neural networks - backpropagation learning algorithm - applications of neural network

Module 5
Latest literature review and case studies.

Lab Work
This course is basically a case study oriented course and everything taught in the class must be applied to solve some problems in the Lab and the same must be submitted for internal assessment.

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

Reference

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

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:

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

Reference:

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.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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 - Computer Graphics and Visualization

Module 1

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

Module 2

Geometric transformation in 2D space – translation, rotation, scaling, reflection. Homogenous co-ordinates and Composite transformation. Affine transformation. Two Dimensional Viewing transformation – Line/Polygon Clipping.

Module 3

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

Module 4

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

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Reference:

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

CSC5204 – Advanced Data Base Management Systems

Module 1
Introduction to Data Bases: Introduction, Levels of abstraction, Data Models – the ER Model, Relational Model, Other Models, Data base design, Functional dependencies, Schema Refinement, Transactions and concurrency control, Crash recovery. Extended Entity Relationship Model and Object Model:- Motivation for complex data types, User defined abstract data types and structured types, Subclasses, Super classes, Inheritance, Specialization and generalization, Relationship types of degree higher than two.

Module 2
Text and Document Databases: Introduction, Precession and recall, stop-lists word-stems, frequency tables, queries, latent semantic indexing, SVD, LSI: document retrieval using SVD, TV-trees and its operations, NN retrieval in TV-trees, other retrieval techniques.

Module 3
Spatial and Temporal data Mobility: Motivation, Time in data bases, spatial and geographical data, Multimedia databases, Mobility and personal databases. Parallel and Distributed Databases and Client–Server Architecture: Architectures for parallel databases, Parallel query evaluation, Parallelizing individual operations, Sorting Joins, Distributed database concepts, Data fragmentation, Replication and allocation techniques for distributed database design, Query processing in distributed databases, An overview of client–server architecture.

Module 4
Data Warehouse and OLAP Technology for Data Mining: Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation. Data Cube computation and data generalization, Efficient methods for data cube computation, further development of Data Cube Technology.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:
1. R. Elmsari and S. Navathe, *Fundamentals of Database Systems*, Addison Wesley, 6th Ed., 2010.
2. R. Ramakrishnan and J. Gehrke, *Database Management Systems*, McGraw Hill, 3rd Ed., 2002.
3. V.S. Subramanian, Principles of Multimedia Data Base Systems, Hardcover – January 15, 1998
4. Silberschatz, H. Korth, S. Sudarshan, *Database System Concepts*, McGraw Hill, 6th Ed., 2010.
5. J. Date, *An Introduction to Database Systems*, Addison Wesley, 8th Ed., 2003.
6. Jiawei Han, MichelineKamber, Jian Pei, *Data Mining: Concepts and Techniques*, Morgan Kaufmann, 2nd Ed., 2005

CSC5301 – Data Mining

Module 1
Introduction: Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Data Preprocessing: Needs Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation. Some Considerations in Multi-Source Data Fusion.

Module 2
Data Mining Primitives, Languages, and System Architectures: Data Mining Primitives, Data Mining Query Languages, Architectures of Data Mining Systems. 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 Association Rules in Large Databases: Association Rule Mining, Mining Single-Dimensional Boolean

Association Rules from Transactional Databases, Dynamic Itemset Counting Algorithm, FP-Tree Growth Algorithm, Constraint-Based Association Mining. Handling large datasets in main memory, the limited pass algorithm, Counting frequent item sets in a stream.

Module 4
Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Other Classification Methods, Prediction, Classifier Accuracy. Uncertain Knowledge Association Through Information Gain. Cluster Analysis Introduction: Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Density-Based Methods, Clustering High-Dimensional data, Constraint-based cluster analysis, Outlier Analysis, Mining Complex Types of Data: Mining Time-Series and Sequence Data, Mining Text Databases, Mining the World Wide Web.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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. Da Ruan, Guoqing Chen, Etienne E. Kerre, Geert Wets, *Intelligent Data Mining: Techniques and Applications* (Studies in Computational Intelligence), Springer, 1st Ed., 2010.
5. M. Mohammadian, *Intelligent Agents for Data Mining and Information Retrieval*, Idea Group Publishing, 2004.

CSC5302 - 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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text book:

1. Rafael C. Gonzalez, Richard E. Woods, "*Digital Image Processing*", 3rd Ed., PHI, 2007.

References:

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

CSC5303 – 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.

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*

CSC5304 – Mini Project

Students should undertake a mini 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 mini project. A detailed project report should be submitted by each student at the end of the semester. Evaluation of the mini-project is fully internal based on demonstration, presentation and report.

CSC5490 – Dissertation

Each student is required to carry out a project work 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 bases 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 internal and external examiners based on the work done and the dissertation submitted.

CSC5001 – Natural Language Processing Dissertation

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

Lab Work
Everything taught in the class and its extended exercises must be implemented in the Lab using NLTK Toolkit and the same must be submitted for internal assessment during the lab hours.

Text Book:
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.
References:
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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text Book:
1. Lawrence Rabiner, Biing-Hwang Juang, B Yegnanarayana, Fundamentals of Speech Recognition, Pearson, 2009.
References
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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text books:

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.

Reference books:

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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

Reference Books

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text books:
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.

Reference Books:
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

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text Book:
1. Raj Kamal, *Embedded Systems*, Second Edition TMH, 2008

Reference:

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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.

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.

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
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:

1. *Bioinformatics: Sequence & Genome Analysis, by David W. Mount, Cold spring Harbor press.*
2. *Introduction to Bioinformatics, by T K Attwood & D J Parry-Smith Addison Wesley Longman*
3. *Fundamentals of bioinformatics and computational biology, by Gautam B. Singh, Springer, 2015*

Reference:

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.

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.
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

History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm, Multilayer Perceptrons (MLPs), Representation Power of MLPs, Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, FeedForward Neural Networks, Backpropagation

Module 2

Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam, Eigenvalues and eigenvectors, Eigenvalue Decomposition, Principal Component Analysis and its interpretations, Singular Value Decomposition, Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders

Module 3

Regularization: Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization, Learning Vectorial Representations of Words

Module 4

Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks, Recurrent Neural Networks, Backpropagation through time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, GRU, LSTMs, Encoder Decoder Models, Attention Mechanism, Attention over images

References:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, An MIT Press book, 2016
2. http://www.deeplearningbook.org

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 raspberry Pi, Home automation

Lab Work

This course is basically a lab oriented flipped classroom learning course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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/

केरल केन्द्रीय विश्वविद्यालय

CENTRAL UNIVERSITY OF KERALA

Tejaswini Hills, Periye PO, Kasaragod – 671 316

No. CUK/ACA/BS/189/2013 869/E2262 Dated, 02nd August 2018

अधिसूचना / NOTIFICATION

1. In terms of the provisions contained in the Ordinance – 5 and in supersession of the Notification Dated, 03rd May 2016, the PG Board of Studies of Department of Computer Science is reconstituted as follows.

i.	Head, Department of Computer Science	Dr.Rajesh.R, Associate Professor	Chairperson
ii.	All Professors in the Department	Vacant	
iii.	Two Associate Professor of the Department	Vacant	
iv.	One Assistant professor from the Department	Mr. V. Kumar, Assistant professor	Member
v	One member of faculty from another Department within the school	Dr. K.A.Germina. Associate Professor, Department of Mathematics	Member
vi.	Four Experts in the discipline	1. Dr.Vineeth Paleri, Department of Computer Science, NITC, Calicut, 9447028869, email- vpaleri@nitc.ac.in 2. Dr.Arunkumar.T, Sr. Professor and Dean, School of Computer Science and Engineering, VIT, Velloor, Tamil Nadu-632014 9994626191, email- arunkumar.thangavelu@gmail.com 3. Prof.Manjaiah, Professor and Head, Department of Computer Applications, Mangalore University Mangalagangothri, Mangalore 9449444638, email- drmdhmu@gmail.com, manju@mangaloreuniversity.ac.in 4. Dr.C.Chandrasekhar, Professor, Department of Computer Science and Engineering, IIT Madras, Chennai 600036, 09840986782, 04422574363 email-cchandra@iitm.ac.in	Members
vii	Special invitees from Industry	1. Mr.Ragesh.N.K Specialist, DSP & Multimedia, Tata Elxsi Ltd., Neyyar, Technopark Campus, Kariavattom, Thiruvananthapuram 695581, Mobile 09633171157, email- ragesh.nk@gmail.com 2. Mr.Sagar Padmanabhan, TechLead, Infosys. Mobile 9895783132	Special Invitee Special Invitee

2. The term of office of the members of the Board of Studies shall be for a period of three years.

3. The Chairperson shall have powers to co-opt experts, as special invitees, to attend specific meetings of the Board, as and when necessary, with the prior permission of the Vice - Chancellor.

4. This is issued with the approval of the Vice Chancellor.

Deputy Registrar (Acad.)

No. CUK/ACA/BS/189/2013

Dated ...22th...August 2018

Copy to:

1. P S to Vice Chancellor,
2. PS to Registrar
3. PS to Finance Officer
4. The Dean, SPS
5. The Head, Dept. of Computer Science
6. All Members
7. Office Copy.

Deputy Registrar (Acad.)

CENTRAL UNIVERSITY OF KERALA
केरल केन्द्रीय विश्वविद्यालय

DEPARTMENT OF COMPUTER SCIENCE

SCHOOL OF MATHEMATICAL AND PHYSICAL SCIENCES

Minutes of BOS in Computer Science Held on 09 July 2016 at 11.00 AM

Agenda: To discuss about the Syllabus, feedback of students, previous question papers, evaluation strategies

The following members were present during the meeting.

1. Dr. P. S. Hiremath, Professor, KLE Technological University
2. Dr. Rajesh R.
3. Dr. T.M. Thasleema
4. Mr. Ragesh N.K., Specialist, DSP & Multimedia, Tata Elxsi Ltd., Thiruvananthapuram
5. Mr. Fasil O.K., Software Engineer, NuCore Software Solutions

1) The BOS members have gone through the previous syllabus and current syllabus. The BOS observes the improvement in the curriculum/syllabus. The BOS members also suggested to include some industry related electives. The BOS approved the syllabus.
2) The feedback of 2014-16 batch students and 2015 admitted students were obtained. The BOS members has gone through the measures taken by the Faculty Council and approved the same.
3) The BOS members has gone through the previous question papers. The BOS members also verified (i) whether the question paper covers the entire syllabus, (ii) whether the question papers are upto the mark, (iii) whether the evaluation strategies of the answer papers are good. The BOS members were satisfied with procedures for the same.

Dr. P. S. Hiremath

Dr. Rajesh R.

Dr. T.M. Thasleema

Mr. Ragesh N.K.

Mr. Fasil O.K.

कंप्यूटर विज्ञान विभाग
केरल केंद्रीय विश्वविद्यालय
CENTRAL UNIVERSITY OF KERALA
कासरगोड / KASARAGOD
पेरिया / Periye - 671316
Department of Computer Science

CENTRAL UNIVERSITY OF KERALA

DEPARTMENT OF COMPUTER SCIENCE

M.Sc. (Computer Science)

Specialization: Intelligent Systems

Programme Structure

For 2016 Admission Onwards

CENTRAL UNIVERSITY OF KERALA
DEPARTMENT OF COMPUTER SCIENCE
M.Sc. COMPUTER SCIENCE – PROGRAMME STRUCTURE
(2016 Admission Onwards)

COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
SEMESTER I					
CSC511	Computational Mathematics	2	2	1	4
CSC512	Programming Concepts	2	2	1	4
CSC513	Advanced Data Structures and Algorithms	2	2	1	4
CSC514	Digital Signal Processing	2	2	1	4
CSC515	Computational Intelligent Systems	2	2	1	4
	Total	**10**	**10**	**5**	**20**
SEMESTER II					
CSC521	Cryptography and Network Security	2	2	1	4
CSC522	Image Processing	2	2	1	4
CSC523	Computer Graphics and Visualization	2	2	1	4
CSC524	Advanced Data Base Management System	2	2	1	4
CSC50XX	Elective 1	2	2	1	4
	Total	**10**	**10**	**5**	**20**
SEMESTER III					
CSC531	Data Mining	2	2	1	4
CSC532	Pattern Recognition	2	2	1	4
CSC533	High Performance Computing	2	2	1	4
CSC50XX	Elective 2	2	2	1	4
CSC534	Minor Project	-	6	1	4
	Total	**8**	**14**	**5**	**20**
SEMESTER IV					
CSC541	Dissertation	-	16	4	8
CSC50XX	*Elective 3	2	2	1	4
	Total	**2**	**18**	**5**	**12**

* Elective 3 is focused on increasing the self-reading, self-understanding and self-implementing of a research subject and hence contact hours are not mandatory for students who do the projects outside the University. Class tests, assignment, and end semester exams will be conducted as usual with other elective courses.

ELECTIVES					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC5001	Natural Language Processing	2	2	1	4
CSC5002	Digital Speech Processing	2	2	1	4
CSC5003	Wireless Sensor Networks	2	2	1	4
CSC5004	Cloud Computing	2	2	1	4
CSC5005	Nature Inspired Computing	2	2	1	4
CSC5006	Web Mining and Social Networking	2	2	1	4
CSC5007	Multimedia Database Systems	2	2	1	4
CSC5008	Computational Biology	2	2	1	4
CSC5009	Embedded Systems	2	2	1	4
CSC5010	Computer Vision	2	2	1	4
CSC5011	Biometrics	2	2	1	4
CSC5012	Information Retrieval Systems	2	2	1	4

Lec = Lecture, Tut = Tutorial, Lab = Practical

Credits for Core Courses	:	48
Credits for Elective Courses	:	12
Minor Project	:	04
Dissertation	:	08
Total	:	72 (Minimum Credits Required is72)

केरल केंद्रीय विश्वविद्यालय
CENTRAL UNIVERSITY OF KERALA
कासरगोड / KASARAGOD
पेरिया / Periye - 671316
Department of Computer Science

AUDITED COURSES*					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC50A1	Operating Systems	1	1	1	2
CSC50A2	Computer Networks	1	1	1	2
CSC50A3	MATLAB	1	1	1	2
CSC50A4	LATEX	1	1	1	2
CSC50A5	Software Engineering	1	1	1	2
CSC50A6	Internet of Things	1	1	1	2
CSC50A7	Big Data Analytics	1	1	1	2

*Syllabus may vary and will be customized based on the level of students. These credits will not be added to marklists.

OPEN COURSES (for other departments)*					
COURSE CODE	COURSE TITLE	CONTACT HRS/WEEK			CREDITS
		LEC	LAB	TUT	
CSC50C1	C	1	1	1	2
CSC50C2	C++	1	1	1	2
CSC50C3	MATLAB	1	1	1	2
CSC50C4	LATEX	1	1	1	2

*Syllabus may vary and will be customized based on the level of students.

कंप्यूटर विज्ञान विभाग
केरल केंद्रीय विश्वविद्यालय
CENTRAL UNIVERSITY OF KERALA
कासरगोड / KASARAGOD
पेरिया / Periye - 671316
Department of Computer Science

CSC511 - 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. Finite difference schemes for partial differential equations.

Module 4

Introduction to Graph theory.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:

1. K Sankara Rao, *Numerical Methods for Scientists and Engineers*, PHI Publication, Eastern Economy edition, 2009.
2. Laurene V Fausett, *Applied Numerical Analysis using MATLAB,* Pearson Edition, 2011.
3. V Rajaraman, *Computer Oriented Numerica Methods,* PHI Publication, Eastern Economy edition, 2009
4. Kreyszig E, *Advanced Engineering Mathematics,* Wiley India edition, 2008.

CSC512 - Programming Concepts

Module 1: Basics of Programming

Reasons for studying concepts of programming languages, programming domains, language evaluation criteria, influences on language design, language categories, language design trade-offs, implementation methods, programming environments, names, bindings, and scopes. Data types, expressions and assignment statements, statement-level control structures, subprograms and pointers.

Module 2: Advanced C Programming

Functions, pointers, structures and unions, file handling.

Module 3: C++ Programming

A glance on C++, C++ programming constructs, modular programming with functions, classes and objects, object initialisation and clean up and dynamic objects.

Module 4: C++ Programming – cont.

Operator overloading, inheritance, virtual functions, generic programming with templates, exception handling.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:

obert W. Sebesta, *Concepts of Programming Languages*, Addison-Wesley, 10th Edition.
Venugopal K.R., *Mastering C*, Tata McGraw-Hill Education India Pvt. Ltd., New Delhi, 2006
Venugopal K.R., Rajkumar Buyya, *Mastering C++*, McGraw-Hill Education India Pvt. Ltd, New Delhi, 2013

CSC513 - Advanced Data Structures and Algorithms

Module 1: Introduction and Analysis of Algorithm

Introduction to algorithms, Role of Algorithms in computing, asymptotic notations: big O, omega, theta notations– properties of asymptotic notations. Divide and Conquer: General method, Maximum sub array problem, Convex hull problem. Greedy Method: The General Method, Knapsack problem, Minimum Cost Spanning Trees.

Module 2: Algorithm Design

Dynamic Programming: The General Method, Matrix chain multiplication, Rod cutting problem. Back Tracking: The General method, 8-queens problem, Knapsack problem. NP-Hard and NP-Complete problems.

Module 3: Selection and Search Structures

Heap 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 4: Multimedia Structures

Segment trees – k-d trees – Point Quad trees – MX-Quad trees – R-trees TV trees. Analysis and complexity of all above topics. Hash list- Hash table- Hash tree- Applications: Huffman coding

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:

1. Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest, *Introduction to Algorithms*, Third Edition, PHI 2009.
2. Adam Drozdex, *Data Structures and Algorithms in C++,* Second Edition, Thomson learning – Vikas publishing house, 2001.
3. E. Horowitz, S. Sahni and Dinesh Mehta, *Fundamentals of Data structures in C++,* Galgotia, 1999.
4. G. Brassard and P. Bratley, *Algorithmics: Theory and Practice*, Printice –Hall,1988.
5. V.S. Subrahmanian, *Principles of Multimedia Database systems*, Morgan Kaufman, 1998.
6. E. Horowitz, et.al., *Fundamentals of Computer Algorithms*, Galgotia Publications, 1998.

CSC514 – 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.

Module 2

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

Module 3

Frequency Analysis of Signals- Frequency Analysis of Continuous Time Signals, Frequency Analysis of Discrete Time Signals, Frequency domain and Time Domain Signal Properties, Properties of Fourier Transform for Discrete Time Signals.

Module 4

Sampling and Reconstruction of Signals- Ideal Sampling and Reconstruction of Continuous-Time Signals, Discrete-Time Processing of Continuous-Time Signals, Analog-to-Digital and Digital-to-Analog Converters, Sampling and Reconstruction of Continuous-Time Bandpass Signals, Sampling of Discrete-Time Signals, Oversampling A/D and D/A Converters.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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

CSC515 - Computational Intelligence Systems

Module 1

Introduction to softcomputing - relevance, advantage and importance of softcomputing - components of softcomputing - applications of softcomputing - ability of softcomputing to handle uncertainty, vagueness, ambiguity - introduction to computational intelligence - relationship between computational intelligence and softcomputing

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 fuzzy rules - Takagi-Sugeno type fuzzy rules.

Module 3

Introduction to genetic algorithm - applications of genetic algorithm - concepts of genes, chromosomes, population and its initialization - fitness function - types of selection mechanism, working of roulette wheel selection - types of crossover operations - working of one point, two point, multipoint and arithmetic crossovers - mutation - reinsertion - steps of simple genetic algorithm

Module 4

Introduction to biological neurons - Introduction to artificial neurons - types of transfer functions - architecture of feedforward neural networks - backpropagation learning algorithm - applications of neural network

Module 5

Latest literature review and case studies.

Objective

This course is basically a case study oriented course and everything taught in the class must be applied to solve some problems in the Lab and the same must be submitted for internal assessment.

Text Books

1. James 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

Reference Books

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

CSC521 - Cryptography and Network Security

Module 1

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

Module 2

Advanced Encryption Standard (AES) encryption and decryption, Principals of public key crypto systems, RSA algorithm, security of RSA. Hash functions, security of hash functions, Secure hash algorithm (SHA). Digital Signatures, Elgamal Digital Signature Techniques, Digital signature standards (DSS), proof of digital signature algorithm.

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: Introductory idea of Intrusion, Intrusion detection, Viruses and related threats, firewalls.

Text books:

1. William Stallings, *Cryptography and Network Security*, Pearson Education, 4th Edition, 2005
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

Reference books:

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, 2nd Edition, 2003
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.

CSC522 - 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, Region splitting and merging. Fundamentals of video processing.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text book:

1. Rafael C. Gonzalez, Richard E. Woods, "*Digital Image Processing*", 3rd Ed., PHI, 2007.

References:

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

CSC523 - Computer Graphics and Visualization

Module 1

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

Module 2

Geometric transformation in 2D space – translation, rotation, scaling, reflection. Homogenous co-ordinates and Composite transformation. Affine transformation. Two Dimensional Viewing: Viewing transformation - Line Clipping – Polygon Clipping.

Module 3

Geometric transformation in 3D space – translation, rotation, scaling, reflection. Projections. Modeling 3D space – curve, surfaces.

Module 4

Knowledge about Visible–Surface Detection. OpenGL light and material properties and models. Texture basics and texture map. Color Models and Color Applications: RGB – YIQ – CMY – HSV.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Reference:

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

CSC524 – Advanced Data Base Management Systems

Module 1

Introduction to Data Bases: Introduction, Levels of abstraction, Data Models – the ER Model, Relational Model, Other Models. Data base design. Functional dependencies. Schema Refinement. Transactions and concurrency control. Crash

very. Extended Entity Relationship Model and Object Model:- Motivation for complex data types, User defined ostract data types and structured types, Subclasses, Super classes, Inheritance, Specialization and generalization. Relationship types of degree higher than two.

Module 2

Text and Document Databases: Introduction, Precession and recall, stop-lists word-stems, frequency tables, queries, latent semantic indexing, SVD, LSI: document retrieval using SVD, TV-trees and its operations, NN retrieval in TV-trees, other retrieval techniques.

Module 3

Spatial and Temporal data Mobility: Motivation, Time in data bases, spatial and geographical data, Multimedia databases, Mobility and personal databases. Parallel and Distributed Databases and Client–Server Architecture: Architectures for parallel databases, Parallel query evaluation, Parallelizing individual operations, Sorting Joins, Distributed database concepts, Data fragmentation, Replication and allocation techniques for distributed database design, Query processing in distributed databases, An overview of client–server architecture.

Module 4

Data Warehouse and OLAP Technology for Data Mining: Data Warehouse, Multidimensional Data Model, Data Warehouse Architecture, Data Warehouse Implementation. Data Cube computation and data generalization, Efficient methods for data cube computation, further development of Data Cube Technology.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:

1. R. Elmsari and S. Navathe, *Fundamentals of Database Systems*, Addison Wesley, 6th Ed., 2010.
2. R. Ramakrishnan and J. Gehrke, *Database Management Systems*, McGraw Hill, 3rd Ed., 2002.
3. V.S. Subramanian, Principles of Multimedia Data Base Systems, Hardcover – January 15, 1998
4. Silberschatz, H. Korth, S. Sudarshan, *Database System Concepts*, McGraw Hill, 6th Ed., 2010.
5. J. Date, *An Introduction to Database Systems*, Addison Wesley, 8th Ed., 2003.
6. Jiawei Han, MichelineKamber, Jian Pei, *Data Mining: Concepts and Techniques*, Morgan Kaufmann, 2nd Ed., 2005

CSC531 – Data Mining

Module 1

Introduction: Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Data Preprocessing: Needs Preprocessing the Data, Data Cleaning, Data Integration and Transformation, Data Reduction, Discretization and Concept Hierarchy Generation. Some Considerations in Multi-Source Data Fusion.

Module 2

Data Mining Primitives, Languages, and System Architectures: Data Mining Primitives, Data Mining Query Languages, Architectures of Data Mining Systems. 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 Association Rules in Large Databases: Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases, Dynamic Itemset Counting Algorithm, FP-Tree Growth Algorithm, Constraint-Based Association Mining. Handling large datasets in main memory, the limited pass algorithm, Counting frequent item sets in a stream.

Module 4

Classification and Prediction: Issues Regarding Classification and Prediction, Classification by Decision Tree Induction, Other Classification Methods, Prediction, Classifier Accuracy. Uncertain Knowledge Association Through Information Gain. Cluster Analysis Introduction: Types of Data in Cluster Analysis, A Categorization of Major Clustering Methods, Density-Based Methods, Clustering High-Dimensional data, Constraint-based cluster analysis, Outlier Analysis, Mining Complex Types of Data: Mining Time-Series and Sequence Data, Mining Text Databases, Mining the World Wide Web.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

References:

1. Jiawei Han, MichelineKamber, 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. Da Ruan, Guoqing Chen, Etienne E. Kerre, Geert Wets, *Intelligent Data Mining: Techniques and Applications* (Studies in Computational Intelligence), Springer, 1st Ed., 2010.
5. Masoud Mohammadian, *Intelligent Agents for Data Mining and Information Retrieval*, Idea Group Publishing, 2004.

CSC532 – 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.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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

CSC533 – 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

Principles of Message-passing, send and receive operations, message passing interface (MPI), examples of parallel algorithms: The Sieve of Eratosthenes, Matrix-Vector Multiplication, Document Classification, Matrix multiplication, sorting.

Module 4

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

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*

CSC534 – Mini Project

Students should undertake a mini project work to get an exposure in developing applications related to Intelligent Systems as the field of specialization. Each student will be allotted to an Internal Guide (Faculty Member) who will guide the students in the successful implementation of the mini project. A detailed project report should be submitted by each student at the end of the semester. Evaluation of the mini-project is fully internal based on demonstration, presentation and report.

CSC541 – Dissertation

Each student is required to carry out a project work under the supervision of a 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 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 bases 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 internal and external examiners based on the work done and the dissertation submitted.

CSC5001 – Natural Language Processing Dissertation

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 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

Lab Work
Everything taught in the class and its extended exercises must be implemented in the Lab using NLTK Toolkit and the same must be submitted for internal assessment during the lab hours.

Text Book:

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 Intelligence, 2008.

References:

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

CSC5002 – Digital Speech Processing

Module I

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 II

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 III

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 IV

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text Book:

1. Lawrence Rabiner, Biing-Hwang Juang, B Yegnanarayana, Fundamentals of Speech Recognition, Pearson, 2009.

References
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 I

Introduction and Overview of wireless sensor networks: Introduction and basic overview of wireless sensor network, Challenges and hurdles, Basic sensor network architectural elements, Wireless communications: Link quality, Shadowing and Fading effects. Applications of wireless sensor networks: Range of applications, Examples of category 1 WSN applications, Examples of category 2 WSN applications. Wireless sensor and Wireless transmission technology: Introduction, Sensor node technology, Sensor Taxonomy, WN Operating Environment, WN trends, Radio technology primer, Available wireless technologies.

Module II

Medium access control protocols for wireless sensor networks: Introduction, Fundamentals of MAC protocols, MAC protocol for WSNs, Sensor MAC case study, IEEE 802.15.4 LR-WPANs standard case study. Routing protocols for wireless sensor networks: 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. Transport control protocols for wireless sensor networks: Traditional transport control protocol, Transport protocol design issues, Examples of existing transport control protocols, Performance of transport control protocols.

Module III

Network management of wireless sensor networks: Introduction, Network management requirements, Traditional network management models, Network management design issues, Other issues: Naming, Localization. Sensor tasking and Control: Introduction, Task-Driven sensing, Roles of sensor nodes and utilities, Information-Based sensor tasking, Joint routing and information aggregation.

Module IV

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Objective of the course:
To provide practical, hands-on experience of NS-2 simulator.

Student learning outcomes / objectives:
At the closing of the course, the students will be able to understand how to implement various topologies, wireless and wired network.

Text books:
1. Kazem Sohraby, Daniel Minoli, Taieb F. Znati, Wireless Sensor Networks: technology, protocols and application, Wiley, 2007.
2. Feng Zhao and Leonidas Guibas, *Wireless Sensor Networks*, Morgan Kaufmann, San Francisco, 2004.

Reference books:
3. H. Karl, A. Willing, Protocols and Architectures for Wireless Sensor Networks, Wiley, 2005.
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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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. Other Biological Computing Methods - Immune System Algorithms - Cellular Automata - Lindenmeyer Systems - Artificial Neural Networks - Simulated Annealing

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text Books

1. Stephan Olariu and Albert Zomaya, *Hanbook of Bioinspired Algorithms and Applications*, Chapman and Hall, 2006
2. Marco Dorigo, Thomas Stutzle, *Ant Colony Optimization*, MIT Press, 2004.
3. Eric 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

Reference Books

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 University 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.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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.

Lab Work

This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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

quencing 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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text books:
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.

Reference Books:
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

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

Text Book:

1. Raj Kamal, *Embedded Systems*, Second Edition TMH, 2008

Reference:

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.

Lab Work
This course is basically a lab oriented course and everything taught in the class must be implemented in the Lab and the same must be submitted for internal assessment during the lab hours.

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

metric, 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.

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 I

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

Module II

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 III

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 IV

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.

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.

The Panel of External Examiners

Prof Dr. N. K Narayanan, Department of Information Technology Kannur University, Kerala. Mob: +91 9446955830 Email : nknarayanan@gmail.com	Prof Dr P S Hiremath Department of Computer Science KLE Technological University BVBCER, Hubli, Karnataka Mob: +91 9480226698 Email:
Prof Dr M R Kaimal Chairperson Department of Computer Science Amritha University Kollam Mob: +91 9895685055 Email :	Prof Dr. Achuthshankar S Nair Department of Computational Biology and Bioinformatics, University of Kerala, Thiruvananthapuram Phone: +91 4712308759 Email: sankar.achuth@gmail.com
Prof Dr. Sathidevi P. S Department of Electronics and Communication Engineering, National Institute Of Technology Calicut Mob: +91 495 2286704 Email: sathi@nitc.ac.in	Dr. N. Geethanjali Asosciate Professor Department of Computer Science & Technology Sri Krishna Devaraya University Anantapur Mob : +91 9440896370 Email : geethanajali.sku@gmail.com
Prof Dr. Suresha, Department of Studies in Computer Science, Manasagangotri, University of Mysore, Karnataka Mob: Email:	Prof Dr. Guru D. S, Department of Studies in Computer Science Manasagangotri, University of Mysore, Karnataka. Mob :+91 8212419557 Email:dsg@compsci.uni-mysore.ac.in
Prof Dr. Hemantha Kumar G. Department of Studies in Computer Science, Manasagangotri, University of Mysore, Karnataka Mob : +91 8212419300 Email :ghk.2007@yahoo.com	Dr Raju G, Associate Professor, Department of Information Technology, Kannur University, Kerala. Mob : +91 9446106628 Email :kurupgraju@gmail.com
Dr Babu Anto P Associate Professor, Department of Information Technology, Kannur University, Kerala. Mob: +91 9447405362 Email : batop@gmail.com	Prof Dr T Devi Departmnt of Computer Application Bharatiar University Coimbatur Mob: +91 979000435 Email :
Dr Rajkumar K K Associate Professor, Department of Information Technology, Kannur University, Kerala. Mob : +91 9847854885 Email : rajatholy@yahoo.com	Dr Arumugaperumal Associate Professor, Department of Computer Science St. Hindu College, Nagarkoil Mob : +91 9443402050 Email :
Dr. Nagendraswamy H. S,	Dr. Arun Kumar Thangavel

कंप्यूटर विज्ञान विभाग
केरल केंद्रीय विश्वविद्यालय
CENTRAL UNIVERSITY OF KERALA
कासरगोड / KASARAGOD
पेरिया / Periye - 671316
Department of Computer Science

Associate Professor, Department of Studies in Computer Science, Manasagangotri, University of Mysore, Karnataka Mob: +91 9480476830 Email: swamy_hsn@yahoo.com	Associate Professor, Department of Computer Science Vellur Institute of Technology
Dr. Mahendra Dhore Associate Professor, Department of Computer Science	Prof. Ananthanarayana V S Dept. of Information Technology, NITK, Surathkal Mob : +91 0824-2473550 Email : anvs@nitk.ac.in
Prof. G Ram Mohana Reddy Dept. of Information Technology NITK, Surathkal Mob : +91 0824-2473550 Email : profgrmreddy@nitk.ac.in	Dr. P Santhi Thilagam Associate Professor Dept. of Computer Science &Engg. NITK, Surathkal Mob: +91 0824-2473404 Email: santhi@nitk.ac.in
Prof C Narasimham Dept. of CSE Vignan Institute of Technology Visakhapatnam Mob: +91 9966656635 Email: Narasimham_c@yahoo.com	Dr. B. H. Shekar, Associate Professor, Department of Computer Science, Mangalore University, Mangalagangotri, Manglaore, Karnataka. Mob: +91 8242287670 Email: bhshekhar@yahoo.com
Dr.Manjunath Aradhya V. N, Associate Professor, Department of MCA, Sri Jayachamarajendra College of Engineering, Mysore, Karnataka, Mob: +91 9886896108 Email: aradhya.mysore@gmail.com	Dr. Harish B. S, Associate Professor, Department of Information Science and Engineering, Sri Jayachamarajendra College of Engineering, Mysore, Karnataka Mob: +91 9886779078 Email: bsharish@sjce.ac.in
Dr.Nagasundra K B, Associate Professor, Department of Computer Science and Engineering, SDM College of Engineering, Dharward, Karnataka.	Dr. Shashireka H L Associate Professor, Department of Computer Science, Mangalore University, Mangalagangotri, Manglaore, Karnataka.
Dr. Lalitha R, Associate Professor, Department of Studies in Computer Science, Manasagangotri, University of Mysore, Mysore, Karnataka. Dr P S Hermath	Dr. Murali S, Professor, Maharaja Institute of Technology, Mandya, Karnataka.

कंप्यूटर विज्ञान विभाग
केरल केंद्रीय विश्वविद्यालय
CENTRAL UNIVERSITY OF KERALA
कासरगोड / KASARAGOD
पेरिया / Periye - 671316
Department of Computer Science

Dr. Vasudev T, Professor, Maharaja Institute of Technology, Mandya, Karnataka.	Dr. Punitha P, Technical Manager, HCL Technologies, Bangalore, Karnataka.
Dr. Dinesh R, Manager, Amazon, Bangalore, Karnataka.	Dr. J Satheesh Kumar Coordinator Computer Centre Bharathiar University Coimbatur Mob: +91 9443968110 Email: jsathee@rediffmail.com