KANNUR UNIVERSITY

DEPARTMENT OF INFORMATION TECHNOLOGY
Choice Based Credit &Semester System (CBCSS)

M.Sc. Computer Science SYLLABUS

(Effective from Academic Year 2020-21)

CONTENTS

1. ABOUT THE DEPARTMENT

School of Information Science and Technology is one of the pioneer departments in the field of computer science and Information Technology started in the year 2000. The main objective of the department is to provide high quality education and research in different fields of Information Technology.

2. INTRODUCTION TO CHOICE BASED CREDIT SEMESTER SYSTEM (CBCSS)

The CBCSS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

2.1. DEFINITIONS:

(i) **Academic Programme** means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ Centre.

(ii) **Course** means a segment of a subject that is part of an Academic Programme.

(iii) **Programme Structure** means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission.

(iv) **Core Course** means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.

(v) **Elective Course** means an optional course to be selected by a student out of such courses offered in the same Department specified by the pool system

(vi) **Open Elective or** MOOC Course means an elective course which is available for students of all programmes including students of same department. Students of other Department will opt these courses subject to fulfilling of eligibility of criteria as laid down by the Department offering the course.

(vii) **Credit** means the value assigned to a course which indicates the level of instruction; One-

hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course.

(viii) **SGPA** means Semester Grade Point Average calculated for individual semester.

(ix) **CGPA** is Cumulative Grade Points Average calculated for all courses completed by the students in the last year of the course by clubbing together SGPA of four semesters.

2.2. PROGRAMME OBJECTIVES:

- The MSc Computer Science programme was introduced in 2000.
- It is a four-semester course which aims at imparting quality education in core Computer Science, so that the students are prepared to face the challenges of the highly competitive IT industry as well as carry out research and development.
- The objective of the programme is to impart sound knowledge of theory and hands on practical skills in various areas of Computer Science.
- The course structure includes a minor project in the third semester followed by a major project in the final semester which helps in development of research skills in the areas of their interest.

2.3. PROGRAMME OUTCOMES :

- **PSO1:** Unify the students to take up a career in the highly competitive IT industry with research and development skills acquired through minor and major projects.

- **PSO2:** Equip students with comprehensive knowledge and understanding of advanced theoretical fundamentals in computer science as well as contemporary key research issues in specialized areas of computer science.

- **PSO3:** Provide freedom to choose subjects of interest from the list of specialized courses and to allow the students to follow the career path they have dreamt of.

- **PSO4:** Attain knowledge in the advanced areas of computer science especially Algorithms Design, Artificial Intelligence, Signal Analysis, Data Science and Information Security.

3. M.SC.COMPUTER SCIENCE PROGRAMME DETAILS

The MSc. program is a two-year course divided into four-semesters. A student is required to complete 80 credits for the completion of course and the award of degree.

3.1 PROGRAMME STRUCTURE

	Semester	Semester
First Year	I	II
Second Year	III	VI

Semester	Theory	Practical
Semester I	5	Lab- 2
Semester II	5(1 elective)	Lab-2,Research Seminar
Semester III	5(2 elective)	Lab- 2, Mini Project
Semester IV	2(1 elective+ 1 open elective)	Major Project

COURSE CREDIT SCHEME:

(With effect from 2020 admission onwards)

Semester	Core	Elective	Open Elective	Practical	Project	Total
I	17	0	0	4	0	21
II	13	3	0	4	0	20
III	10	6	0	3	3	22
IV	0	3	4	0	10	17
Total	40	12	4	11	13	80

SEMESTER WISE DETAILS:

SEMESTER I						
Sl. No	Course Code	Course Title	Theory	Practical	Tutorial	Credits
1	MSCCS01C01	Discrete structure and Optimization	3	0	0	3
2	MSCCS01C02	Digital Signal Processing	3	0	0	3
3	MSCCS01C03	Principles of Programming and Numerical Methods	4	0	0	4
4	MSCCS01C04	Advanced Database Management System	4	0	0	4
5	MSCCS01C05	Digital Design and Computer Organizations	3	0	0	3
6	MSCCS01L01	Lab- I (Digital Signal Processing)	0	4	2	2
7	MSCCS01L02	Lab–II (Principles of Programming and Numerical Methods)	0	4	3	2
	Total Hour and credit distribution in Semester – I		**17**	**8**	**5**	**21**

SEMESTER II						
Sl. No	**Course Code**	**Course Title**	**Theory**	**Practical**	**Tutorial**	**Credits**
1	MSCCS02C06	Data Structure and Algorithms	3	0	0	3
2	MSCCS02C07	Theory of Computation	3	0	0	3
3	MSCCS02C08	Computer Graphics and Visualization	4	0	0	3
4	MSCCS02C09	System Software and Advanced Operating Systems	4	0	0	3
5	MSCCS02E01/ 02/03/04/05/06/ 07	Elective-I	3	0	0	3
6	MSCCS02C10	Research Seminar	0	0	3	1
7	MSCCS02L03	Lab –III (Advanced Data Structure and Algorithm)	0	4	1	2

	MSCCS02L04	Lab IV Data Modeling and Forecasting	0	4	1	2
	Total Hour and credit distribution in Semester –II		**17**	**8**	**5**	**20**

POOL A: List of Electives for Semester II (MSCCS02EXX)

Course code	Course Title	Theory	Practical	Tutorial
MSCCS02E01	Time Series Analysis and Forecasting	3	0	0
MSCCS02E02	Artificial Neural networks	3	0	0
MSCCS02E03	Modeling and Simulation	3	0	0
MSCCS02E04	Foundations in Data science	3	0	0
MSCCS02E05	Compiler Design	3	0	0
MSCCS02E06	Research methodology and Technical writing	3	0	0
MSCCS02E07	GPU Programming	3	0	0

SEMESTER III

Sl. No	Course Code	Course Title	Theory	Practical	Tutorial	Credits
1	MSCCS03C11	Digital Image Processing	3	0	0	3
2	MSCCS03C12	Data Communication and Network Administration	4	0	0	3
3	MSCCS03C13	Machine Learning	4	0	0	4
4	MSCCS03E08/ 09/10/11/12/13/ 14/15/16/17/18/ 19	Elective – II	3	0	0	3
5	MSCCS03E08/ 09/10/11/12/13/ 14/15/16/17/18/ 19	Elective – III	3	0	0	3
6	MSCCS03L05	Lab V i. Digital Image Processing ii. Machine Learning	0	4	4	3
7	MSCCS03P01	Mini Project	0	4	1	3
	Total Hour and credit distribution in Semester –II		**17**	**8**	**5**	**22**

POOL B: List of Electives for Semester III (MSCCS03EXX)				
Course code	Course Title	Theory	Practical	Tutorial
MSCCS03E08	Natural Language Processing	3	0	0
MSCCS03E09	Big Data Analytics	3	0	0
MSCCS03E10	Data Mining and Warehousing	3	0	0
MSCCS03E11	Block chain and Crypto currency technologies	3	0	0
MSCCS03E12	Pattern Recognition	3	0	0
MSCCS03E13	Digital Forensics	3	0	0
MSCCS03E14	Speech, Audio and Video forensics	3	0	0
MSCCS03E15	Mobile and Satellite Communication Networks	3	0	0
MSCCS03E16	Deep learning	3	0	0
MSCCS03E17	Artificial Intelligence	3	0	0
MSCCS03E18	Computer Vision	3	0	0
MSCCS03E19	Data and information visualization	3	0	0

SEMESTER IV

Sl. No	Course Code	Course Title	Theory	Practical	Tutorial	Credits
1	MSCCS04E 20/ 21/22/23/24/25/26/ 27/28/29/30/31/32/ 33/34/35/36/37/38	Elective- IV	3	0	0	3
2	MSCCS04P02	Main project & Viva	0	18	5	10
	Number of elective courses: 1					
3	Offered by other departments	**Open Elective courses** / MOOC Course	3	1	0	4
	Total Hour and credit distribution in Semester –IV		**6**	**19**	**5**	**17**

POOL C: List of Elective in Semester IV (MSCCS04EXX)				
Course code	Course Title	Theory	Practical	Tutorial
MSCCS04E20	Software Engineering	3	0	0
MSCCS04E21	Information Retrieval System	3	0	0
MSCCS04E22	Graph Theory and Combinatorics	3	0	0
MSCCS04E23	Embedded Systems	3	0	0
MSCCS04E24	Grid and Cloud Computing	3	0	0
MSCCS04E25	High Performance Computing	3	0	0
MSCCS04E26	Bio Informatics	3	0	0
MSCCS04E27	Geographical Information System (GIS)	3	0	0
MSCCS04E28	Internet of Things (IoT)	3	0	0
MSCCS04E29	Robotics	3	0	0
MSCCS04E30	Quantum Computing and Information	3	0	0

	Theory			
MSCCS04E31	Nature Inspired Computing	3	0	0
MSCCS04E32	Advanced Microprocessors and Microcontrollers	3	0	0
MSCCS04E33	Digital Speech Processing	3	0	0
MSCCS04E34	Information Storage and Management	3	0	0
MSCCS04E35	Fuzzy Sets and Systems	3	0	0
MSCCS04E36	Operations Research	3	0	0
MSCCS04E37	Design and Analysis of Algorithms	3	0	0
MSCCS04E38	Cyber Physical Systems	3	0	0

List of Open Electives

Course code	Course Title	Theory	Practical	Tutorial	Credits
MSCCS04O01	Principle of Programming and Numerical Methods	3	1	0	4
MSCCS04O02	Java Programming	3	1	0	4
MSCCS04O03	Machine Learning	3	1	0	4
MSCCS04O04	Foundations in Data science	3	1	0	4
MSCCS04O05	Digital Signal Processing	3	1	0	4
MSCCS04O06	Quantum Computing and Information Theory	3	1	0	4
MSCCS04O07	Design and Analysis of Algorithms	3	1	0	4

Selection of Elective Courses:

For selection of elective courses, a student may choose one course in semester II (Pool A) and two courses in semester III (Pool B) and IV(Pool C) from the lists of options being offered by the Department.

Open Elective Courses:

Students can join for the open course depending on their choice and availability of seats in the departments offering such courses. Open Elective Courses will be offered by other Departments/Centres/Institutions as options. Open Courses can be opted in any of the Semesters during the entire programme other than the first semester.

Teaching:

The faculty of the Department is primarily responsible for organizing lecture work of M.Sc.Computer Science. There shall be 90 instructional days excluding examinations in a semester.

3.2. ELIGIBILITY FOR ADMISSIONS:

A pass in BCA/ Bachelor Degree in Computer Science/ Mathematics/ Physics/ Statistics/ Chemistry/ Engineering or equivalent degree recognized by the Kannur University

RELAXATION & WEIGHTAGE:

Usual relaxation of marks or GPA shall be given to eligible categories as per the following rules.

1. SC/ST Category: minimum pass marks in the relevant subjects or part of subjects is required for admission to PG Degree program.
2. OBC Category: a relaxation of 5% of marks in the concerned subjects or part of subjects from the prescribed minimum is allowed.
3. OEC Category: a relaxation of 5% of marks in the qualifying examination from the prescribed minimum is allowed.

NUMBER OF SEATS -14

MODE OFSELECTION:

SELECTION will be based on Entrance examination conducted by the University. The Entrance examination will consist of questions from the following:

i. Mathematics: 50%

(Syllabus: Set Theory, Propositional Logic, Boolean Algebra, Linear Algebra, Coordinate Geometry and Conic Section, Trigonometry, Matrices, Vectors, Linear Programming, Differential Calculus, Series and Sequences, Real and Complex numbers, Polynomials, Permutations &Combinations and Elementary Probability Theory)

ii. Aptitude and Mental Ability: 50%

3.3. ASSESSMENT OF STUDENTS PERFORMANCE AND SCHEME OF EXAMINATIONS

ATTENDANCE

The minimum attendance required for each Course shall be 60% of the total number of classes conducted for that semester. Those who secure the minimum attendance in a semester alone will be allowed to register for the End Semester Examination. Condonation of attendance to a maximum of 10 days in a Semester subject to a maximum of two spells within a Programme will be granted by the Vice-Chancellor. Benefit of Condonation of attendance will be granted to the students on health grounds, for participating in University Union activities, meetings of the University Bodies and

participation in extra-curricular activities on production of genuine supporting documents with the recommendation of the Head of the Department concerned . A student who is not eligible for Condonation shall repeat the Course along with the subsequent batch.

EVALUATION

There shall be two modes of evaluation - the Continuous Evaluation (CE) and the End Semester Evaluation (ESE).The total mark for each course including the Project shall be divided into 40% for CE and 60% for ESE.

CONTINUOUS EVALUATION (CE): Continuous Evaluation (CE) of a course shall be based on periodic written tests, assignments, and Seminar / Viva-voce / Case studies in respect of theory courses and record and test/viva in respect of practical courses. The marks assigned to various components for CE for theory and practical is as follows:

Components of CE Theory

	Components	**Marks. Max (40)**
a	Test paper	16
b	Assignment	8
c	Seminar / viva –voce / Case studies / Practical assignments	16

Components of CE practical's

	Components	**Marks. Max (40)**
a	Record	10
b	Test/ Viva	30

Assignments: Each student shall be required to submit a minimum of two assignments for each course. The details such as number of assignments, mark distribution and Weightage for each assignment will be announced by the faculty in charge of the course at the beginning of the semester.

Tests: A minimum of two class tests will be conducted for each course. The details such as number of tests, mark distribution and Weightage for each test will be announced by the faculty in charge of the course at the beginning of the semester.

Seminar / Viva-voce / Case studies / practical assignments: The faculty in charge of the course shall design the evaluation pattern based on one or more of these components and will be announced

at the beginning of the semester.

Evaluation of Practical courses: The details regarding the CE as well as ESE for each practical course will be specified as part of the syllabus for the course. End-Semester Evaluation (ESE): The End-Semester Evaluation in

Evaluation of Research seminar

The research seminar allows students to work with leading researchers and experts and adjust their individual curricula, helps students refine their skills of research, text processing, searching scholarly information and presenting their work. Students also improve their understanding of study design, which includes defining the hypothesis, providing a rationale for it and selecting a line of argument. Students then write term papers to showcase and review the results obtained during research seminars

	Components	Marks.Max(50)
a	Report	16
b	Presentation and defense	24
c	Topic & content organization of presentation	10

Minor Group Project

Minor Project Objective: Before starting internship, the student will gain prerequisite knowledge of working in a industry or academic research. Mini projects should motivate the students to imagine and identify existing problems.

Outcome: Students should be able to discover existing research and technological challenges. They should be able to find research problems and do background studies which will help their futures Dissertation works in industry as well as academic.

Objectives

At the end of the course students should:
• Have a good understanding of how software is developed
• Have consolidated the theoretical understanding of software development. (By following SDLC life cycle)
• Appreciate the importance of planning and controlling a project, and of documentation and Presentation.
• Have gained confidence in their ability to develop significant software projects.

Evaluation of Minor Project

	Components	Marks. Max (50)
a	Report	10
b	Design and development	20
c	Implementation/ finding	10
d	Presentation and defense	10

Major Project:

Major project work shall be done individually by each student under the guidance of a faculty member from the department. An internal evaluation team consisting of at least three members, chaired by the Head of Department or a senior faculty member shall be constituted at the college every year by the end of fourth semester. The project guide of the candidate can be one of the members in the team. If the student chooses to do his project in an organization other than the university, the department shall ensure the following:

(i) The project is supervised by a qualified person. The External Supervisor shall be a post graduate in either Science/Applied Science/Engineering branches. He/She shall have at least 3 years experience in running/managing/implementing/supervising such projects. A declaration shall be obtained in this regard from that person, and shall be kept with the Department.

(ii) An attendance statement and a performance feedback shall be obtained from the External supervisor. The student has to present periodic reports and attend for evaluation process before the internal evaluation team at the university as per the schedule.

Evaluation of Major Project (CE)

	Components	Marks. Max (140)
a	Study Phase activities & Report/Literature survey	25
b	Design & Methodology	25
c	Implementation/ finding	25
d	Presentation and defense	25
e	Viva voce	40

End Semester Evaluation (ESE)

The ESE shall be made based on examinations for each course conducted by Controller of Examinations as per the common norms under the CCSS. The question paper for ESE for Theory Examinations shall contain three sections. The Question paper should contain minimum 3 questions from each unit and shouldn't contain more than 5 questions from the same unit.. The distribution of the no of questions and marks are given in the following table.

Part	Marks	Number of questions to be answered	Number of questions in the question paper	Type of questions (Level - Bloom's Taxonomy)
A	15	5	6	1 Remembering 2 Understanding
B	15	3	5	6. creating
C	30	3	5	3. Applying 4. Analysing 5. Evaluating
Total	60	11	16	

Major Project(ESE)

Major Project shall be evaluated at the examination centers by a panel of two examiners appointed by the university, one of which shall be from other university. The project report shall be finalized after the internal evaluation. The candidates shall present the findings/output of their work before the examiners during the examination hours. The examiners will conduct a viva voce also

	Components	Marks. Max (210)
a	Novelty of the Topic	20
b	Methodology and Content	30
c	Findings/Implementation	30
d	Report of the work	30
e	Presentation and defense	50
f	Viva voce	50

3.4 SPAN PERIOD

No students shall be admitted as a candidate for the examination for any of the Years/Semesters after the lapse

of 4 years from the date of admission to the first year of the M.A./M.Sc. programme.

3.5 CONVERSION OF MARKS INTO GRADES

An alphabetical Grading System shall be adopted for the assessment of a student's performance in a Course. The grade is based on a 6 point scale. The following table gives the range of marks %, grade points and alphabetical grade.

Range of Marks%	Grade Points	Alphabetical Grade
90-100	9	A+
80-89	8	A
70-79	7	B+
60-69	6	B
50-59	5	C
Below 50	0	F

A minimum of grade point 5 (Grade C) is needed for the successful completion of a course. A student who has failed in a course can reappear for the end semester examination of the same course along with the next batch without taking re-admission or choose another course in the subsequent semesters of the same programme to acquire the minimum credits needed for the completion of the programme. There shall not be provision for improvement of CE and ESE.

3.6 GRADE POINT AVERAGE (GPA)

Performance of a student at the end of each Semester is indicated by the Grade Point Average (GPA) and is calculated by taking the weighted average of grade points of the Courses successfully completed. Following formula is used for the calculation. The average will be rounded off to two decimal places.

$$CGPA = \frac{\text{Sum of (grade points in a course multiplied by its credit)}}{\text{Sum of Credits of Courses}}$$

3.7 CGPA CALCULATION

At the end of the Programme, the overall performance of a student is indicated by the Cumulative Grade Point Average (CGPA) and is calculated using the same formula given above. Empirical formula for calculating the percentage of marks will be **(CGPA x 10)+5.** Based on the CGPA overall letter grade of the student and classification shall be in the following way.

CGPA	Overall Letter Grade	Classification

8.5 and above	A+	First Class with Distinction
7.5 and above but less than 8.5	A	
6.5 and above but less than 7.5	B+	First Class
5.5 and above but less than 6.5	B	
5 and above but less than 5.5	C	Second Class

Appearance for Continuous Evaluation (CE) and End Semester Evaluation (ESE) are compulsory and no Grade shall be awarded to a candidate if he/she is absent for CE/ESE or both.
A student who fails to complete the programme/semester can repeat the full programme/ semester once, if the department council permits to do so.

Grievance Redressal Mechanism

Committees will be constituted at the Department and University levels to look into the written complaints regarding continuous Evaluation (CE). Department Level Committee (DLC) will consist of the Department Council and a student nominee of the Department Students' Union from the concerned faculty. 8.2 University Level Committee (ULC) will consist of the Pro-Vice-Chancellor (Chairman and Convener), the Convener of the Curriculum Committee (vice-chairman), the Head of the Department concerned and a nominee of the Students' Union. Department Level Committee will be presided over by the HOD and the University Level Committee by the Pro-Vice Chancellor. Department Level Committee will have initial jurisdiction over complaints against CE and University Level Committee will hear appeals against Department level decisions. Complaints will have to be submitted to the Department concerned within two weeks of publication of results of CE and disposed of within two weeks of receipt of complaint. Appeals to university Level Committee should be made within one month of the decision taken by the Department level committee and disposed within two months of the receipt of the complaint. 8.3 Complaints unsolved by the University Level Grievance committee shall be placed before the Vice Chancellor

SCHEME OF END SEMESTER EXAMINATIONS:

SEMESTER –I

Sl.No	Course Code	Title of the Course	Credits	Duration of Exam	Max. Marks
1	MSCCS01C01	Discrete structure and Optimization	3	3hrs	60
2	MSCCS01C02	Digital Signal Processing	3	3hrs	60
3	MSCCS01C03	Principles of Programming and Numerical Methods	4	3hrs	60
4	MSCCS01C04	Advanced Database Management System	4	3hrs	60
5	MSCCS01C05	Digital Design and Computer Organizations	3	3hrs	60
6	MSCCS01L01	Lab- I (Digital Signal Processing)	2	3hrs	60
7	MSCCS01L02	Lab–II(Principles of Programming and Numerical Methods)	2	3hrs	60

SEMESTER –II

Sl.No	Course Code	Title of the Course	Credits	Duration of Exam	Max. Marks
1	MSCCS02C06	Data Structures and Algorithms	3	3hrs	60
2	MSCCS02C07	Theory of Computation	3	3hrs	60
3	MSCCS02C08	Computer Graphics and Visualizations	4	3hrs	60
4	MSCCS02C09	System Software and Advanced Operating Systems	4	3hrs	60
5	MSCCS02E01	Elective-I	3	3hrs	60
6	MSCCS02C10	Research seminar	1		50
7	MSCCS02L03	Lab –III (Advanced Data Structure and Algorithm)	2	3hrs	60
8	MSCCS02L04	Lab –III (Data modeling and forecasting)	2	3hrs	60

SEMESTER –III

Sl.No	Course Code	Title of the Course	Credits	Duration of Exam	Max. Marks
1	MSCCS03C11	Digital Image Processing	3	3hrs	60
2	MSCCS03C12	Data Communication and Network Administration	3	3hrs	60
3	MSCCS03C13	Machine Learning	4	3hrs	60
4	MSCCS03E08 /09/10/11/12/13/ 14/15/16/17/18/19	Elective – II	3	3hrs	60
5	MSCCS03E08 /09/10/11/12/13/14 /15/16/17/18/19	Elective – III	3	3hrs	60
6	MSCCS03L05	Lab V iii. Digital Image Processing . ii. Machine Learning	2	3hrs	60
7	MSCCS03P01	Mini Project	2		50

SEMESTER –IV

Sl.No	Course Code	Title of the Course	Credits	Duration of Exam	Max. Marks
1	MSCCS04E 20/ 21/22/23/24/25/26/ 27/28/29/30/31/32/ 33/34/35/36/37/38	Elective- IV	3	3hrs	60
2	MSCCS04P02	Main project & Viva	10		350
3	Offered by other departments	Open Elective Course/MOOC Course	4	3hrs	60

4. COURSE WISE CONTENT DETAILS FOR M.SC. COMPUTER SCIENCE

4.1 THE DETAILED SYLLABUS-CORE COURSES

Objective of these courses are to impart the theoretical framework of different core areas of computer science to students.

SEMESTER-I

MSCCS01C01 DISCRETE STRUCTURES AND OPTIMIZATION

Contact Hours/ week: 4

Credit: 3

Course Learning Outcomes:	CO1:Accomplish knowledge in the fundamental mathematical concepts and terminology for Computer Science . CO2: Acquire knowledge in Mathematical Logic. CO3: Gain knowledge in Boolean algebra. CO4: Acquire knowledge in set Theory, Relations and functions. CO5: Awareness about basics of mathematical induction and counting principles. CO6: Awareness of fundamentals of probability CO7: Gain knowledge in graph theory and Group Theory CO8: Awareness about the importance of Optimization in Computer Science

Unit 1

Mathematical logic: Propositional and Predicate Logic, Propositional Equivalences, Normal Forms, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference. Boolean Algebra: Boolean Functions and its Representation, Simplifications of Boolean Functions. Set and relations: Set Operations, Representation and Properties of Relations

Unit 2

Functions and Relations: Functions – Types of Functions, Composition of Functions and Inverse Functions. Relations - Relations and Their Properties, Functions as relations, Closure of Relations, Composition of relations, Equivalence Relations and Partitions. Partial Ordering, Hasse Diagram. Mathematical Induction .Recurrence Relation ,Generating function. Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Inclusion- Exclusion Principle. Probability :Continuous and Discrete Probability: Bayes' Theorem.

Unit 3

Group Theory: Groups, Subgroups, Semi Groups, Product and Quotients of Algebraic Structures, Isomorphism, Homomorphism, Automorphism, Rings, Integral Domains, Fields, Applications of Group Theory. Graph Theory- Basic concepts- Introduction, Directed Graph, Undirected Graph, Connected and Disconnected Graphs, Bipartite Graph, Complete Bipartite Graph, Isomorphic Graphs, Subgraph. Paths and Circuits.Minimum Spanning Trees.Shortest Paths in Weighted Graphs- Dijkstra's Algorithm. All pair shortest path- Floyd Warshall algorithm. Eulerian Paths and Circuits, Hamiltonian Paths and Circuits.Storage representation and manipulation of graphs.

Unit 4

Optimization: Linear Programming - Mathematical Model, Graphical Solution, Simplex and Dual Simplex Method, Sensitive Analysis; Integer Programming, Transportation and Assignment Models, PERT-CPM: Diagram Representation, Critical Path Calculations, Resource Leveling, Cost Consideration in Project Scheduling.

Reference Books:

1. Discreate Mathematics and Its Applications with Combinatorics and Graph Theory, Kamala Krithivasan, McGraw Hill Education, 2011 (Seventh Edition).
2. Kenneth H. Rosen, Discrete Mathematics and Applications, TMH 2003
3. J.P.Tremblay and R Manohar, Discrete Mathematical Structures with Applications to Computer Science, TMH 2001
4. Discreate Mathematics, N Ch S N Iyengar, V M Chandrasekharan, KA Venkatesh, PS Arunachalam, Vikas Publishing, 2003.

MSCCS01C02DIGITAL SIGNAL PROCESSING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	CO1:To study the modern digital signal processing algorithms and applications. CO2: To study the analysis of discrete time signals. CO3: Comprehensive knowledge to use of digital systems in real time applications CO4. Apply the algorithms for wide area of recent applications.

Unit 1

Signals and Signal Processing - Characterization and classification of Signals, Typical signal processing operations, Typical Signal Processing Applications, Advantage of Digital Signal Processing.

Unit 2

Classification of signals –Introduction to vector space - The concept of frequency in continuous and discrete time signals -Sampling of analog signals – Sampling theorem – Quantization and Coding – Digital to analog conversion .

Unit 3

Time Domain Representation of signals and systems - Discrete time signals, Operations on sequences, Discrete time Systems, Linear Time invariant Discrete Time Systems-convolution sum – correlation of discrete time signals , Z-Transform.

Unit 4

Frequency Analysis of Signals - Frequency Analysis of Continuous Time Signals, Frequency Analysis of Discrete Time Signals, Fourier Transform of discrete time signals –Discrete Fourier Transform (DFT). FFT(Qualitative idea only)-Wavelet Transform - FIR and IIR Filters

Reference Books:

1.Proakis, John G. and Dimitris G. Manolakis. *Digital signal processing: principles algorithms and applications*. Pearson Education India, 2001.
2.Roberts, Michael J. *Signals and systems: analysis using transform methods and MATLAB*. McGraw-Hill Higher Education, 2011.
3. Oppenheim, Alan V., and Ronald W. Schafer. Digital Signal Processing [by] Alan V. Oppenheim [and] Ronald W. Schafer.Prentice-Hall, 1975.
4. Antoniou, Andreas. *Digital signal processing*.McGraw-Hill, 2016.
5. Rabiner, Lawrence R., Bernard Gold, and C. K. Yuen. *Theory and application of digital signal processing*. Prentice-Hall, 2007.

MSCCS01C03 PRINCIPLES OF PROGRAMMING AND NUMERICAL METHODS

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1:** Acquainted with Numerical Methods. **CO2:** Obtain the knowledge about Errors and Approximations. **CO3:** Ripen skill in programming **CO4:** Understanding the basic concepts of Python programming.

Unit 1

Introduction to Programming: Basic concepts, algorithm, flow chart, programming languages – classification.Syntax and semantics of programming languages- Imperative and OO Languages-Functional Languages-Logic Programming Languages.

Features of Python, Different Methods to Run Python, Basic Elements (Objects, Expressions, Numerical Types, Strings, Variables), Comments, Indentation in Python, Input and Output in Python,

import function, Operators in Python, Branching (if, else, elif), Iteration (while, for), range and enumerate functions, Tuples, Lists, Sets, Dictionaries, Built-in methods of lists, sets and dictionaries, Mutable and Immutable Objects.

Unit 2

Functions Definition, Function Calling, Function Arguments (Required, Keyword, Default), Recursion, Modules, Built-in Modules, Creating Modules, File Handling (Opening, Closing, Writing, Reading), Exceptions, Built-in Exceptions (IndexError, OverflowError, ZeroDivisionError, RuntimeError), Exception Handling. Class Definition, Object Creation, Built-in Attribute Methods, Object Oriented Programming Features of Python. Arrays in Python, Numpy Module, ndarray, Creating Arrays (array, zeros, ones, empty, linspace, arrange, random), Two-Dimensional Array, Indexing, Slicing, Iterating, Copying, Splitting, Shape Manipulation (reshape, transpose, resize), Arithmetic Operations on Arrays. Data Visualization in Python matplotlib Module, pyplot, plot(), scatter, bar charts, Formatting, figure(), subplot(), text(), xlabel(), ylabel(), title(), Plotting Simple Mathematical Functions (sin x, x^2).

Unit 3

Introduction to Numerical Methods: Nature of numerical problems; computer based solutions. Errors and Approximations.Nonlinear equations – Bisection Method, Regular- Falsie Method, Newton-Raphson.System of Linear Equations- Gauss elimination, Gauss Jordan elimination, Triangulation method, Iterative method, Jacobi.Case study by writing algorithms.

Unit 4

Numerical Integration and Differentiation: Concept of differentiation and Integration. Taylors series and Eulers methods-Simpson's Romberg, Gaussian, Runge- Kutta methods. Case study by writing algorithms.

Reference Books:

1. Discrete Mathematical Structures with Application to Computer Science-McGraw Hill
2. Introductory Methods of Numerical Analysis – January 2012 PHI bySastry S.S
3. Balagurusamy, E., "Numerical Methods", Tata McGraw-Hill, New Delhi, 1999.
4. R.G.Dromey , How to solve it by computer, Pearson education, fifth edition, 2007.
5. Taming Python By Programming, Dr. Jeeva Jose, Khanna Publishing
6. Introduction to Computation and Programming Using Python with Application to Understanding Data - John V. Guttag, PHI (2016)
7. https://www.numpy.org/devdocs/user/quickstart.html
8. https://matplotlib.org/users/pyplot_tutorial.html

MSCCS01C04ADVANCED DATABASE MANAGMENT SYSTEM

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1**:Understand database concepts and structures and query language **CO2**:Understand the E R model and relational model **CO3:**To design and build a simple database system and demonstrate competence with the **CO4: F**undamental tasks involved with modeling, designing, and implementing a DBMS. **CO5:**Understand Functional Dependency and Functional Decomposition. **CO6:**Apply various Normalization techniques **CO7:**Perform PL/SQL programming using concept of Cursor Management, Error Handling, Package and Triggers **CO8:**Execute various advance SQL queries related to Transaction Processing & Locking using **CO9:**concept of Concurrency control.

Unit 1

Introduction: Database System Applications, Database Systems versus File Systems, View of Data, Data Models, Schemas, DDL, DML, Data Dictionary, Data Integration, Database Access Method, Database System Structure, Application Architectures, Advantages of Using a DBMS. The Relational model: Data modeling using Entity Relationship (ER), ER Diagram, Entity sets, attributes and keys, Relationships, Relationship types, Weak Entity. Types, Specialization and generalization. Relational model concepts, Relational model constraints.

Unit 2

Database Design: Functional dependencies. Basic definitions, Functional dependencies. First, Second, Third and Fourth Normal Forms, Boyce Codd normal form, Basics of SQL, DDL, DML, DCL, structure – creation, alteration, defining constraints – Primary key, foreign key, unique, not null, check, IN operator, aggregate functions.

Unit 3

SQL: Built-in functions – numeric, date, string functions, set operations, sub-queries, correlated sub-queries, join, Exist, Any, All, joined relations. Integrity and security: domain constraints, referential integrity, assertion, triggers, authorization in SQL. Views: Introduction to views, data independence, security, updates on views, comparison between tables and views.

Unit 4

Emerging database technologies and applications: Mobile databases, Multimedia databases,Geographic Information Systems. Basics of NoSql Database: BASE transactions and eventual consistency- Properties of NOSQL databases.Key-Value data-stores – Column Stores-Document data-stores - Architecture of Dynamo DB, Big Table, HBase, Cassandra and Mongo DB, Graph Database.

Reference Books:

1. Silbersehatz, Korth and Sudarshan, Database system concepts, 6th edition MGH 2011
2. Ramakrishnan and Gehrke, Database Management Systems, 3rd Edn, McGraw Hill, 2003
3. A Leon & M Leon, Database Management Systems , Leon Vikas – 2003.
4. Elmasri and Navathe, Fundementals of Database systems, 5thEdition ,Pearson 2009
5. O'Reilly, Practical PostgreSQLShroffPublishers(SPD) 2002
6. C J Date, An Introduction to Database systems, Pearson, 2004.
7. Cornell, Morris, Mob, Database Systems, Cenage, Learning, 2013
8. M. Gruber, Understanding SQL, Sybex.
9.Nosql - https://class.coursera.org/datasci-001/lecture/preview
10. Ian Robinson, Jim Webber, Emil Eifrem, Graph databases- , O'Reilly, 2013.
11. Manoj V, comparative study of NOSQL Document, Column store databases and evaluation of Cassandra, International Journal of Database Management Systems (IJDMS) Vol.6, No.4, August 2014.
12.NoSQL For Dummies By Adam Fowler, John Wiley and sons Inc., 2015
13. An Introduction to XML and Web Technologies, Anders Moller, Michael Schwartzbach, Pearson,2006.

MSCCS01C05 DIGITAL DESIGN AND COMPUTER ORGANIZATIONS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**:To understand the basics of computer hardware and how software interacts with computer hardware **CO2**:Toanalyze and evaluate computer performance **CO3**: To deal with different types of computers **CO4**: To understand how computers represent and manipulate data **CO5**: To understand computer arithmetic and convert between different number systems **CO6**: To identify high performance architecture design **CO7**: To develop independent learning skills and be able to learn more about different computer architectures and hardware.

Unit 1

Number systems and arithmetic operations, Different Binary codes, Gates, Boolean algebra & Laws, Combinational Circuits: Sum of product, Product of sum, simplification by Boolean methods, K-Map Simplification- up to six variables. Tabular method. Decoders, Multiplexer, De-multiplexer, Encoder, Binary Adders, Subtractors, Magnitude comparator, ROM, PLA, PAL

Unit 2

Logic families: General Characteristics, RTL, DTL, TTL, I2L, ECL, NMOS, PMOS, CMOS, CMOS, Transmission Gate Circuits. DAC and ADC. Sequential circuits: Flip-flops, Analysis of Clocked Sequential Circuits, State Reduction and assignments, FF excitation tables, Design procedure Registers: shift registers, SISO, SIPO, PISO, PIPO, Universal Shift Registers

Unit 3

Counters: Ripple Counters, Synchronous counters, Ring counter, Shift Counter, Up-down counters. Basic structure: Basic operational concepts, Instruction set Architecture: Memory locations and addresses, memory operations, instructions and instruction sequencing, addressing modes, RISC vs. CISC, Interrupts, Memory system.

Unit 4

I/O organization: Bus, Interface circuits, interconnection standards (USB, PCI, Firewire, SCSI, SATA). Basic Processing Unit: Fundamental concepts, Instruction execution, Hardwired control, micro programmed control –Pipelining: basic concepts, pipeline organization- Parallel processing: Parallel processing: Hardware multithreading, Vector processing, Shared memory multiprocessors.

Text Books:

1. M. Moris Mano, Digital Design – PHI 2001
2. Hamacher, Vranesic, Zaky, Manjikian, Computer Organization and Embedded Systems, 6thedn,Tata McGraw Hill.

Reference Books:

1. M. Moris Mano, Digital Design – PHI 20012.Ronald J. Tocci, Neal S. Widmer and GrigoryL.Moss, Digital Systems- Principles and applications, Pearson, 2009.
3. John . M. Yarbrough , Digital Logic Applications and Design ,Thomson -2002 .
4. Malvino A P and Leach D P, Digital Principles and applications, Tata Mc-Graw Hill,1991
5. William Stallings, Computer Organization & Architecture – Designing for Performance, 9th Edn,Pearson.
6. John P. Hayes, Computer Architecture and Organization, Third Edn, Tata McGraw Hill.
7. M. Morris Mano, Computer System Architecture, PHI 2003

SEMESTER II

MSCCS02C06 DATA STRUCTURES AND ALGORITHMS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Knowledge about important computational problems. **CO2:** Knowledge to design the algorithm. **CO3:** Knowledge to analyze a given algorithm. **CO4:** Acquire knowledge to analyze algorithm control structures and solving recurrences. **CO5:** Understand the concept of data structures and its relevance in computer science. **CO6:** Familiarize with selected linear and nonlinear data structures.

Unit 1

Introduction to algorithm design: Definition, characteristics, Steps in developing algorithm, methods of specifying an algorithm, important problem types: Combinatorial problems, Geometric problems, Graph problems, Numerical problems, Searching, Sorting and String processing. Basic technique for design of efficient algorithm: Brute Force approach, Divide-and-Conquer approach, Branch-and-Bound technique. Greedy approach, Dynamic programming, Backtracking.

Unit 2

Algorithm analysis: Importance of algorithm analysis, time and space complexity. Growth of functions: asymptotic notations, cost estimation based on key operations- Big Oh, Big Omega, Little Oh, Little Omega and Theta notations. Analyzing algorithm control structures, Solving recurrences: Iteration method, Substitution method, Recursion Tree method, Master's Theorem, problem solving using Master's Theorem case 1, case 2 and case 3. Case study:Analysis of Strassen's algorithm for matrix multiplication, Analysis of Merge sort. Complexity Classes: P, NP, NP Hard and NP Complete problems.

Unit 3

Data structures: Definition and classification. Linear data structure: Array- operations, polynomial representation with arrays; concept of recursion, types of recursion. Case study with Tower of Hanoiproblem. Stack: operations on stack. Application of stack i. postfix expression evaluation. ii. conversion of infix to postfix expression. Queues: operation on queue. Circular queue, dequeue and priority queue. Application of queue: job scheduling. Linked list: single linked list, structure and implementation; operations – traversing, add new node, delete node, reverse a list, search and merge two singly linked lists. Circular linked list– advantage. Queue as circular linked list. Doubly linked list, operations – add/delete nodes, advantages.

Unit 4

Non- linear data structure: Tree- basic terminologies and properties; representation of binary tree, operations on binary tree; type of binary tree, forest, B tree, B+ tree and Trie. Tree traversal: in order, pre order and post order traversals. Binary search tree.Application of tree, AVL tree, Huffmanalgorithm. Representations and operations of sets: Hash table, linked lists, tree and bit

vector. Sorting Techniques: Insertion sort, Bubble sort, Selection sort, Quick sort and Merge sort. Comparison of sorting algorithms. Searching: basic terminologies, linear search: linear search with array, linear search linked lists. Non- linear search techniques, binary search, binary tree searching.

REFERENCE BOOKS:

1. Thomas H Cormen, Charles E Leiserson, and Ronald L Rivest, Introduction to Algorithms, 3rd Edition, Prentice Hall of India Private Limited, New Delhi.
2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Design and Analysis of Computer Algorithms, Addison Wesley.
3. Pallaw, V K, Design and Analysis of Algorithms, Asian Books Private Ltd, 2012.
4. Pandey H M, Design and Analysis of Algorithms, University Science Press, 2013
5. OdedGoldreich, P,NP and NP- Completeness, Cambridge University Press, 2011.
6. Donald Knuth, The Art of Computer Programming, Fundamental Algorithms, Volume- 1
7. Samanta, Classic Data structures, Second Edition, PHI
8. Sahni and Mehta, Fundamentals of Data Structures in C++, 2nd Edn, University Press
9. Sahni, Rajasekaran, Fundamentals of Algorithms, 2ndEdn, University Press
10. M. A. Weis, Data Structures and Algorithm Analysis in C++, Pearson Edu. Asia, 2013
11. Anany Leviton, Introduction to the Design and Analysis of Algorithms, 3rd Edition, Pearson Education.

MSCCS02C07 THEORY OF COMPUTATION

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Acquire knowledge about the fundamental concepts Theoretical Computer Science **CO2:** Understand the concept of Finite Automata, Nondeterministic Finite Automata and Pushdown Automata. **CO3:** Advance knowledge about Regular Languages and Context Free Grammar **CO4:** Attain knowledge about Turning Machine

Unit 1

Introduction to the Theory of computation and Finite Automata: Mathematical preliminaries and notation, Proof techniques, Three basic concepts: languages, grammar & automata. Some applications.Finite automata: Deterministic Finite Acceptors, Nondeterministic Finite Acceptors, Equivalence of deterministic and nondeterministic finite acceptors, Reduction of the number of states in finite automata.

Unit 2

Regular Languages and Regular grammars: Regular expressions, connection between regular

expressions and regular languages , regular grammars. Properties of Regular Languages: closure properties of regular languages, identifying non regular Language

Unit 3

Context-free grammars &languagesContext-free grammars, parsing and ambiguity.Simplification of Context free Grammars and Normal forms : methods of transforming grammars two important normal forms. Pushdown automata for context-free languagesNon deterministic pushdown automata, PDA and context-free languages, deterministic pushdown automata and deterministic context-free languages.Properties of Context-Free Languages: pumping lemmas for context free languages and linear languages, closure properties for context-free languages.

Unit 4

Turing machine: Standard Turing machine, combining Turing machines for complicated tasks, Turing's thesis. Other models of Turing machine: Minor variations on the Turing machine theme, Turing machine with complex storage, nondeterministic Turing machine, a universal Turing machine, Linear bounded automata. Limits of Algorithmic computation: Problems that cannot be solved by Turing machines, Undecidable Problems for Recursively enumerable Languages, The Post Correspondence problem.

Text Book:

1. An introduction to Formal Languages and Automata, Peter Linz, 4thedn, Narosa publishing House.

Reference Books

1. John C Martin, Introduction to Languages and the Theory of Automata, McGraw Hill 1997
2. Mishra &Chandrasekharan, Theory of Computer Science : Automata, Languages andComputation, 3rd edn, PHI
3. Hopcroft, Motwani and Ullman, Introduction to automata theory, Languages and Computation, 3rdEdn,., Pearson

MSCCS02C08 COMPUTER GRAPHICS AND VISUALIZATION

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1**:Understanding the concepts of Graphics Input Output devices **CO2**:Analysis of algorithms such as line drawing, circle drawing **CO3**:Understanding 2D&3D transformations and projection **CO4:**Understanding fundamentals of visualization

Unit 1

Basic concepts in Computer Graphics – Types of Graphic Devices – Interactive Graphic inputs – Raster Scan and Random Scan Displays.Line Drawing Algorithm- DDA, Bresenham's algorithm – Circle Generation Algorithms –Mid point circle algorithm, Bresenham's algorithm- Scan Conversion-frame buffers – solid area scan conversion – polygon filling algorithms.

Unit 2

Two dimensional transformations.Homogeneous coordinate systems – matrix formulation and concatenation of transformations. Windowing concepts –Window to Viewport Transformation- Two dimensional clipping-Line clipping – Cohen Sutherland,Polygon clipping-Sutherland Hodgeman algorithm, Three dimensional object representation, Polygon surfaces, Quadric surfaces – Basic 3D transformations.

Unit 3

Three-dimensional viewing : Overview of 3D viewing concepts, 3D viewing pipeline, 3D viewing coordinate parameters, Transformation from world to viewing coordinates, Projection transformations, orthogonal projections (axonometric and isometric, orthogonal projection coordinates, clippingwindow and orthogonal projection view volume, Normalization transformation), Oblique parallel projections (Cavalier and cabinet projections, Clipping window and Oblique parallel-projection view volume, Oblique parallel projection transformation matrix, normalization transformation), Perspective projections (transformation coordinates, perspective-projection equations, vanishing points, view volume, transformation matrix, symmetric and oblique perspective-projection frustum, Normalized perspective-projection transformation coordinates), 3D clipping algorithms (region codes, point and line clipping, polygon clipping)

Unit 4

3D Object representation: Quadric surfaces, superquadrics, spline representations.
Visible surface detection methods : Classification, Back-face detection, depth-Buffer method, Abuffer method. Wireframe visibility methods.Illumination models and surface rendering methods :Light sources, Surface lighting effects, Basic illumination models (Ambient light, Diffuse reflection, Specular reflection and the Phong model), polygon rendering methods (constant intensity surface rendering, Gouraud surface rendering, Phong surface rendering), Ray tracing methods – basic Ray-tracing algorithm.

Text Books:

1. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996
2. E. Gose, R. Johnsonbaugh and S. Jost., Pattern Recognition and Image Analysis, PHI PTR, 1996 (Module VI – Image Processing part)
3. William M. Newman and Robert F. Sproull , Principles of Interactive Computer Graphics. McGraw Hill, 2e, 1979
4. Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGraw Hill, 1986.

References:

1. David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill, 2001.
2. M. Sonka, V. Hlavac, and R. Boyle, Image Processing, Analysis, and Machine Vision, Thomson India Edition, 2007.
3. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing. Pearson, 2017.

MSCCS02C09 SYSTEM SOFTWARE AND ADVANCED OPERATING SYSTEMS

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1:** Students will get an idea of different system software. **CO2:** Provide a thorough understanding of the internals of Compiler Design. **CO3**: Students are able to understand phases of compilation. **CO4**: Compare the various algorithms and comment about performance of various algorithms used for management of memory, CPU scheduling, File handling and I/O operations. **CO5:** Apply various concept related with Deadlock to solve problems related with Resources allocation, after checking system in Safe state or not. **CO6:**To appreciate role of Process synchronization towards increasing throughput of system

Unit 1

System programming – Assemblers, linkers, loaders and compiler (basic ideas).
Introduction to compilers: Different Phases. Lexical Analysis: role of the lexical analyzer, inputbuffering, specification of tokens, Recognition of tokens. Syntax Analysis: role of the parser Context free grammar, writing a grammar, Top down parsing, Recursive descent parsing, Predictive parsing. Bottom Up Parsing, Shift Reduce parsing, Operator precedence parsing, LR parsers (SLR, Canonical and LALR).

Unit 2

Syntax-directed translation – Syntax-directed definitions: S-attributed definition, L-attributed definition. Top-down and bottom-up translation, Type checking. Run time Environment: source language issues, storage organization - Storage organization Schemes, Activation records. Storage allocation strategies (basic concepts only), Parameter Passing mechanisms, Symbol

tables.Intermediate code generation, intermediate languages, declaration and assignment statements.

Unit 3

Run time storage management, Runtime storage allocation, basic blocks and flow graphs. Code optimization: Principal sources of optimization.Distributed Operating Systems- Motivation, types of network-based operating system, distributed systems robustness, design issues. Distributed File System- Naming and transparency, remote file access, stateful v/s stateless services, file replication.

Unit 4

Distributed Synchronization—event ordering, mutual exclusion, atomicity, concurrency control, Deadlock handling, election algorithms, reaching agreement. Real Time Systems- Characteristics, features of real time kernels, implementation, real time CPU scheduling. Features of real time Linux.

Text Books:

1. Silberschatz, A., Galvin, P.B. & Gagne, G. “Operating System Concepts”, 8th Ed. Wiley- India.
2. D.M. Dhamdhere, "Systems Programming and Operating Systems", TMH, 2003.
3. 2. A.V. Aho, R. Semi, J.D. Ullman, "Compilers - Principles, techniques and tools", Pearson Education, 2003

References Books:

1. Dhamdhere, D. M. “Operating Systems”, 2nd Ed. The McGraw - Hill Companies.
2. Kochan, S, G., Wood, P., “Unix shell programming”, 3rd ed. Pearson Education, 2003
3. Ditel, Deital and Choffness, Operating Systems, Pearson, 3rdEdn
4. A.V. Aho and J.D. Ullman, " Principles of Compiler Design", Narosa, 2002
5. Kenneth.C.Louden, Compiler Construction: Principles And Practice, Thomson Learning, India
6. Dave and Dave, Compilers – principles and practice, pearson, 2012
7. Appel, Modern Compiler Implementation in C, Cambridge, 2012

SEMESTER III

MSCCS03C11 DIGITAL IMAGE PROCESSING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**: Students will be able to apply various image processing techniques for real time applications

Unit 1

Steps in Digital image Processing, Elements of Visual perception, Image Sensing and Acquisition, Image sampling and quantization, Basic pixel relationships, Basic Intensity Transformation functions – Negatives, Log transforms, Power law transformations, Piecewise Linear Transformation functions.

Unit 2

Histogram processing, Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters.Filtering in the Frequency domain: DFT of one and two variables, Properties of 2-D DFT, Basics of filtering in the Frequency domain. Image smoothing filters (Ideal Lowpass, Gaussian Low pass), Image sharpening filters (ideal High pass, Gaussian High pass, Laplacian in the Frequency domain. Selective filtering – Notch filters.

Unit 3

Image restoration and reconstruction: Model, noise models, restoration in the presence of noiseonly – spatial filtering, Periodic noise reduction by frequency domain filtering. Linear, Position – invariant degradation. Color models – RGB and HIS. – Basics of color image processing.

Unit 4

Image compression: Fundamentals, Compression methods (Huffman, Arithmetic coding, LZWCoding, run Length coding, Wavelet coding). Digital watermarking.Morphological Image Processing: Erosion and dilation, opening and closing, Hit-or-miss transformation, Morphological algorithms (Boundary extraction, Thinning, thickening, skeletons,pruning). Image segmentation: Fundamentals, Point and line and edge detection, Thresholding, Region-based thresholding.

Reference Books:

1. Rafael C ,Gonzalez,., and Richard E. Woods. "*Digital image processing [M].*"Pearson Fourth Edition 2018
2. Anil K. Jain, *Fundamentals of Digital image Processing*, Prentice Hall, US Ed., 1989.
3. William K. Pratt, Digital Image Processing: PIKS Scientific Inside, Wiley Interscience, 4th Ed., 2007.

4. Bernd Jahne, *Digital Image Processing*, Springer, 6th Ed., 1997.
5. Sonka, Hlavac, Boyle, *Digital Image Processing and Compurter Vision*, Cengage, 2008

MSCCS03C12 DATA COMMUNICATION AND NETWORK ADMINISTRATION

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO 1:** Understand the basics of Computer Network **CO2:** Familiarize with OSI reference model **CO3:** To study basic Linux commands and understand the file system structure **CO4:** To learn different system services, maintenance and configuring **CO5:** Understand the concepts of Inter Process Communication **CO6:** Comprehend the concepts of Network Configuration

Unit 1

Introduction, Basic concepts- Line configuration, Topology, Transmission mode, Categories of networks, Internetworks, Transmission media - Twisted pair Cable, Coaxial Cable, Optical Fiber, Satellite Communication, Cellular Telephony, Terrestrial Microwave, OSI and TCP/IP models, Functions of Physical Layer, Data link layer, Network layer, Transport Layer, Session Layer, Presentation Layer and Application Layer.

Unit2

Introduction: Important parts of kernel; Major services in a UNIX system: init, login from terminals, syslog, periodic command execution crown and at; Boot process: The LILO boot process: LILO parameters, /etc/lilo.conf; The GRUB boot process; The /boot directory and files; initrd file and mkinitrd; Run levels: /etc/inittab, start-up script /etc/rc.d/rc.sysinit; System Configuration: The /etc/sysconfig/… files,kernel modules; kernel daemon; /etc/conf. modules and module parameters; /lib/modules/… directory structure and contents. File system configuration: file system types, /etc/fstabloyout and meaning; Basic user environment: /etc/skel/… and home directories, Window manager configuration file locations; System Security: Host security: tcp_wrappers and /etc/hosts.allow and /etc/hosts. deny, /etc/security, shadow password, ile permissions, users groups and umask; Adding and deleting users; System maintenance: Syslogd, klogd and /etc/syslog.conf; Using a remote syslog; The system crontab, dailyscript, tmpwatch and logrotate; Using and managing the system log files; Basic system backup and restore operations; Emergency rescue operations.

Unit 3

Inter Process Communication programming : Create a process- fork() system call, Parent and Child Process, Process ID, User and Group ID Half Duplex Unix Pipes, Named Pipes, (First In First Out), Streams and messages, System V IPC :Message Queues, Semaphores, Shared memory, Sample programs for IPC that uses Pipes, FIFO; Socket Programming: Overview, socket address, Elementary Socket System Calls: socket, socket pair, bind, connect, listen, accept, send, sendto, recv,

recvfrom, close, Byte ordering routines, Byte Operations, Address conversion routines, Simple client Programs that uses some reserved ports, Simple Client / Server Program using unreserved ports.

Unit4

TCP / IP Network Configuration: Introduction to TCP / IP network, Protocols, IP address, Hostname, Configuring a Host : setting the host name, assigning IP address, broad cast, net mask and name server address, Editing Host and network files, Interface Configuration: loop back interface, Ethernet interface, The SLIP and PPP interface, Configuring Gateway, Routing through gateway, Network commands: ifconfig, netstat, route. Network applications Configuration: File Transfer Protocol (FTP) and Trivial File Transfer Protocol (TFTP), Network File Systems (NFS), Network Information System(NIS),Hyper Text Transfer Protocol (HTTP) and Web server, Server Message Block (SMB) Protocol and Samba server, Dynamic Host configuration Protocol (DHCP) Firewalls, Remote booting. Domain Name Services (DNS) and Mail services: working of DNS, Host name Resolution Name lookup with DNS, Reverse Lookup, Domain Name Servers and Zones, DNS database: SOA, NS, MX, A and PTR records, Secondary and primary DNS, Zone change notification, root servers, internet root domains, configuring DNS, Using nslookup. Simple Mail Transfer Protocol (SMTP), Post office Protocol(POP) Multipurpose Internet Mail Extension (MIME), SMTP and POP3 command, Mail routing, Configuring A mail server.

Reference Books: -

1. Data Communications and networking, Fourth Edition by Behrouz A. Forouzan, McGraw Hill 2017.
2. Computer Networks, Fourth Edition by Andrew S. Tanenbaum, Prentice-Hall 2003
3. Data and computer communication, Eighth Edition by William Stallings, Prentice-Hall 2007
4.EviNemeth , et al, Linux Administration Hand Book , PHI 2003
5. Nicholas Wells, Linux Installation and Administration, Thomson Vikas 2000.
6. Olaf Kirch& Terry Dawson, Linux Network Administrators Guide, O'relly, 2003
7. Hunt, Linux DNS server Administration, BPB Publication, 2003
8. W Richard Stevens, Unix Network Programming, PHI, 2002

MSCCS03C13 MACHINE LEARNING

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1:** Appreciate machine learning approach to Artificial Intelligence, and understand fundamental issues and challenges of supervised and unsupervised learning techniques. **CO2:** Design and implement supervised and unsupervised machine learning algorithms for real-world applications, while understanding the strengths and weaknesses. **CO3:** Appreciate the underlying mathematical relationships within and across Machine Learning algorithms. **CO4:** Attain knowledge in machine learning algorithms.

Unit-1

Introduction: Learning theory.Basics: Introduction to Machine Learning - Different Forms of Learning, Basics of Probability Theory, Linear Algebra and Optimization. Regression Analysis: Linear Regression, Ridge Regression, Lasso, Bayesian Regression, Regression with Basis Functions

Unit-2

Supervised learning: Linear separability and decision regions, Linear discriminants, Bayes optimal classifier, Linear regression, Standard and stochastic gradient descent, Lasso and Ridge Regression, Logistic regression, Support Vector Machines, Artificial Neural Networks ,Perceptron, Back propagation, , Decision Tree Induction, Overfitting, Pruning of decision trees, Bagging and Boosting, Dimensionality reduction and Feature selection. Support VectorMachines:Structural and empirical risk, Learning nonlinear hypothesis using kernel functions.

Unit-3

Unsupervised learning: Clustering, Mixture models, Expectation Maximization, Spectral Clustering, Non-parametric density estimation. Dimensionality Reduction: Principal Component Analysis, Independent Component Analysis, Multidimensional Scaling, and Manifold Learning. Reinforcement Learning: Q-Learning, Temporal Difference Learning

Unit-4

Introduction to Deep Networks:Fundamentals of deep learning, Deep Feedforward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Introduction to Convolutional Networks, Sequence Modelling using Recurrent Nets, overview of LSTM, fundamentals of Generative adversarial Network.

Reference Books:

1. E. Alpaydin, Introduction to Machine Learning, 3rd Edition, Prentice Hall of India, 2014.
2. T Hastie, R Tibshirani and J Friedman, The Elements of Statistical Learning Data Mining, Inference, and Prediction, 2nd Edition, Springer, 2009.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2010.
4. R. O. Duda, P. E. Hart, and D.G. Stork, Pattern Classification, John Wiley and Sons, 2012.
5. Simon O. Haykin, Neural Networks and Learning Machines, Pearson Education, 2016
6. Machine Learning. Tom Mitchell.

Additional Textbooks:

Pattern Classification.R.O.Duda, P.E. Hart and D.G. Stork.
Data Mining: Tools and Techniques. Jiawei Han and MichellineKamber.
Elements of Statistical Learning.Hastie, Tibshirani and Friedman.Springer.

4.1 THE DETAILED SYLLABUS-CORE COURSES

POOL A

MSCCS02E01 TIME SERIES ANALYSIS AND FORECASTING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:**Compute and interpret a correlogram and a sample spectrum **CO2:**Derive the properties of ARIMA and state-space models **CO3:**Choose an appropriate ARIMA model for a given set of data and fit the model using an appropriate package **CO4:**Compute forecasts for a variety of linear methods and models

Unit-1

Characteristics of Time Series:The Nature of Time Series Data -Time Series Statistical Models - Measures of Dependence - Stationary Time Series - Estimation of Correlation – Vector Valued and Multidimensional Series.

Unit-2

Time Series Regression and Exploratory Data Analysis - Classical Regression in the Time Series Context - Exploratory Data Analysis - Smoothing in the Time Series Context

Unit-3

ARIMA Models **:**Autoregressive Moving Average Models - Difference Equations- Autocorrelation and Partial Autocorrelation- Forecasting- Estimation -.Integrated Models for Non-stationary Data Building ARIMA Models - Regression with Auto-correlated Errors - Multiplicative Seasonal ARIMA Models .

Unit-4

Non Linear time series analysis-Some basic concepts- linearity vs nonlinearity –Examples of non linear time series- Nonlinearity tests- Non parametric and parametric tests.

Reference books:

1. R. H. Shumway and D. S. Sto_er (2017), Time Series Analysis and Its Applications (With R Examples, fourth Edition).Springer, New York.
2. Non linear time series analysis .Ruey S. Tsay and Ronngchen. Wiley 2019
2. Enders W. *Applied Econometric Time Series*. John Wiley & Sons, Inc., 1995.
2. Mills, T.C. *The Econometric Modelling of Financial Time Series*. Cambridge University Press, 1999
3. Andrew C. Harvey. *Time Series Models.Harvesterwheatsheaf*, 1993.

4. Andrew C. Harvey. *The Econometric Analysis of Time Series*. Philip Allan, 1990.

MSCCS02E02 ARTIFICIAL NEURAL NETWORKS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** describe the role of neural networks in engineering, artificial intelligence, and cognitive modeling. **CO2:** design single and multi-layer feed-forward neural networks for practical applications, **CO3:** analyse performance of neural networks and tune various hyper-parameters.

Unit-1

Introduction: Neuron as basic unit of neurobiology, perceptron as a model of learning, perceptron convergence theorem, batch perceptron learning algorithm, relation between perceptron and Bayesian learner for a Gaussian environment; linear regression model, maximum a posteriori (MAP) estimation of the parameter vector, least mean squares algorithm.

Unit-2

Multilayer Perceptrons:Back-propagation algorithm, batch learning and online learning, adaptive control of learning rate; estimating regularization parameter: Tikhonov's regularization theory, complexity regularization, and network pruning.

Unit-3

Kernel Methods and Support Vector Machines:Separability of patterns, interpolation problem, radial basis function (RBF) networks, support vector machines.

Unit-4

Introduction to Hopefield networks, Boltzmann machines, restricted Boltzmann machines.

Readings:

1. Simon O. Haykin, Neural Networks and Learning Machines, Pearson Education, 2016
2. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2010.
3. C. Bishop, Neural Networks and Machine Learning, Springer, 1998.

MSCCS02E03 MODELING AND SIMULATION

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** acquire basic understanding of systems, models and simulation and familiarity with Modeling and simulation tools**.** **CO2:** perform parameter estimation and test goodness of fit in a model**.** **CO3:** check system's stability, observability and controllability**.** **CO4:** apply statistical methods in modeling and simulation**.** **CO5:** apply modeling and simulation to real world problems**.**

Unit-1

Systems, Models and Simulation study: Natural and Artificial Systems, Complex Systems, Definition and types of model, Mathematical models, Cyber-physical systems and its modeling, Network models, Steps in simulation study, Advantage and disadvantage of simulation**.**

Unit-2

Random Numbers: True and pseudo random numbers, Properties of random numbers, Generation of pseudo random numbers, Tests for randomness, Random variate generation using inverse transformation, Direct transformation, Convolution method and Acceptance-rejection method**.**

Unit-3

Design and Analysis of simulation experiments: Data collection, Identifying distributions with data, Parameter estimation, Goodness of fit tests, Selecting input models without data, Multivariate and time series input models, Verification and validation of models, Steady-state simulation, Terminating simulation, Confidence interval estimation, Output analysis for steady state simulation, Stochastic simulation**.**

Unit-4

Control Systems: Laplace transform, Transfer functions, State- space models, Order of systems, z-transform, Feedback systems, Stability, Observability, Controllability. Statistical Models in Simulation: Common discrete and continuous distributions, Poisson process, Markov chain, Empirical distributions, Queuing systems, Transient and steady-state behavior, performance, Network of queues**.** Modeling and Simulation tools: Open Modelica, Netlogo, Python modules for modeling and simulation, GPSS**.**

Reference Books:

1. Ross, S., Simulation, 5th Edition, Academic Press, 2012.

2. Frank L. Severance, System ModelingAnd Simulation: An Introduction, Wiley, 2001.

3. Jerry Banks, John S. Carson II, Barry L. Nelson, Devid M. Nicol, P. Shahabudeen: Discrete-Event system simulation, 5th Edition, 2009.

4. Geoffrey Gordon: System Simulation, 2nd Edition, 2002.

5. A.M. Law and W.D. Kelton: Simulation and Modeling and analysis, 5th Edition, 2015.

MSCCS02E04 FOUNDATION IN DATA SCIENCE

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Demonstrate proficiency with statistical analysis of data. **CO2:** Develop the ability to build and assess data-based models. **CO3:** Execute statistical analyses and interpret outcomes. **CO4:** Apply data science concepts and methods to solve problems in real-world contexts and will communicate these solutions effectively.

Unit-1

Introduction: Introduction data acquisition, data preprocessing techniques including data cleaning, selection, integration, transformation and reduction, data mining, interpretation.

Unit-2

Statistical data modeling:Review of basic probability theory and distributions, correlation coefficient, linear regression, statistical inference, exploratory data analysis and visualization.

Unit-3

Predictive modeling: Introduction to predictive modeling , decision tree, nearest neighbor classifier and naïve Baye's classifier, classification performance evaluation and model selection.

Unit-4

Descriptive Modeling: Introduction to clustering, partitional, hierarchical, and density-based clustering (k-means, agglomerative, and DBSCAN), outlier detection, clustering performance evaluation. Association Rule Mining: Introduction to frequent pattern mining and association rule mining, Apriori algorithm, measures for evaluating the association patterns. Text Mining: Introduction of the vector space model for document representation, term frequency-inverse document frequency (tf-idf) approach for term weighting, proximity measures for document comparison, document clustering and text classification**.**

Reference Books:

1. W. McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy and iPython, 2nd Ed., O'Reilly, 2017.

2. P. Tan, M. Steinbach, AKarpatne, and V. Kumar, Introduction to Data Mining, 2nd Ed., Pearson Education, 2018.

3. G James, D Witten, T Hastie and R TibshiraniAn Introduction to Statistical Learning with Applications in R, Springer Texts in Statistics, Springer, 2013.
4. G. Grolemund, H. Wickham, R for Data Science, 1st Ed., O'Reilly, 2017.

MSCCS02E05 COMPILER DESIGN

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** describe how different phases of a compiler work. **CO2:** implement top down and bottom up parsing algorithms. **CO3**: use compiler tools like lex and yacc for implementing syntax directed translator.

Unit-1

Lexical Analysis: Review of regular languages and finite automata, design of a lexical analyzer generator, context-free grammars.

Unit-2

Syntax Analysis: Review of context free grammar, top-down parsing: recursive descent and predictive parsing, LL(k) parsing; bottom-up parsing: LR parsing, handling ambiguous in bottom-up parsers.

Unit-3

Syntax directed translation: Top down and bottom up approaches, data types, mixed mode expression; subscripted variables, sequencing statement, subroutines and functions: parameters calling, subroutines with side effects.

Unit-4

Code generation: Machine code generation, machine dependent and machine independent optimization techniques.

Reference Books:

1. Alfred V. Aho, Ravi Sethi, D. Jeffrey Ulman, Monica S. Lam, Principles, Techniques and Tools,

Pearson Education India, 2nd edition,,

2. A.V. Aho, M. S. Lam, R. Sethi and J. D. Ullman, Compilers, Pearson, 2016.

3.Moder Dick Grune, Kees van Reeuwijk, Henri E. Bal, Ceriel J.H. Jacobs, Springer, 2016.

MSCCS02E06 RESEARCH METHODOLOGY AND TECHNICAL WRITING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	• The aim of the course is to provide participants with an introduction to research methods and report writing. • Upon successful completion of the course you are expected to **CO1:** Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling. • **CO2:** Have basic knowledge on qualitative research techniques • **CO3:** Have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis • **CO4:** Have basic awareness of data analysis-and hypothesis testing procedures

Unit-1

Research Methodology**:** Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research.

Unit-2

Research Design: Reading and Reviewing-Research literature, Finding Research Papers, Critical Reading, Developing a literature Review, Guidelines for Research Skills and Awareness, Validity of Research, Reliability in Research. Meaning of Research Design, Need for Research Design, Features of good design, Different Research Designs.

Unit-3

Data Collection and Analysis**:** Introduction, Need for Data Collection**,** Methods ofData Collection, Principles for Accessing Research Data, Data Processing, Data Analysis, Presentation of Data, Error Analysis, Scientific Models. Scientific Methodology - Introduction Rules and Principles of Scientific Method, Hypothesis,Testing of Hypothesis, Basic concepts, Procedure,Important parametric tests: z-test ,t-test, χ2-square test, F test.

Unit-4

Reporting and thesis writing: Presentation of algorithms, Environment of Algorithms, Asymptotic Cost. Graphs. Technical Reports- Structuring General format, Report-Bibliography referencing and footnotes.Research in Practice- Literature Review, Journals, Conference Proceedings, journal Impact Factor, citation Index, h Index .Application of Computer in Research --MS office and its application in Research, Use of Internet in Research – Websites, search Engines, E-journal and E-Library.

Reference Books:

1. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.Publishers(Second revised edition)
2. Justin Zobel,Writing For Computer Science, Springer (Third Edition)
3. K Prathapan,Research Methodology for Scientific Writing ,I.K International Publishing House Pvt.Ltd
4. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
5. S.P Satarkar, S.V., 2000. Intellectual Property Rights and Copy right.Ess Publications.

MSCCS02E07 GPU PROGRAMMING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Describe GPU architecture and parallel programming models. **CO2:** Implement fundamental GPU Algorithms – reduce, scan, and histogram. **CO3:** Analyze, and figure out portion of programs being parallelizable. **CO4:** Optimize GPU programs.

Unit-1:

Introduction: Introduction to heterogeneous computing, overview of CUDA C/Python, and kernel-based parallel programming.

Unit-2:

Performance Issues: Memory model for locality, tiling for conserving memory bandwidth, handling boundary conditions, and performance considerations, simple matrix-matrix multiplication in CUDA environment.

Unit-3:

Introduction to OpenCL:operations such as vector addition using streams.

Unit-4:

Applications:Parallel convolution pattern, parallel scan pattern, parallel histogram pattern and atomic operations, data transfer and task parallelism.

Readings:

1. Shane Cook, CUDA Programming: A Developer's Guide to Parallel Computing with GPUs, Elsevier; 2014.
2. Norman Matloff, Parallel Computing for Data Science: With Examples in R, C++ and CUDA, Chapman & Hall/CRC, 2015.

POOL B

MSCCS03E08 NATURAL LANGUAGE PROCESSING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**:appreciate the fundamental concepts of Natural Language Processing. **CO2:**design algorithms for NLP tasks. **CO3**:develop useful systems for language processing and related tasks involving text processing

Unit-1

Introduction to Language: Linguistic Knowledge, Grammar, Language and Thought, computational linguistics vs NLP, why NLP is hard, why NLP is useful, classical problems. Words of Language, Content Words and Function Words, Lexical categories, Regular expressions and automata. Morphology: Morphemes, Rules of Word Formation, Morphological parsing and Finite state transducers.

Unit- 2

N-grams: simple N-grams, Applications, language modelling. Word classes and POS taggi tag sets, techniques: rule based, stochastic and transformation based. Introduction to Natı Language Understanding- Levels of language analysis- Syntax, Semantics, Pragmatics.

Unit -3

Grammars and Parsing- Grammars for Natural Language: CFG, Probabilistic Context Free Grammar, Parsing methods-top down and bottom up parsing and Efficient Parsing, statistical parsing, Ambiguity Resolution- Statistical Methods. Features and Unification: Feature structures and Unification of feature structures. Lexical semantics, formal semantics and discourse, WSD.

Unit4

Knowledge Representation and Reasoning- FOPC, Elements of FOPC. Discourse processing: monologue, dialogue, reference resolution. Text coherence. Dialogue acts: Interpretation of dialogue acts, plan inference model, clue-based model. Semantics: Representing meaning, Semantic analysis. Applications: Natural Language Generation: surface realization and discourse planning. Machine translation

Text books:

1. Jurafsky and Martin, Speech and Language Processing, Pearson, 2013

Reference Books:

2. Allen, James, Natural Language Understanding, Second Edition, Benjamin/Cumming, 1995

3. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.
4. Manning, Christopher and Heinrich, Schutze, Foundations of Statistical Natural Language Processing, MIT Press
5. Kao, Natural Language Processing and Text Mining, Springer

MSCCS03E09 BIG DATA ANALYTICS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Acquire knowledge about the importance of Big Data. **CO2:** Information about Stream Data Model in Big Data **CO3:** Achieve the knowledge about the Big Data Analytics. **CO4:** Make awareness about Hadoop Distributed File System

Unit 1

Introduction to Big Data Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting - Modern Data Analytic Tools -Statistical Concepts: Sampling Distributions - Re-Sampling - Statistical Inference - Prediction Error.

Unit 2

Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP)Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.

Unit 3

The Hadoop Distributed File System – Components of Hadoop- Analyzing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFSBasics-Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map ReduceJob run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types andFormats- Map Reduce Features. Setting up a Hadoop Cluster - Cluster specification - Cluster Setup and Installation – Hadoop Configuration-Security in Hadoop - Administering Hadoop – HDFS - Monitoring-Maintenance- Hadoop benchmarks- Hadoopin the cloud.

Unit 4

Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - IBM InfoSphereBigInsights and Streams. Visualizations - Visual data analysis techniques, interaction techniques;Systems and applications

Reference Books:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Tom White, Hadoop: The Definitive Guide, 3rdEdn, O'reily Media, 2012.
3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, Understanding BigData:Analytics for Enterprise Class Hadoop and Streaming Data, McGrawHill Pub, 2012
4. AnandRajaraman& Jeffrey D Ullman, Mining of Massive Datasets, Cambridge University Pres,2012.
5. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & sons, 2012.
6. Glen J. Myyat, Making Sense of Data, John Wiley & Sons, 2007
7. Pete Warden, Big Data Glossary, O'Reily, 2011 .
8. Han, Kamber, Data Mining Concepts and Techniques, 3rdEdn, Morgan Kauffman, 2012.
9. Da Ruan, Guoquing Chen, Etienne E.Kere, Geert Wets, Intelligent Data Mining, Springer,2007
10. Paul Zikopoulos ,DirkdeRos , Krishnan Parasuraman , Thomas Deutsch , James Giles , DavidCorigan , Harness the Power of Big Data The IBM Big Data Platform, Tata McGraw Hill Pub,2012
11. Michael Mineli, Michele Chambers, AmbigaDhiraj, Big Data, BigAnalytics: Emerging BusinessIntelligence and Analytic Trends for Today's Business,WileyPublications,2013
12. Zikopoulos, Paul, Chris Eaton, Understanding Big Data: Analytics for Enterprise Class Hadoopand Streaming Data, Tata McGraw Hill Pub, 2011

MSCCS03E10 DATA MINING AND WAREHOUSING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**: Acquire knowledge about the importance of Data Warehousing. **CO2:**Understanding the importance of Data Mining **CO3:** Attain knowledge about Clustering techniques **CO4:** Understand the applications of Decision Trees

Unit -1:

Introduction; data warehousing – what is, Multidimensional data model, OLAP operations, warehouse schema, Data warehousing Architecture, warehouse server, Metadata, OLAP engine, data

warehouse Backend Process.

Unit- 2:

Data mining – what is, KDD vs data mining, DBMS vs data mining, DM Techniques, issues and challenges, Applications. Association rules – What is, Methods, a priori algorithm, partition algorithm, Pincer- search algorithm, FP-tree growth algorithm, incremental and Border algorithms, Generalized Associationrule.

Unit -3:

Clustering techniques – Paradigms, Partitioning Algorithms, k – Medoid algorithms, CLARA, CLARANS, hierarchical clustering, DBSCAN, Categorical Clustering, STIRR.

Unit -4:

Decision trees – what is, tree construction principles, Best split, Splitting indices, Splitting criteria, decision tree construction algorithms, CART, ID3, C4.5, CHAID. Introduction to web, spatial and temporal datamining.

Reference Books:

1. Data Mining Techniques, A K Pujari, University press.

2. J.Han,M.Kamber,"DataMiningConceptsandTechniques",HarcourtIndiaPvtLtd.

3. M. Dunham, " Data Mining : introductory and Advanced Topics", PearsonPub.

MSCCS03E11 BLOCKCHAIN AND CRYPTOCURRENCY TECHNOLOGIES

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:**To Understand and apply the fundamentals of Cryptography in Crypto currency **CO2:**To gain knowledge about various operations associated with the life cycle of Block chain and Crypto currency **CO3:** To deal with the methods for verification and validation of Bitcoin transactions **CO4:** To demonstrate the general ecosystem of several Cryptocurrency **CO5:** To educate the principles, practices and policies associated Bitcoin business

Unit:1

Introduction to Cryptography and Cryptocurrencies:Foundations of Cryptography and security: Ciphers and secret messages, security attacks and services. Mathematical tools for cryptography: substitution techniques, modular arithmetic, Euclid's algorithm, finite fields, polynomial arithmetic. Design Principles of Block Ciphers: Theory of Block Cipher Design, Feistel cipher network

structure, DES and Triple DES, modes of operation (ECB, CBC, OFB, CFB), strength of DES.

Unit:2

Blockchain Achieves:Decentralization-Centralization vs. Decentralization-Distributed consensus, Consensus with- out identity using a blockchain, Incentives and proof of work. Simple Local Storage, Hot and Cold Storage, Splitting and Sharing Keys, Online Wallets and Exchanges, Payment Services,
Transaction Fees, Currency Exchange Markets.

Unit:3

Mechanics of Bitcoin**:** Bitcoin transactions, Bitcoin Scripts, Applications of Bitcoin scripts, Bitcoin blocks, The Bit- coin network, Limitations and improvements. BitcoinMining :The task of Bitcoin miners, Mining Hardware, Energy consumption and ecology, Mining pools, Mining incentives and strategies. Bitcoin and Anonymity: Anonymity Basics, How to De-anonymizeBitcoin, Mixing, Decentralized Mixing, Zerocoin and Zerocash.

Unit:4

Community, Politics, and Regulation:Consensus in Bitcoin, Bitcoin Core Software, Stakeholders: Who‟s in Charge, Roots of Bitcoin, Governments Notice on Bitcoin, Anti Money Laundering Regulation, New York‟s Bit License Proposal. Bitcoin as a Platform: Bitcoin as an Append only Log, Bitcoins as Smart Property, Secure Multi Party Lotteries in Bitcoin, Bitcoin as Public Randomness, Source-Prediction, Markets, and Real World Data Feeds.

Text Book(s)

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., and Goldfeder, S. (2016). Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press.
2. William Stallings, *Cryptography and Network Security*, Pearson 2004.

Reference Books:

1. Antonopoulos, A. M. (2014). Mastering Bitcoin: unlocking digital cryptocurrencies.OReilly Media, Inc.”.
2. Franco, P. (2014). Understanding Bitcoin: Cryptography, engineering and economics. John Wiley and Sons.

MSCCS03E12 PATTERN RECOGNITION

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1 :**Introduces the fundamental pattern recognition and machine learning theories. **CO2 :**Make the students able to design systems and algorithms for pattern recognition with focus on• sequences of patterns that are analyzed and analyze classification problems probabilistically and estimate classifier performance. **CO3 :**Also helps to understand and analyze methods for automatic training of classification systems.

Unit 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.

Unit 2

Min-max and Neymann-Pearson classifiers, Discrminant functions, Decision surfaces.Maximum likelihood estimation and Bayesian parameter estimation. Overview of Nonparametric density estimation- Histogram based approach, classification using Parzen window.

Unit 3

K-nearest neighbor estimation and classification.Classification of clustering algorithm- hierarchical clustering- agglomerative clustering.Partitional clustering- Forgy's algorithm. K-means clustering.

Unit 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. Neural network structures for Pattern Recognition – Neural network based Pattern associators – Unsupervised learning in neural Pattern Recognition – Self-organizing networks – Fuzzy logic – Fuzzy pattern classifiers

Reference Books:

1.Duda R.O., and Har P.E., Pattern Classification and Scene Analysis, Wiley, New York, 1973.
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:AMatlab approach, Academics Press 2010.

MSCCS03E13 DIGITAL FORENSICS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:**Infer the role of a Computer forensics profession for investigation. **CO2:** Summarize the requirements for use of data acquisition. **CO3:** Identify the need of Process crime and Incident scenes for digital evidence. **CO4:** Choose suitable data Recover techniques in windows environment. **CO5:** Analyze various validation techniques of forensics data. **CO6:** Experiment with current computer forensics hardware and software tools for E-mail investigation and mobile device forensics. **CO7:** Prioritize the challenges associated with real time forensics applications/tools.

Unit-1

Computer Forensics and Investigation:Understanding computer forensics, Preparing for Computer Investigations, Corporate High Tech Investigation. Data Acquisition and Recovery .Storage formats, Using acquisition tools, Data Recovery: RAID Data acquisition.

Unit-2

Processing Crime and Incident Scene:Identifying and collecting evidence, Preparation for search, Seizing and Storing Digital evidence. Computer Forensics tools (Encase) and Windows OperatingSystem. Understanding file structure and file system, NTFS disks, Disk Encryption and Registry. Manipulation.Computer Forensics software and hardware tools.

Unit-3

Computer Forensics Analysis and Validation:Data collection and analysis, validation of forensics data, Addressing – data hiding technique. Email Investigation and Mobile device Forensics-Investigation e-mail crimes and Violations, Using specialized E-mail forensics tools. Understanding mobile device forensics and Acquisition procedures.

Unit-4

Role of Digital Forensics in Real time applications - SANS SIFT Investigative tool, PRO Discover Basic, Voltality, Sleuth Kit, CAINE investigative environment. Industry Trends**.**

Text Book(s):

1. Bill Nelson, Amelia Philips, Christopher Steuart, Guide to Computer Forensics and Investigations, Fourth Edition, Cengage Learning, 2016.

Reference Books:

1. David Lilburn Watson, Andrew Jones, Digital Forensics Processing and Procedures, Syngress, 2013.
2. Cory Altheide, Harlan Carvey, Digital Forensics with Open Source Tools, British Library Cataloguing-in-Publication Data, 2011
3. Greg Gogolin,Digital Forensics Explained,CRC Press, 2013.

MSCCS03E14 SPEECH, AUDIO AND VIDEO FORENSICS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1 :** Recognize the significance of speech,audio&video forensics and its applications **CO2 :** List various methods for modeling of speech, audio& video forensics .

Unit - 1

Physics of sound: waves and sound, analysis and synthesis of complex waves, Human and non-human utterances, anatomy of vocal tract, vocal formants, analysis of vocal sound, frequencies and overtones . Electronics of Audio Recording, Transmission and Playback devices, noise and distortion, voice storage and preservation

Unit –2

Forensic Linguistics: Phonetics, Morphology, Syntax, Semantics, Stylistics, Pragmatics, Script, orthography and graphology, Difference between language and speech, Psycholinguistics, Neurolinguistics, Sociolinguistics, Scientific approaches; Reliability and admissibility of evidence in the court, linguistic profile, language register Discourse Analysis: Connivance, acceptance, listening

feedback and rejection in the context of Mens-Rea, Narrative, Dialectology, Linguistic variety as a geographical marker, Idiolects and speaker characterization, Phonology, Morphology and Word formation processes as individual linguistic abilities.

Unit - 3

Various approaches in Forensic Speaker Identification, Instrumental Analysis of speech sample, Interpretation of result, Statistical interpretation of probability scale, Objective/Subjective methods, discriminating tests, closed test, open test, likelihood ratio calculation, Concept of test and error in Speaker Identification, ase studies. Techniques and Best Practices for examination of Audio recording authentication and case studies.

Unit – 4

Audio /video forensics: Spectrography – Conversion of different voice file formats in to forensic voice module formats. Various types of spectrograms, spectrographic cues for vowels and consonants.Speech analysis in forensic sciences.Speech synthesis by analysis, Speech recognition and speaker identification.Fundamentals of Digital Signal processing and communication system. Analogue and digital systems, Analogue signal and digital signals, Analogue to digital and digital to analogue converters, need and advantages of digital systems and digital signal processing. Forensic extraction of video files from DVR and other storage media.Forensic examination of DVR containing video footages, its frame analysis. Forensic examination and authentication of meta data present in video/audio files. Enhancement of video/ Photo and its comparison/authentication.

Reference Books:

1. Bengold& Nelson Moryson; “Speech and Audio signal processing”, John Wiley & Sons, USA (1999)
2. D.B. Fry; “The Physics of Speech, Cambridge University Press”, (2004)
3. Dwight Bolingeret. al.; “Aspects of Language”, Third Edition, Harcourt Brace Jovanovich College Publishers, USA, (1981)
4. Gloria J. Borden et. al.; “Speech Science Primer (Physiology, Acoustics and perception of Speech)”, 6th Ed, a Wolters Kluwer Company, USA, (2011)
5. Harry Hollien; “Forensic Voice Identification”, Academic Press, London. (2001)
6. Harry Hollien; “The Acoustics of Crime- The New Science of Forensic Phonetics”, Plenum Press, New York and London (1990)
7. Oscar Tosi; “Voice Identification-Theory of Legal Applications”, University Park Press, Baltimore (1979)
8. O'Shaughnessy, Douglas; “Speech Communication”, Hyderabad Universities Press (India) Pvt. Ltd. (2001)
9. Patricia Ashby; “Speech Sounds”, 2nd Ed. Routledge, London and New York (2005)
10.Philip Rose; “Forensic Speaker Identification,” Taylor and Francis, Forensic Science Series, London (2002)
11.Simon J. Godsill; “Digital Audio Restoration”, Springer, (1998)

MSCCS03E15 MOBILE AND SATELLITE COMMUNICATION NETWORKS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**: describe various wireless communication techniques. **CO2**: describe various multiple access schemes and tune the multiple access parameters to reduce call drops and enhance the quality of conversation. **CO3**: describe different wireless networks and develop skills for improving spectrums reusability, interconnectivity and interoperability between different service providers. **CO4**: develop skills to write new GPS software.

Unit-1

Wireless Communication Principles: Wireless propagation characteristics, multipath fading, intrusion handling, modulation techniques and bandwidth estimations, Direct Sequence and Frequency Hopping Spread Spectrum technologies.

Unit-2

Multiple access and Duplexing techniques: Frequency Division Multiple Access, Time Division Multiple Access, Code Division Multiple Access, Space Division Multiple Access, Wavelength Division Multiple Access, duplexing techniques- Time Division Duplexing, Frequency Division Duplexing.

Unit-3

Mobile cellular networks:Global Systems for Mobile combinations (GSM), General Packet Radio Services (GPRS), Enhanced Data rates for GSM Evolution (EDGE), Mobility and Hands-off in mobile cellular networks. 2G 3G, 4G mobile communications Networks.

Unit-4

Wireless Local Area Networks:Carrier Sense Multiple Access (CSMA/CA) protocol. Distributed Coordination Function, Point Coordination Function, Infrastructure based WLAN, ADHOC WLAN, IEEE 802.11 WLAN standards. Satellite Communication and Networks: Geosynchronous satellites, Medium Earth Orbit satellites, Global Positioning Systems, Low Earth Orbit Satellites, ALOHA, VSAT networks.

Reference Books:

1. A.S. Tanenbaum, David J Wetherall, Computer Networks, 5th Edition , Pearson, 2013.
2. Behrouz A. Forouzan, Data Communications and Networking, 5th Edition, McGraw Hill 2017.
3. C.N. Thurwachter, Wireless Networking, Prentice-Hall of India, 2002.
4. M. Richharia, Mobile Satellite Communications: Principles & Trends, Pearson Education.

MSCCS03E16 DEEP LEARNING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** describe the feed forward and deep networks. **CO2:** design single and multi-layer feed-forward deep networks and tune various hyper-parameters. **CO3:** analyse performance of deep networks.

Unit-1

Introduction:Historical context and motivation for deep learning; basic supervised classification task, optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum, and adaptive sub-gradient method.

Neural Networks: Feed-forward neural networks, deep networks, regularizing a deep network, model exploration, and hyper-parameter tuning.

Unit-2

Convolution Neural Networks: Introduction to convolution neural networks: stacking, striding and pooling, applications like image, and text classification.

Unit-3

Sequence Modeling, Recurrent Nets, Unfolding computational graphs, recurrent neural networks (RNNs), bidirectional RNNs, encoder-decoder sequence to sequence architectures, deep recurrent networks.

Autoencoders:Undercompleteautoencoders, regularized autoencoders, sparse autoencoders, denoisingautoencoders, representational power, layer, size, and depth of autoencoders, stochastic encoders and decoders.

Unit-4

Structuring Machine Learning Projects:Orthogonalization, evaluation metrics, train/dev/test distributions, size of the dev and test sets, cleaning up incorrectly labeled data, bias and variance

with mismatched data distributions, transfer learning, multi-task learning.

Reference Books:

1. Ian Goodfellow, Deep Learning, MIT Press, 2016.

2. Jeff Heaton, Deep Learning and Neural Networks, Heaton Research Inc, 2015.

3. Mindy L Hall, Deep Learning, VDM Verlag, 2011

4. Li Deng (Author), Dong Yu, Deep Learning: Methods and Applications (Foundations and Trends in Signal Processing), Now Publishers Inc, 2009.

MSCCS03E17 ARTIFICIAL INTELIGENCE

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Differentiate between various approaches to Artificial Intelligence. **CO2:** Design intelligent agents and distinguish between Utility based agents and Goal based agents. **CO3:** Apply concepts, methods, and theories of search, heuristics, games, knowledge representation, planning. **CO4:** Apply Natural language processing techniques. **CO5:** Understand the limitations of Artificial Intelligence techniques.

Unit-1

Introduction: Introduction to Artificial Intelligence, various definitions of AI, AI Applications and Techniques, Turing Test and Reasoning - forward & backward chaining.

Unit-2

Intelligent Agents: Introduction to Intelligent Agents, Rational Agent, their structure, reflex, model-based, goal-based, and utility-based agents, behavior and environment in which a particular agent operates.

Unit-3

Problem Solving and Search Techniques: Problem Characteristics, Production Systems, Control Strategies, Breadth First Search, Depth First Search, iterative deepening, uniform cost search, Hill climbing and its Variations, simulated annealing, genetic algorithm search; Heuristics Search Techniques: Best First Search, A* algorithm, AO* algorithm, Minmax& game trees, refining minmax, Alpha – Beta pruning, Constraint Satisfaction Problem, Means-End Analysis.

Unit-4

Knowledge Representation: Introduction to First Order Predicate Calculus, Resolution Principle, Unification, Semantic Nets, Conceptual Dependencies, semantic networks, Frames system,

Production Rules, Conceptual Graphs, Ontologies. Planning: Basic representation for planning, symbolic-centralized vs. reactive-distributed,partial order planning algorithm.Reasoning with Uncertain Knowledge:Different types of uncertainty - degree of belief and degree of truth, various probability constructs - prior probability, conditional probability, probability axioms, probability distributions, and joint probability distributions, Bayes' rule, other approaches to modeling uncertainty such as Dempster-Shafer theory and fuzzy sets/logic.

Reference Books:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education, 2015.
2. Elaine Rich and Kelvin Knight, Artificial Intelligence, 3rd edition, Tata McGraw Hill , 2017.
3. DAN.W. Patterson, Introduction to A.I. and Expert Systems – PHI, 2007.
4. Michael Wooldridge, An Introduction to MultiAgent Systems, 2nd edition, John Wiley & Sons, 2009.
5. Fabio Luigi Bellifemine, Giovanni Caire, Dominic Greenwood, Developing Multi-Agent Systems with JADE, Wiley Series in Agent Technology, John Wiley & Sons, 2007.
6. W.F. Clocksin and C.S. Mellish, Programming in PROLOG, 5th edition, Springer, 2003.
7. SarojKaushik, Logic and Prolog Programming, New Age International Publisher, 2012.
8. Ivan Bratko, Prolog Programming for Artificial Intelligence, Addison-Wesley, Pearson Education, 4th edition, 2011.

MSCCS03E18COMPUTER VISION

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** To implement fundamental image processing techniques required for computer vision **CO2:** Understand Image formation process **CO3:** To perform shape analysis **CO4:** Extract features form Images and do analysis of Images **CO5:** Generate 3D model from images **CO6:** To develop applications using computer vision techniques **CO7**: Understand video processing, motion computation and 3D vision and geometry

Unit1

Introduction : Image Processing, Computer Vision and Computer Graphics , What is Computer Vision - Low-level, Mid-level, High-level , Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality.

Unit2

Image Formation Models : Monocular imaging system , Radiosity: The 'Physics' of Image Formation, Radiance, Irradiance, BRDF, color etc, Orthographic & Perspective Projection,• Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading , Photometric Stereo, Depth from Defocus , Construction of 3D model from images.

Unit 3

Image Processing and Feature Extraction: Image preprocessing, Image representations (continuous and discrete) , Edge detection .Motion Estimation : Regularization theory , Optical computation , Stereo Vision , Motion estimation , Structure from motion . Shape Representation and Segmentation : Contour based representation, Region based representation, Deformable curves and surfaces , Snakes and active contours, Level set representations , Fourier and wavelet descriptors , Medial representations , Multi-resolution analysis.

Unit4

Object recognition : Hough transforms and other simple object recognition methods, Shape correspondence and shape matching , Principal component analysis , Shape priors for recognition. Image Understanding : Pattern recognition methods, HMM, GMM and EM. Applications: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground-background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians

Reference Books:

1. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.
2. Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.
3. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 1992.
4. D. H. Ballard, C. M. Brown. Computer Vision.Prentice-Hall, Englewood Cliffs, 1982.
5. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010
6. Image Processing, Analysis, and Machine Vision. Sonka, Hlavac, and Boyle. Thomson.
7. E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012
8. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012
9. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.

MSCCS03E19 DATA AND INFORMATION VISUALIZATION

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Understand the significance of data representation. **CO2:** Accomplish skills to represent the facts and information. **CO3:** Comprehend the methods for information visualization **CO4:** Familiarize with scientific visualization techniques.

Unit- 1

Data and types of data, Data variability, uncertainty and context. Basics of Data Visualization: Definition of Data Visualization, Need for Visualization, How to visualize data, General types of Data Visualization, pros and Cons of Data Visualization. Visualization Components: Visual cues, Coordinate systems, Scales, and Context. Diagrams used for data visualization: Bar chart, Histogram, Scatter plot, Scatter plot, Network, Streamgraph, Treemap, Gantt chart, Stripe graphic, Animated spiral graphic. Visualization based on types of data: Visualizing Categorical data , Visualizing Time series data , VisualizingSpatial data.

Unit -2

Information Visualization: Definition, Objectives of Information Visualization. Visual representation of large scale collection of non- numerical information. Design Principles of Information Visualization: Principle of Simplicity, Principle of Proximity, Principle of Similarity, Principle of Closure, Principle of Connectedness, Principle of Good Continuation, Principle of Common fate, Principle of Familiarity, Principle of Symmetry.

Unit -3

Methods for Information Visualization: Cartogram, Cladogram (phylogeny), Concept Mapping, Dendrogram (classification). Graph drawing, Heat map, Hyperbolic Tree, Tree mapping Multidimensional scaling. Information visualization reference model.Case study with real world problem.

Unit- 4

Scientific visualization: Introduction, Methods for visualizing two-dimensional and three dimensional data sets, volume visualization. Data Visualization using in Python matplotlib Module, pyplot, plot(), scatter, bar charts, Formatting, figure(), subplot(), text(), xlabel(), ylabel(), title(), Plotting Mathematical Functions.

Reference Books:

1. Nathan Yau, Data Points. Wiley Big Data Series
2. Healy, Kieran, Data Visualization: A Practical Introduction. Princeton University Press
3. Ben Bederson and Ben Shneiderman. The Craft of Information Visualization: Readings and Reflections. Morgan Kaufmann, 2003
4. Riccardo Mazza. Introduction to Information Visualization, Springer, 2009
5. Gowrishankar S, Veena A, "Introduction to Python Programming", 1st Edition, CRC Press/Taylor & Francis, 2018. ISBN-13: 978-0815394372
6. Alberto Fernandez Villan, Mastering OpenCV 4 with Python, Packt Publishing Ltd
7. Dr. R NageswaraRao, Core Python Programming, 2nd edition, Dreamtech Publisher, 2019
8. Geron, Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 1st Edition,O'Reilly Media, 2017.
9. Wesley J. Chun, Core Python Programming, Second Edition, Publisher: Prent Hall Pub
10. Introduction to Computer Science using Python - Charles Dierbach, Wiley,2015

POOL C

MSCCS04E20 SOFTWARE ENGINEERING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:**Understanding life cycle models and applying best model **CO2:**Obtaining requirements by understanding and analyzing the problem **CO3:**Making designs according to the requirement specification **CO4:** Applying suitable testing for the software **CO5:**Delivering a product which is reliable economically and functionally.

Unit 1

Introduction to software engineering- scope of software engineering – historical aspects, economic aspects, maintenance aspects, specification and design aspects, team programming aspects. Software engineering a layered technology – processes, methods and tools. Software process models – prototyping models, incremental models, spiral model, waterfall model.

Process Framework Models: Capability maturity model (CMM), ISO 9000. Phases in Software

development – requirement analysis- requirements elicitation for software, analysis principles, software prototyping, specification.

Unit 2

Planning phase – project planning objective, software scope, empirical estimation models-COCOMO, single variable model, staffing and personal planning.
Design phase – Abstraction, Architecture, Patterns, Separation of Concerns, Modularity, Information Hiding, Functional Independence, Cohesion and Coupling; Object-Oriented Design, Data Design, Architectural Design, User Interface Design, Component Level Design.

Unit 3

Component-Level Design: What is a Component?, Designing Class-Based Components. User Interface Design: The Golden Rules, User Interface Analysis and Design. Software Configuration Management, The SCM Repository, The SCM Process.

Unit 4

Coding – programming practice, verification, size measures, complexity analysis, coding standards. Testing – Verification and Validation; Error, Fault, Bug and Failure; Unit and Integration Testing; White-box and Black-box Testing; Basis Path Testing, Control Structure Testing, Deriving Test Cases, Alpha and Beta Testing; Regression Testing, Performance Testing, Stress Testing.

Text Book:

Software Engineering – Roger S Pressman, 'Software Engineering: A Practitioner's Approach, 7 th Edition, McGraw-Hill International Edition, 2010.

Reference Books:

1. Richard Fairey, 'Software Engineering concepts, Tata McGraw-Hill 2009 reprint
2. Ian Sommerville, 'Software Engineering'. 6th Ed., Addison Wesley
3. Waman S Jawadekar, 'Software Engineering Principles and Practice', Tata McGraw Hill, 2004

MSCCS04E21 INFORMATION RETRIEVAL SYSTEM

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**: Understand the theoretical basis behind the standard models of IR (Boolean, Vector-space, Probabilistic and Logical models), **CO2**: Understand the difficulty of representing and retrieving documents, images, speech, etc., **CO3**: Be able to implement, run and test a standard IR system **CO4**: Understand the standard methods for Web indexing and retrieval **CO5**:Uderstand how techniques from natural language processing, artificial intelligence, human-computer interaction and visualization integrate with IR **CO6**:Be familiar with various algorithms and systems.

Unit 1

Introduction: Retrieval strategies: vector space model, Probabilistic retrieval strategies: Simple term weights, Nonbinary independence model, Language models. Retrieval Utilities: Relevance feedback, clustering, N-grams, Regression analysis, Thesauri.

Unit 2

Semantic networks, parsing Cross –Language: Information Retrieval: Introduction, Crossing the Language barrier.

Unit 3

Efficiency: Inverted Index, Query processing, Signature files, Duplicate document detection.

Unit 4

Integrating structured data and text. A historical progression, Information retrieval as relational application, Semi Structured search using a relational schema. Distributed Information Retrieval: A theoretical Model of Distributed retrieval, web search.

Text book:

1. David A. Grossman, OphirFrieder, Information Retrieval – Algorithms and Heuristics, Springer, 2nd Edition (Distributed by Universal Press), 2004

Reference books:

1.Gerald J Kowalski, Mark T Maybury,"Information Storage and Retrieval Systems: Theory and Implementation", Springer, 2004.

2.SoumenChakrabarti, "Mining the Web: Discovering Knowledge from Hypertext Data", Morgan – Kaufmann Publishers, 2002.

3.Christopher D Manning, PrabhakarRaghavan, HinrichSchutze, "An Introduction to Information Retrieval" , Cambridge University Press, England, 2009.

MSCCS04E22 GRAPH THEORY AND COMBINATORICS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**: Accomplish knowledge about Graph Theory **CO2**: Understand the applications of Graph Theory **CO3**: Acquire knowledge about Combinatorics **CO4**: Cognizance about Recurrence and nonhomogeneous recurrence relations.

Unit 1

Introduction to Graphs, definitions, sub graphs, paths and cycles, matrix representation of graphs, Euler tours, Chinese postman problem, planar graphs, Euler's formula, platonic bodies, applications of Kuratowski's theorem, Hamiltonian graphs, graph colouring and chromatic polynomials, map

colouring.

Unit 2

Trees: definition and properties, rooted trees, trees and sorting, weighted trees and prefix codes, biconnected components and articulation points. Kruskal's and Prim's algorithms for minimal spanning trees.Disjkstra's shortest path algorithm, Bellman – Ford algorithm, all-pairs shortest paths, Floyed – Warshall algorithms, the max-flow min-cut theorem, maximum bipartite matching.

Unit 3

Fundamental principles of counting, permutations and combinations, binomial theorem, combinations with repetition, combinatorialnumbers, Principle of inclusion, derangements, arrangements with forbidden positions.

Unit 4

Generating functions, partitions of integers, the exponential generating function, the summation operator.Recurrence relations, first order and second order, nonhomogeneous recurrence relations, method of generating functions.

Reference Books:

1. Grimaldi R.P., ―Discrete and Combinatorial Mathematics : an applied Introduction‖, 3e, Addison Wesley, 1994
2. Corman T. H., Leiserson C. E., Rivest R. L., ―Introduction to algorithms:, Prentice Hall India, 1990
3. Mott J.L., Kandel A. and Baker T.P., ―Discrete Mathematics for Computer Scientists and Mathematicians‖, 2e, PHI
4. Rosen K.H., ―Discrete Mathematics and its Applications‖, 3e, McGraw Hill 5. Clark J. and Holton D. A., ―A first look at Graph theory‖, World Scientific.

MSCCS04E23 EMBEDDED SYSTEMS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1** :Ability to design an embedded system **CO2** :Ability to distinguish various operating system services **CO3**:Ability to distinguish between various process scheduling algorithms **CO4** :Ability to distinguish various memory management schemes

Unit 1

Introduction to Embedded Systems– Components of embedded system hardware–Software embedded into the system – Embedded Processors - CPU architecture of ARM processor (ARM9) – CPU Bus Organization and Protocol. Design and Development life cycle model - Embedded system design process – Challenges in Embedded system design.

Unit 2

Serial Communication Standards and Devices - UART, HDLC, SCI and SPI. Serial Bus Protocols - I2C Bus, CAN Bus and USB Bus. Parallel communication standards ISA, PCI and PCI-X Bus.

Unit 3

Real-time operating systems - Services- Goals – Structures -Kernel - Process Management – Memory Management –Device Management – File System Organization. Micro C/OS-II RTOS - System Level Functions – Task Service Functions – Memory Allocation Related Functions – Semaphore Related Functions. Study of other popular Real-time Operating Systems.

Unit 4

Memory devices and systems - memory map – DMA - I/O Devices – Interrupts - ISR – Device drivers for handling ISR – Memory Device Drivers – Device Drivers for on-board bus. Programming concepts of embedded programming – Features of Embedded C++ and Embedded Java (basics only). Software Implementation, Testing, Validation and debugging, system-on-chip.Design Examples: Mobile phones, ATM machine, Set top box.

Reference Books:

1. David E. Simon, *An Embedded Software Primer*, Pearson Education Asia, First Indian Reprint 2000.
2. Wayne Wolf, *Computers as Components: Principles of Embedded Computing System Design*, Morgan Kaufman Publishers - Elsevier 3ed, 2008.
3. Frank Vahid and Tony Givargis, *Embedded Systems Design – A Unified Hardware / Software Introduction*, John Wiley, 2002.
4. Iyer - *Embedded Real time Systems*, 1e, McGraw Hill Education New Delhi, 2003.
5. K.V. Shibu, *Introduction to Embedded Systems*, 2e, McGraw Hill Education India, 2016.
6. Lyla B. Das, *Embedded Systems: An Integrated Approach*, 1/e ,Lyla B. Das, Embedded Systems, 2012.
7. Rajkamal,*Embedded Systems Architecture, Programming and Design*, TMH, 2003.
8. Steve Heath,*Embedded Systems Design*, Newnes – Elsevier 2ed, 2002.
9. Tammy Noergaard, *Embedded Systems Architecture, A Comprehensive Guide for Engineers and Programmers*, Newnes – Elsevier 2ed, 2012.

MSCCS04E24 GRID AND CLOUD COMPUTING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**: Realize the business value **CO2**: Conceptual understanding of grid deployment and ability to apply them in practical solution. **CO3**: identify the significance of implementing virtualization techniques. **CO4**:interpret the various cloud computing models and services **CO5**:compare the various public cloud platforms and software environments. **CO6**:apply appropriate cloud programming methods to solve big

	data problems. **CO7**:appreciate the need of security mechanisms in cloud **CO8**:illustrate the use of various cloud services available online.

Unit 1

Evolution of Distributed computing: Scalable computing over the Internet – Technologies for network based systems – clusters of cooperative computers – Grid computing Infrastructures – cloud computing – service oriented architecture – Introduction to Grid Architecture and standards – Elements of Grid – Overview of Grid Architecture.

Unit 2

Introduction to Open Grid Services Architecture (OGSA) – Motivation – Functionality Requirements – Practical & Detailed view of OGSA/OGSI – Data intensive grid service models – OGSA services. Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software

Unit 3

Pros and Cons of cloud computing – Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation. Open source grid middleware packages – Globus Toolkit (GT4) Architecture, Configuration – Usage of Globus – Main components and Programming model

Unit 4

Introduction to Hadoop Framework – Map reduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job – Design of Hadoop file system, HDFS concepts, command line and java interface, dataflow of File read & File write.

Grid security infrastructure – Cloud Infrastructure security: network, host and application level – aspects of data security, provider data and its security, Identity and access management architecture, IAM practices in the cloud, SaaS, PaaS, IaaS availability in the cloud, Key privacy issues in the cloud.

References Books:

1. Kai Hwang, Geoffery C. Fox and Jack J. Dongarra, “Distributed and Cloud Computing: Clusters, Grids, Clouds and the Future of Internet”, First Edition, Morgan Kaufman Publisher, an Imprint of Elsevier, 2012.
2. Jason Venner, “Pro Hadoop- Build Scalable, Distributed Applications in the Cloud”, A Press, 2009
3. Tom White, “HadoopThe Definitive Guide”, First Edition. O“Reilly, 2009.
4. Bart Jacob (Editor), “Introduction to Grid Computing”, IBM Red Books, Vervante, 2005
5. Ian Foster, Carl Kesselman, “The Grid: Blueprint for a New Computing Infrastructure”, 2nd Edition, Morgan Kaufmann.
6. Frederic Magoules and Jie Pan, “Introduction to Grid Computing” CRC Press, 2009.
7. Daniel Minoli, “A Networking Approach to Grid Computing”, John Wiley Publication, 2005.

8. Barry Wilkinson, "Grid Computing: Techniques and Applications", Chapman and Hall, CRC, Taylor and Francis Group, 2010.

MSCCS04E25 HIGH PERFORMANCE COMPUTING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**: The learner will be able to design, formulate, solve and implement high performance versions of standard single threaded algorithms **CO2**: The learner will know and will be able to demonstrate the architectural features in the GPU and MIC hardware accelerators. **CO3**: The learner will be able to design programs to extract maximum performance in a multicore, shared memory execution environment processor. **CO4**: The learner will be able to design and deploy large scale parallel programs on tightly coupled parallel systems using the message passing paradigm.

Unit 1

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

Unit 2

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

Unit 3

Synchronization- Scheduling- Job Allocation-Job Partitioning- Dependency Analysis- Mapping Parallel Algorithms onto Parallel Architectures- Performance Analysis of Parallel Algorithms.

Unit 4

Bandwidth Limitations- Latency Limitations- Latency Hiding/Tolerating Techniques and their limitations- Power-aware Processing Techniques-Power-aware Memory Design- Power-aware Interconnect Design-Software Power Management.Petascale Computing-Optics in Parallel Computing- Quantum Computers- Recent developments in Nanotechnology and its impact on HPC.

Reference Books:

1. George S. Almasi and AlanGottlieb, Highly Parallel Computing, Benjamin Cumming Publishers.
2. Kai Hwang ,Advanced Computer Architecture: Parallelism, Scalability, Programmability,

McGraw Hill 1993
3. David Culler, Jaswinder Pal Singh, Anoop Gupta, Parallel Computer Architecture: A hardware/Software Approach, Morgan Kaufmann, 1999.
4. K. Hwang& Z. Xu, Scalable Parallel Computing – Technology, Architecture, Programming., McGraw Hill 1998.
5. William James Dally and BrianTowles, Principles and Practices on Interconnection Networks, Morgan Kauffman 2004.
6. Hubert Nguyen , GPU Gems 3, Addison Wesley, 2008, (Chapter 29 to Chapter 41)
7. AnanthGrama, Anshul Gupta, George Karypis, and Vipin Kumar, Introduction to Parallel Computing, , 2nd edition, Pearson, 2003.
8. David A. Bader (Ed.), Petascale Computing: Algorithms and Applications, Chapman & Hall/CRC, 2008.

MSCCS04E26 BIOINFORMATICS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Expose students to the popular genomic and proteomic databases and to impart knowledge in processing and analyzing genomic data. **CO2:** Introduce advanced topics in Bioinformatics.

Unit 1

Bioinformatics - introduction to - nature and scope of computational biology and Bioinformatics. Cells - prokaryotes and eukaryotes - DNA double helix - central dogma – RNA, Amino acids, Proteins - string representations. A glossary of Bioinformatics terms - file format for bio-molecular sequences, sequence alignment, phylogeny, gene finding, microarray analysis, homology and evolutionary relationships.

Unit 2

Basic algorithms in Computational Biology - exhaustive search methods and their applications in Computational Biology - string matching algorithms. Motif finding - tandem repeats – concept of dynamic programming - graph algorithms - clustering algorithms.

Unit 3

Sequence alignment - pair-wise sequence alignment, need of scoring schemes - penalizing gaps, scoring matrices for amino acid sequence alignment, PAM probability matrix and log odds matrix, BLOSUM, Dot-plot visualization, Needleman-Wunsch algorithm- effect of scoring schemes – evalues - BLAST and FASTA, Smith – Waterman algorithm for local alignment. Multiple sequence alignment - sequence alignment using dynamic programming, N-dimensional dynamic programming.Tools for MSA - muscle and T-Coffee.Phylogenetic algorithms - evaluation of

phylogenetic trees, significance.

Unit 4

Introduction to the major resources - NCBI, EBI and ExPASy - nucleic acid sequence databases - GenBank, EMBL, DDBJ – Protein sequence databases - SWISS-PROT, TrEMBL, PIR_PSD - genome databases at NCBI, EBI, TIGR, SANGER – procedures to access these databases and to make use of the tools available.

Reference books:

1. Mount D, Bioinformatics: Sequence & Genome Analysis, 2nd Edition, Cold spring Harbor Press, ISBN: 978-087969712.
2. Dan Gusfield, Algorithms on Strings Trees and Sequences, 1st Edition, Cambridge University Press, ISBN: 0521585198.
3. Pevzner P A, Computational Molecular Biology: An Algorithmic Approach, MIT Press, Cambridge, MA, ISBN: ISBN: 9780262161978.
4. Jeremy J. Ramsden, Bioinformatics: An Introduction, Springer, ISBN: 9789401570961.
5. Sushmita M and Tinku A, Data Mining: Multimedia, Soft Computing and Bioinformatics, Wiley-Interscience, ISBN: 9780471460541.

MSCCS04E27 GEOGRAPHICAL INFORMATION SYSTEM (GIS)

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Discuss in an informed way the techniques, terms and applications of GIS **CO2:**Gather spatial information from various sources to include on a map **CO3:**Use GIS to analyze and visualize spatial data to gain new knowledge **CO4**:Collect, display, query, and analyze spatial and tabular data **CO5**: Produce maps that communicate a purpose and adhere to the principles of good map design.

Unit 1

Introduction to GIS, Defining GIS and Introduction to Spatial data, thematic characteristics of spatial data, sources of spatial data: census, survey data, air photos, satellite images, field data. Satellite Navigation Systems, Models of the Earth; Geoid and Ellipsoid, Datum and Projections, Spatial and attribute data modelling and Management: Spatial entities - Spatial data structures; Raster and Vector GIS implementation architecture; Desktop GIS, GIS Server, Web GIS applications.

Unit 2

Free and Open Source Software for GIS, Standards and Interoperability, Open Geospatial

ConsortiumWeb Map Servers- Web Feature Servers- Metadata standard, XML, Geographic Markup Language.

Unit 3

Customization of GIS Overview- the need and benefit of Customization – programming for GIS applications - the enhancement of GIS functionalities through customization – Automation of redundant processes - Data development/update automation – Discuss various case studies that involve customization.

Unit 4

Spatial databases, creating a spatially-enabled database, GIS objects, building spatial indexes, spatial queries and spatial functions, Building applications with spatial database, GIS Integration with R and Big Data. Web mapping, Web Mapping Services-Open Layers-Google maps-Yahoo maps and Microsoft map services, Mashups. GeoRSS. Web GIS Implementation: Web Map servers and Data servers

Reference Books:

1.Heywood.L, Comelius.S and S. Carver ,*An Introduction to Geographical Information Systems,* Dorling Kinderseley (India) Pvt. Ltd, 2006.

2.Burrough P A 2000 P A McDonnell, *Principles of Geographical Information systems*, London: Oxford University Press, 2000

3.Lo.C.P., Yeung. K.W. Albert ,*Concepts And Techniques of Geographic Information Systems,* Prentice-Hall of India Pvt ltd, New Delhi , 2002.

4. Longley, P.A., Goodchild, M.F., Maguire, D.J. and Rhind, D.W, *Geographic Information Systems and Science.*Chichester: Wiley. 2nd edition, 2005.

MSCCS04E28 INTERNET OF THINGS (IoT)

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1**:Explain the concept of IoT. **CO2**:Analyze various protocols for IoT. **CO3:**Design a PoC of an IoT system using Rasperry Pi/Arduino **CO4:**Apply data analytics and use cloud offerings related to IoT. **CO5:**Analyze applications of IoT in real time scenario.

Unit 1

Introduction to IoT: Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology.

Unit 2

IoT Architecture: M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture. IoT Protocols: Protocol Standardization for IoT – Efforts – M2M

and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards.

Unit 3

Protocols – IEEE 802.15.4 – BACnet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP–Security. Building IoT with RASPBERRY PI &ARDUINO:Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces.

Unit 4

Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.Case Studies and Real-World Applications :Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

Reference Books:

1. ArshdeepBahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015

2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things‖, Springer, 2011.

3. Honbo Zhou, ―The Internet of Things in the Cloud: A Middleware Perspective‖, CRC Press, 2012.

4. Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.

5. Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols‖, Wiley, 2012

MSCCS04E29 ROBOTICS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:**The Student must be able to design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.

Unit -1

INTRODUCTION Specifications of Robots- Classifications of robots – Work envelope - Flexible automation versus Robotic technology – Applications of Robots ROBOT KINEMATICS AND DYNAMICS Positions, Orientations and frames, Mappings: Changing descriptions from frame to frame, Operators: Translations, Rotations and Transformations - Transformation Arithmetic - D-H

Representation - Forward and inverse Kinematics Of Six Degree of Freedom Robot Arm – Robot Arm dynamics

Unit- 2

ROBOT DRIVES AND POWER TRANSMISSION SYSTEMS Robot drive mechanisms, hydraulic – electric – servomotor- stepper motor - pneumatic drives, Mechanical transmission method - Gear transmission, Belt drives, cables, Roller chains, Link - Rod systems - Rotary-to-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws

Unit- 3

MANIPULATORS :Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and Pneumatic manipulators ROBOT END EFFECTORS Classification of End effectors – Tools as end effectors. Drive system for grippers-Mechanicaladhesive-vacuum-magnetic-grippers. Hooks&scoops. Gripper force analysis and gripper design. Active and passive grippers.

Unit-4

PATHPLANNING & PROGRAMMING: Trajectory planning and avoidance of obstacles, path planning, skew motion, joint integrated motion – straight line motion-Robot languages -.computer control and Robot software.

TEXT BOOKS:

1. Deb S. R. and Deb S., “Robotics Technology and Flexible Automation”, Tata McGraw Hill Education Pvt. Ltd, 2010.

2. John J.Craig , “Introduction to Robotics”, Pearson, 2009.

3. Mikell P. Grooveret. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.

Reference Books:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.

2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics : Control, Sensing, Vision and Intelligence", McGraw Hill, 1987

MSCCS04E30 QUANTUM COMPUTING AND INFORMATION THEORY

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1** :Basics of complex vector spaces **CO2** :Quantum mechanics as applied in Quantum computing **CO3** :Architecture and algorithms **CO4** :Fundamentals of Quantum computations.

Unit 1

Introduction to Quantum Computation: Quantum bits, Bloch sphere representation of a cubit, multiple cubits.

Unit 2

Background Mathematics and Physics: Hilbert space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.

Unit 3

Quantum Circuits: single qubit gates, multiple qubit gates, design of quantum circuits.

Unit 4

Quantum Information and Cryptography: Comparison between classical and quantum information theory. Bell states.Quantumteleportation.Quantum Cryptography, no cloning theorem. Quantum Algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes.Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search.

Reference Books:

1. Nielsen M. A., *Quantum Computation and Quantum Information*, Cambridge University Press.-2002.
2. Benenti G., Casati G. and Strini G., *Principles of Quantum Computation and Information*, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.-2004.
3. Pittenger A. O., *An Introduction to Quantum Computing Algorithms*-2000.

MSCCS04E31 NATURE INSPIRED COMPUTING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Understanding of Natural Inspirations in problem solving **CO2:** Acquire knowledge about Ant Colony Optimization **CO3:** Obtain knowledge about Swarm Intelligence **CO4:** Gain knowledge about Genetic algorithms **CO5:**Attain knowledge about DNA Computing.

Unit-1

Introduction: Nature Inspired Computing. 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.

Unit-2

Ant Colony Optimization : Ant Behavior – Towards artificial Ants - Ant Colony Optimization – Problem solving using ACO – Extensions of Ant Systems – Applications. Swarm Intelligence: Introduction to Swarm Intelligence – Working of Swarm Intelligence – Optimization – Particle Swarms – Applications.

Unit- 3

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 – Linden Meyer Systems – Artificial Neural Networks – Simulated Annealing.

Unit- 4

Computing With New Natural Materials: DNA Computing: Motivation, DNA Molecule , Adelman's experiment , Test tube programming language, Universal DNA Computers , PAM Model , Splicing Systems, Lipton's Solution to SAT Problem , Scope of DNA Computing , From Classical to DNA Computing.

Text books

1. Stephen Olariu and Albert Y.Zomaya, "Handbook of Bio-Inspired and Algorithms and Applications", Chapman and Hall, 2006.
2. Marco Dorrigo, Thomas Stutzle," Ant Colony Optimization", PHI,2004

3. Eric Bonabeau, Marco Dorrigo, Guy Theraulaz, “Swarm Intelligence: From Natural to Artificial Syatems”, Oxford University Press,2000
4. Mitchell, Melanie, “Introduction to Genetic algorithms”,ISBN:0262133164,MIT Press,1996
5. Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2006

Reference books:

1. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
2. Leandro Nunes de Castro and Fernando .J, " Recent Developments in Biological Inspired Computing", MIT Press,2005

MSCCS04E32 ADVANCED MICROPROCESSORS AND MICROCONTROLLERS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:**Understand the generalized architecture of advanced microprocessors and advanced microcontrollers **CO2:** Develop algorithm/program of the advanced microcontrollers for a particular task **CO3**:Interface advanced microcontrollers with external peripherals

Unit 1

Internal Architecture of 8086, Functional Blocks, Instruction set and 8086 Family Assembly language programming, Assembler directives, Addressing memory and ports, Interrupts and Interrupt service procedures. 80286 Microprocessor and its architecture, addressing modes-Real address and Protected virtual Address mode, Privilege, Protection, additional instructions in 286.

Unit 2

Concept of Math coprocessor, Memory Management Unit concepts, Advanced features of 386 Processor and their architecture, Paging, virtual 8086 mode, enhancement in the instruction sets. Architecture and special features of 486 processor. Overview of the features of Pentium and later processors, architecture – recent trends in microprocessor design. Applications and interfacing of 8086 microprocessor with other peripherals 8251, 8255, 8253, 8257.

Unit 3

Microcontrollers :Overview of Microcontrollers, Types of microcontrollers, embedded system : Hardware architecture; CPU, Memory, Clock circuitry, Watchdog Timer / Reset circuitry, Chip select, I/O devices, Debug port, Communication interfaces, Power supply units. Software architecture, services provided by an operating system, architecture of embedded operating system, Categories of embedded operating systems. Application software, communication software.Development / Testing tools.

Unit 4

Hardware platforms: Types of hardware platforms; single board computers, PC add-on cards, custom-built hardware platforms. 89C51: architecture, instruction set and programming. AVR micro controller development board, PIC microcontrollers. 16F84 architecture, instruction set and programming.

Reference Books:

1. Doughlas V. Hall, Microprocessors and Interfacing-programming and Hardware, Mc-GrawHill Publishers
2. Ray A.K., Bhurchandi K M, Advanced Microprocessors and Peripherals-Architecture, programming and interface, Tata McGraw Hill, 2000
3. WimWilhurt, Embedded Technology.
4. Wayne Wolf, Computers as Components – Principles of embedded Computing system Design.
5. David E. Simon, An Embedded software Primer, Pearson Education, 2002.

MSCCS04E33 DIGITAL SPEECH PROCESSING

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1 :** Recognize the significance of digital speech processing and its applications **CO2 :** Describe speech production mechanism and corresponding physical models **CO3 :** List various methods for modeling of speech signal in continuous and discrete time domain **CO4 :** Apply linear prediction methods for modeling of speech signal **CO5 :** Employ homomorphic speech processing for estimation of excitation and vocal tract model **CO6 :** Develop simple algorithms for speech processing using Matlab **CO7 :** Analyze quantization effects of model coefficients on its accuracy **CO8** : Apply methods for recognition of vowels and speaker identity.

Unit 1

Basic Concepts: Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

Unit 2

Speech Analysis: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization –

Dynamic Time Warping, Multiple Time – Alignment Paths.

Unit 3

Speech Modeling: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

Unit 4

Speech Recognition: Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – ngrams, context dependent sub-word units; Applications and present status.

Reference Books:

1. Rabiner, Lawrence R., Biing-Hwang Juang, and Janet C. Rutledge. *Fundamentals of speech recognition*.Vol. 14. Englewood Cliffs: PTR Prentice Hall, 1993.
2. L R Rabiner and Schafer ,*Digital processing of speech signals*, Prentice hall. 1978.
3.Proakis, John G. *Digital signal processing: principles algorithms and applications*. Pearson Education India, 2001.

MSCCS04E34 INFORMATION STORAGE AND MANAGEMENT

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:**Understand the logical and physical components of a Storage infrastructure. **CO2:**Evaluate storage architectures, including storage subsystems, DAS, SAN, NAS, and CAS. **CO3**:Understand the various forms and types of Storage Virtualization. **CO4**:Describe the different role in providing disaster recovery and business continuity capabilities. **CO5** :Distinguish different remote replication technologies.

Unit 1

Storage Systems:Review the amount of information being created and understand the value of information to a business , Data Centre infrastructure elements and their requirements,role of ILM strategy ,physical and logical components of host, connectivity, and storage , disk drive architecture and performance , concept of RAID and different RAID levels (RAID 0, 1, 3, 5, 0+1/1+0, and Define Intelligent Storage System (ISS) and its components, Implementation of ISS as high-end and midrange storage arrays.

Unit 2

Storage Networking Technologies and Virtualization: implementation of DAS and overview of SCSI ,the architecture, components, and topologies of FC-SAN, NAS, Unified Storage,object based storage system CAS and its application as long-term archiving solution. Overview of emerging technologies such as Cloud storage, Virtual provisioning, FAST.

Virtualization: Server Virtualization (LVM –based virtualization, Memory virtualization, Virtual

Machine, and Hypervisor), Network (VLAN and VSAN), Storage (Disk virtualization, RAID, LUN masking, File and block level virtualization, Virtual Provisioning).

Unit 3

Business Continuity:Understand the concept of information availability and its measurement. the causes and consequences of downtime , RTO, and RPO , failure in a storage infrastructure and solutions for its mitigation , backup/recovery purposes and considerations,architecture and different backup/Recovery topologies ,local replication technologies and their operation, remote replication technologies and their operation. Overview of emerging technologies like de duplication, offsite backup**,** Continuous data protectiontechnology (CDP).

Unit 4

Storage Security and Management: Define information security. List the critical security attributes for information systems. Define storage security domains. List and analyze the common threats in each domain. Identify key parameters and components to monitor in a storage infrastructure. Cloud Computing: Define cloud computing. Describe cloud services (SaaS, PaaS, and Iaas). Discuss cloud concerns and implementations.

Reference Books:

1. EMC Education Services, Information Storage and Management, WileyIndia, 9788126521470.
2. Richard Barker, Paul Massiglia, “Storage Area Network Essentials: A Complete Guide to Understanding and Implementing SAN “, Wiley India, 9788126518586.

MSCCS04E35 FUZZY SETS AND SYSTEMS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:**Understand the concept of Fuzzy Logic **CO2:**Recognize the difference between Classical set and Fuzzy set **CO3:**Cognize the properties of Fuzzy membership functions **CO4:** Appreciate the applications of Fuzzy Logic

Unit 1

Introduction: Fuzzy systems – Historical perspective, Utility and limitations, uncertainty and information, fuzzy sets and membership, Chance vs. Fuzziness. Classical sets and Fuzzy sets: Classical set (Operations, properties, mapping to functions). Fuzzy sets (operations, properties, Alternative fuzzy set operations).

Unit 2

Classical Relations and Fuzzy relations: Cartesian product, crisp relations (cardinality, operations, properties, composition), Fuzzy relations (cardinality, operations, properties, Fuzzy Cartesian products and composition), Tolerance and equivalence relation, Crisp equivalence and tolerance relations, Fuzzy tolerance and equivalence relations, value assignments (Cosine amplitude , Max-min method), other similarity methods, other forms of composition Operation.

Unit 3

Properties of membership functions, Fuzzification and Defuzzification: Features of the -cuts for fuzzyλmembership functions, various forms, Fuzzification, defuzzification to crisp sets, relations, Defuzzification to scalars. Logic and Fuzzy systems: Classical logic, proof, Fuzzy logic, approximate reasoning, other forms of the implication operation. Natural language, Linguistic hedges, Fuzzy rule based systems, Graphical techniques for inference.

Unit 4

Development of membership functions: Membership value assignments (intuition, inference, rank ordering, Neural network, Genetic algorithm, inductive reasoning.) Extension Principle: Crisp functions, mapping and relations, Functions of Fuzzy sets – extension principle, Fuzzy transform, practical considerations.Fuzzy arithmetic: Interval analysis, Approximate methods of extension – DSW and restricted DSW algorithms. Fuzzy classification: Classification by equivalence relation (crisp and Fuzzy), Cluster analysis, cluster validity, C-means clustering (Hard and Fuzzy), Fuzzy c-means algorithm.

Reference books:

1. Ross, Fuzzy Logic with Engineering Applications, 3rd Edn, Wiley India.
2. Hajek P, Metamathematics of Fuzzy Logic. Kluwer, 1998
3. Rajasekharan and Viajayalakshmipai, Neural Networks, Fuzzy Logic and Genetic Algorithm, PHI, 2003. 4. Sivanandan and Deepa, Principles of Soft Computing, John wiley and

MSCCS04E36 OPERATIONS RESEARCH

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:**Recognize the need of Operations Research **CO2:**Understand about the applications of Linear Programming **CO3:** Acquire knowledge about Integer Programming **CO4:** Obtain knowledge about project scheduling

Unit 1

Linear programming: Formulation, Graphical Solution-2 variables, Development of Simplex Method,Artificial Variable Techniques, Big- M method, Two-Phase method, Reversed Simplex method.

Unit 2

Duality in LPP and its formulation, Dual Simplex Method, Bounded variable method, Applications of LPP, Transportation problems, Assignment Problem, Traveling Sales persons problem.

Unit 3

Integer Programming problem (IPP), Cutting Plane algorithm, Branch and bound method of solving IPP, Dynamic programming problems and it's characteristics, Deterministic Dynamic Programming Problem.

Unit 4

Sequencing Problem, Processing n jobs through two machines and their mechanics, Processing n jobs through m machines, Processing 2 jobs through m machines, Project scheduling by PERT / CPM,Difference between PERT / CPM, Constructing the network, Critical path analysis, Float of an activity,Three time estimated for PERT, project cost by CPM.

Reference Books:

1. Thaha H.A.- Operation Research, 9THEdn, Pearson
2. Sharm J.K, Mathematical Models in Operation Research, TMGH, 1989.
3. Trivedi,. Probability, Statistics with Reliability, Queuing and Computer Science Applications, PHI
4. Winston, Operations Research Applications and Algorithms, 4thedn, CENGAGE, 2003Sons, 2007.

MSCCS04E37 DESIGN AND ANALYSIS OF ALGORITHMS

Contact Hours/ week: 3

Credit: 3

Course Learning Outcomes:	**CO1:** Accomplish Knowledge about important computational problems. **CO2:** Acquire knowledge to design the algorithm. **CO3:**Study to analyze a given algorithm. **CO4:** Obtain knowledge to analyze algorithm control structures and solving recurrence. **CO5:** Attain information about Complexity Classes **CO6:** Accomplish knowledge about Parallel Algorithms

Unit 1

Algorithm Design: Introduction, Steps in developing algorithm, Methods of specifying an algorithm, Decisions prior to designing: based on the capabilities of the device, based on the nature of solutions, based on the most suitable data structures. Model of Computation: RAM model and PRAM model.Important Problem Types: Sorting, Searching, String processing, Graph problems, Combinatorial problems, Geometric problems and Numerical problems.

Basic Technique for Design of Efficient Algorithm: Brute Force approach (String matching), Divide-and-Conquer approach (Merge sort), Branch-and-Bound technique (Knapsack problem). Greedy approach (Kruskal'salgorithm and Prim's Algorithm), Dynamic Programming (Longest Common Subsequence), Backtracking(Sum of subsets problem).

Unit 2

Algorithm Analysis: Importance of algorithm analysis, Time and Space Complexity.

Growth of Functions: Asymptotic notations, Cost estimation based on key operations- Big Oh, Big Omega, Little Oh, Little Omega and Theta notations, Big Oh Ratio Theorem, Big Theta Ratio Theorem, Big Omega Ratio Theorem.

Analyzing Algorithm Control Structures, Solving Recurrences: Iteration Method, Substitution Method, The Recursion Tree Method, Master's Theorem, Problem solving using Master's Theorem Case 1, Case 2 and Case 3. Analysis of Strasser's algorithm for matrix multiplication, Analysis of Merge sort.

Unit 3

Complexity- Complexity Classes: P, NP, NP Hard and NP Complete problems. NP Completeness reductions for Travelling Salesman Problem and Hamiltonian Cycle.P versus NP problem.

Unit 4

Design and Analysis of Parallel Algorithms: PRAM models – EREW, ERCW, CREW and CRCW, Relation between various models, Handling read and write conflicts, work efficiency, Brent's theorem. Analyzing Parallel Algorithms: Time Complexity, Cost, Number of Processors, Space Complexity, Speed up, Efficiency, Scalability, Amdahl's Law. Euler Tour Technique, Parallel prefix computation, Parallel merging and sorting.

References Books:

1. Thomas H Cormen, Charles E Leiserson, and Ronald L Rivest, Introduction to Algorithms, 3rd Edition, Prentice Hall of India Private Limited, New Delhi
2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley
3. Pallaw, V K, Design and Analysis of Algorithms, Asian Books Private Ltd, 2012.
4. Razdan S, Fundamentals of Parallel Computing, Narosa Publishing House, 2014.
5. Pandey H M, Design and Analysis of Algorithms, University Science Press, 2013
6. Upadhyay, N, Design and Analysis of Algorithms, SkKataria& Sons, 2008.
7. U. Manber, Introduction to Algorithms: A Creative Approach, Addison Wesley,
8. Gilles Brassard and Paul Bratley, Fundamentals of Algorithmics, Prentice-Hall of India
9. Goodman S E and Hedetniemi, Introduction to the Design and Analysis of Algorithms, Mcgraw Hill
10. Horowitz E and Sahni S, Fundamentals of Computer Algorithms, Galgotia Publications Pvt. Ltd
11. OdedGoldreich, P,NP and NP- Completeness, Cambridge University Press, 2011.
12. Donald Knuth, The Art of Computer Programming, Fundamental Algorithms,Volume- 1, Addison Wesley, 1997.
13. SanjeevArora and Boaz Borak, Computational Complexity- A Modern Approach, Cambridge University Press; 2009.
14. Daniel Hills W and Bruce M Boghosian, Parallel Scientific Computation, Science, Vol 261, Pp. 856-863

MSCCS04E38 CYBER PHYSICAL SYSTEMS

Contact Hours/ week: 3

Credit: 3

Course Learning	**CO1**:Categorize the essential modeling formalisms of Cyber-Physical Systems (CPS).

Outcomes:	**CO2:**Analyze the functional behavior of CPS based on standard modeling formalisms. **CO3**:Implement specific software CPS using existing synthesis tools. **CO4**:Design CPS requirements based on operating system and hardware architecture constraints. **CO5**:Analyze and verify the correctness of CPS implementations against system requirements and timing constraints.

Unit 1

Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS, CPS HW platforms: Processors, Sensors, Actuators, CPS Network, CPS SW stack RTOS, Scheduling Real Time control tasks. Principles of Automated Control Design: Dynamical Systems and Stability, Controller Design Techniques.

Unit 2

Stability Analysis: CLFs, MLFs, stability under slow switching, Performance under Packet drop and Noise. CPS : From features to software components, Mapping software components to ECUs, CPS Performance Analysis : effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, Formal Methods for Safety Assurance of Cyber-Physical Systems.

Unit 3

Advanced Automata based modelling and analysis: Basic introduction and examples ,Timed and Hybrid Automata, Definition of trajectories, zenoness, Formal Analysis: Flow pipe construction, reachability analysis, Analysis of CPS Software, Weakest Pre-conditions, Bounded Model checking.

Unit 4

Hybrid Automata Modelling :Flowpipe construction using Flowstar, SpaceX and Phaver tools, CPS SW Verification: Frama-C, CBMC, Secure Deployment of CPS : Attack models, Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study : Vehicle ABS hacking, Power Distribution Case study : Attacks on Smart grid.

Reference books:

1. E. A. Lee and S. A. Seshia, “Introduction to Embedded Systems: A Cyber-Physical Systems Approach”, 2011.
2. R. Alur, “Principles of Cyber-Physical Systems,” MIT Press, 2015.
3. T. D. Lewis “Network Science: Theory and Applications”, Wiley, 2009.
4. P. Tabuada, “Verification and control of hybrid systems: a symbolic approach”, Springer-Verlag 2009.
5. C. Cassandras, S. Lafortune, “Introduction to Discrete Event Systems”, Springer 2007.
6. Constance Heitmeyer and Dino Mandrioli, “Formal methods for real-time computing”, Wiley publisher, 1996.

5. OPEN ELECTIVE COURSES

5.1THE DETAILED SYLLABUS – OPEN ELECTIVE COURSES

MSCCS04O01 PRINCIPLES OF PROGRAMMING AND NUMERICAL METHODS

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1:** Acquainted with Numerical Methods. **CO2:** Obtain the knowledge about Errors and Approximations. **CO3:** Ripen skill in programming **CO4:** Understanding the basic concepts of Python programming.

Unit 1

Introduction to Programming: Basic concepts, algorithm, flow chart, programming languages – classification. Syntax and semantics of programming languages- Imperative and OO Languages- Functional Languages-Logic Programming Languages.

Features of Python, Different Methods to Run Python, Basic Elements (Objects, Expressions, Numerical Types, Strings, Variables), Comments, Indentation in Python, Input and Output in Python, import function, Operators in Python, Branching (if, else, elif), Iteration (while, for), range and enumerate functions, Tuples, Lists, Sets, Dictionaries, Built-in methods of lists, sets and dictionaries, Mutable and Immutable Objects.

Unit 2

Functions Definition, Function Calling, Function Arguments (Required, Keyword, Default), Recursion, Modules, Built-in Modules, Creating Modules, File Handling (Opening, Closing,

Writing, Reading), Exceptions, Built-in Exceptions (IndexError, OverflowError, ZeroDivisionError, RuntimeError), Exception Handling. Class Definition, Object Creation, Built-in Attribute Methods, Object Oriented Programming Features of Python. Arrays in Python, Numpy Module, ndarray, Creating Arrays (array, zeros, ones, empty, linspace, arrange, random), Two-Dimensional Array, Indexing, Slicing, Iterating, Copying, Splitting, Shape Manipulation (reshape, transpose, resize), Arithmetic Operations on Arrays. Data Visualization in Python matplotlib Module, pyplot, plot(), scatter, bar charts, Formatting, figure(), subplot(), text(), xlabel(), ylabel(), title(), Plotting Simple Mathematical Functions (sin x, x^2).

Unit 3

Introduction to Numerical Methods: Nature of numerical problems; computer based solutions. Errors and Approximations.Nonlinear equations – Bisection Method, Regular- Falsie Method, Newton-Raphson.System of Linear Equations- Gauss elimination, Gauss Jordan elimination, Triangulation method, Iterative method, Jacobi.Case study by writing algorithms.

Unit 4

Numerical Integration and Differentiation: Concept of differentiation and Integration. Taylors series and Eulers methods-Simpson's Romberg, Gaussian, Runge- Kutta methods. Case study by writing algorithms.

Reference Books:

1. Discrete Mathematical Structures with Application to Computer Science-McGraw Hill
2. Introductory Methods of Numerical Analysis – January 2012 PHI bySastry S.S
3. Balagurusamy, E., "Numerical Methods", Tata McGraw-Hill, New Delhi, 1999.
4. R.G.Dromey , How to solve it by computer, Pearson education, fifth edition, 2007.
5. Taming Python By Programming, Dr. Jeeva Jose, Khanna Publishing
6. Introduction to Computation and Programming Using Python with Application to Understanding Data - John V. Guttag, PHI (2016)
7. https://www.numpy.org/devdocs/user/quickstart.html
8. https://matplotlib.org/users/pyplot_tutorial.html

MSCCS04O02 JAVA PROGRAMMING

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1:** appreciate object-oriented concepts – Classes, Objects, Inheritance, Polymorphism – for problem solving. **CO2:** handle program exceptions. **CO3:** design, implement, document, test, and debug a

	Java application consisting of multiple classes. **CO4 :**handle input/output through files. **CO5 :**create Java applications with graphical user interface (GUI).

Unit-1
Review of Programming Concepts: program, identifiers, variables, constants, primitive data types, expressions, control statements, structured data types, arrays, functions.

Unit-2
Object Oriented Concepts: Abstraction, encapsulation, objects, classes, methods, constructors, inheritance, polymorphism, static and dynamic binding, overloading, Abstract classes, Interfaces and Packages**.**

Unit-3
File Handling: Byte Stream, Character Stream, File I/O Basics, File Operations, Serialization**.**

Unit-4
Exception handling: Throw and Exception, Throw, try and catch Blocks, Multiple Catch Blocks, Finally Clause, Throwable Class, Types of Exceptions, java.lang Exceptions, Built-In Exceptions**.** GUI Design**:** GUI based I/O, Input and Message Dialog boxes, Swng components, Displaying text and images in windows.

Reference Books:
1.James Gosling, Bill Joy, Guy L. Steele Jr, GiladBracha, Alex Buckley, The Java Language Specification, Java SE 7 Edition, Addison-Wesley, 2013.
2. Cay S. Horstmann, Core Java - Vol. I – Fundamentals, 10th Edition, Pearson, 2017.
3. Deitel&Deitel, Java-How to Program (9th ed.), Pearson Education, 2012.
4. Richard Johnson, An Introduction to Java Programming and Object-Oriented Application Development, Thomson Learning, 2006.
5. Herbert Schildt, Java: The Complete Reference, 10th Edition, McGraw-Hill Education, 2018.

MSCCS04O03 MACHINE LEARNING

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1:** appreciate machine learning approach to Artificial Intelligence, and understand fundamental issues and challenges of supervised and unsupervised learning techniques. **CO2:** design and implement supervised and unsupervised machine learning algorithms for real-world applications, while understanding the strengths and weaknesses. **CO3:** appreciate the underlying mathematical relationships within and across Machine Learning algorithms.

	CO4: fine tune machine learning algorithms and evaluate models generated from data.

Unit-1

Introduction: Learning theory. Basics: Introduction to Machine Learning - Different Forms of Learning, Basics of Probability Theory, Linear Algebra and Optimization. Regression Analysis: Linear Regression, Ridge Regression, Lasso, Bayesian Regression, Regression with Basis Functions

Unit-2

Supervised learning: Linear separability and decision regions, Linear discriminants, Bayes optimal classifier, Linear regression, Standard and stochastic gradient descent, Lasso and Ridge Regression, Logistic regression, Support Vector Machines, Artificial Neural Networks ,Perceptron, Back propagation, , Decision Tree Induction, Overfitting, Pruning of decision trees, Bagging and Boosting, Dimensionality reduction and Feature selection. Support VectorMachines: Structural and empirical risk, Learning nonlinear hypothesis using kernel functions.

Unit-3

Unsupervised learning: Clustering, Mixture models, Expectation Maximization, Spectral Clustering, Non-parametric density estimation. Dimensionality Reduction: Principal Component Analysis, Independent Component Analysis, Multidimensional Scaling, and Manifold Learning. Reinforcement Learning: Q-Learning, Temporal Difference Learning

Unit-4

Introduction to Deep Networks: Fundamentals of deep learning, Deep Feedforward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Introduction to Convolutional Networks, Sequence Modelling using Recurrent Nets, overview of LSTM, fundamentals of Generative adversarial Network.

Readings:

1. E. Alpaydin, Introduction to Machine Learning, 3rd Edition, Prentice Hall of India, 2014.
2. T Hastie, R Tibshirani and J Friedman, The Elements of Statistical Learning Data Mining, Inference, and Prediction, 2nd Edition, Springer, 2009.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2010.
4. R. O. Duda, P. E. Hart, and D.G. Stork, Pattern Classification, John Wiley and Sons, 2012.
5. Simon O. Haykin, Neural Networks and Learning Machines, Pearson Education, 2016
6. Machine Learning. Tom Mitchell.Additional Textbooks:
7. Pattern Classification. R.O. Duda, P.E. Hart and D.G. Stork.
8. Data Mining: Tools and Techniques. Jiawei Han and MichellineKamber.
9. Elements of Statistical Learning. Hastie, Tibshirani and Friedman.Springer.

MSCCS04O04 FOUNDATION IN DATA SCIENCE

Contact Hours/ week: 4

Credit: 4

Course	**CO1:** Demonstrate proficiency with statistical analysis of data.

Learning Outcomes:	**CO2:** Develop the ability to build and assess data-based models. **CO3:** Execute statistical analyses and interpret outcomes. **CO4:** Apply data science concepts and methods to solve problems in real-world contexts and will communicate these solutions effectively.

Unit-1

Introduction: Introduction data acquisition, data preprocessing techniques including data cleaning, selection, integration, transformation and reduction, data mining, interpretation.

Unit-2

Statistical data modeling: Review of basic probability theory and distributions, correlation coefficient, linear regression, statistical inference, exploratory data analysis and visualization.

Unit-3

Predictive modeling: Introduction to predictive modeling , decision tree, nearest neighbor classifier and naïve Baye's classifier, classification performance evaluation and model selection.

Unit-4

Descriptive Modeling: Introduction to clustering, partitional, hierarchical, and density-based clustering (k-means, agglomerative, and DBSCAN), outlier detection, clustering performance evaluation. Association Rule Mining: Introduction to frequent pattern mining and association rule mining, Apriori algorithm, measures for evaluating the association patterns. Text Mining: Introduction of the vector space model for document representation, term frequency-inverse document frequency (tf-idf) approach for term weighting, proximity measures for document comparison, document clustering and text classification**.**

Reference Books:

1. W. McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy and iPython, 2nd Ed., O'Reilly, 2017.
2. P. Tan, M. Steinbach, AKarpatne, and V. Kumar, Introduction to Data Mining, 2nd Ed., Pearson Education, 2018.
3. G James, D Witten, T Hastie and R TibshiraniAn Introduction to Statistical Learning with Applications in R, Springer Texts in Statistics, Springer, 2013.
4. G. Grolemund, H. Wickham, R for Data Science, 1st Ed., O'Reilly, 2017.

MSCCS04O05 DIGITAL SIGNAL PROCESSING

Contact Hours/ week: 4

Credit: 4

Course Learning	**CO1:**To study the modern digital signal processing algorithms and

Outcomes:	applications. **CO2:** To study the analysis of discrete time signals. **CO3:** Comprehensive knowledge to use of digital systems in real time applications **CO4**: Apply the algorithms for wide area of recent applications.

Unit 1

Signals and Signal Processing - Characterization and classification of Signals, Typical signal processing operations, Typical Signal Processing Applications, Advantage of Digital Signal Processing.

Unit 2

Classification of signals –Introduction to vector space - The concept of frequency in continuous and discrete time signals -Sampling of analog signals – Sampling theorem – Quantization and Coding – Digital to analog conversion .

Unit 3

Time Domain Representation of signals and systems - Discrete time signals, Operations on sequences, Discrete time Systems, Linear Time invariant Discrete Time Systems-convolution sum – correlation of discrete time signals , Z-Transform.

Unit 4

Frequency Analysis of Signals - Frequency Analysis of Continuous Time Signals, Frequency Analysis of Discrete Time Signals, Fourier Transform of discrete time signals –Discrete Fourier Transform (DFT). FFT(Qualitative idea only)-Wavelet Transform - FIR and IIR Filters

Reference Books:

1.Proakis, John G. and Dimitris G. Manolakis. *Digital signal processing: principles algorithms and applications*. Pearson Education India, 2001.
2.Roberts, Michael J. *Signals and systems: analysis using transform methods and MATLAB*. McGraw-Hill Higher Education, 2011.
3. Oppenheim, Alan V., and Ronald W. Schafer. Digital Signal Processing [by] Alan V. Oppenheim [and] Ronald W. Schafer.Prentice-Hall, 1975.
4. Antoniou, Andreas. *Digital signal processing*.McGraw-Hill, 2016.
5. Rabiner, Lawrence R., Bernard Gold, and C. K. Yuen. *Theory and application of digital signal processing*. Prentice-Hall, 2007.

MSCCS04O06 QUANTUM COMPUTING AND INFORMATION THEORY

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1** :Basics of complex vector spaces **CO2** :Quantum mechanics as applied in Quantum computing **CO3** :Architecture and algorithms

	CO4 :Fundamentals of Quantum computations.

Unit 1

Introduction to Quantum Computation: Quantum bits, Bloch sphere representation of a cubit, multiple cubits.

Unit 2

Background Mathematics and Physics: Hilbert space, Probabilities and measurements, entanglement, density operators and correlation, basics of quantum mechanics, Measurements in bases other than computational basis.

Unit 3

Quantum Circuits: single qubit gates, multiple qubit gates, design of quantum circuits.

Unit 4

Quantum Information and Cryptography: Comparison between classical and quantum information theory. Bell states.Quantumteleportation.Quantum Cryptography, no cloning theorem. Quantum Algorithms: Classical computation on quantum computers. Relationship between quantum and classical complexity classes.Deutsch's algorithm, Deutsch's-Jozsa algorithm, Shor factorization, Grover search.

Reference Books:

1. Nielsen M. A., *Quantum Computation and Quantum Information*, Cambridge University Press.-2002.
2. Benenti G., Casati G. and Strini G., *Principles of Quantum Computation and Information*, Vol. I: Basic Concepts, Vol II: Basic Tools and Special Topics, World Scientific.-2004.
3. Pittenger A. O., *An Introduction to Quantum Computing Algorithms*-2000.

MSCCS04O07 DESIGN AND ANALYSIS OF ALGORITHMS

Contact Hours/ week: 4

Credit: 4

Course Learning Outcomes:	**CO1:** Accomplish Knowledge about important computational problems. **CO2:** Acquire knowledge to design the algorithm. **CO3:** Study to analyze a given algorithm. **CO4:** Obtain knowledge to analyze algorithm control structures and solving recurrence. **CO5:** Attain information about Complexity Classes

	CO6: Accomplish knowledge about Parallel Algorithms

Unit I

Algorithm Design: Introduction, Steps in developing algorithm, Methods of specifying an algorithm, Decisions prior to designing: based on the capabilities of the device, based on the nature of solutions, based on the most suitable data structures. Important Problem Types: Sorting, Searching, String processing, Graph problems, Combinatorial problems, Geometric problems and Numerical problems. Basic Technique for Design of Efficient Algorithm: Brute Force approach (String matching), Divide-and-Conquer approach (Merge sort), Branch-and-Bound technique (Knapsack problem). Greedy approach (Kruskal's algorithm and Prim's Algorithm), Dynamic Programming (Longest Common Subsequence), Backtracking(Sum of subsets problem).

Unit II

Algorithm Analysis: Importance of algorithm analysis, Time and Space Complexity. Growth of Functions: Asymptotic notations, Cost estimation based on key operations- Big Oh, Big Omega, Little Oh, Little Omega and Theta notations, Big Oh Ratio Theorem, Big Theta Ratio Theorem, Big Omega Ratio Theorem. Analyzing Algorithm Control Structures, Solving Recurrences: Iteration Method, Substitution Method, The Recursion Tree Method, Master's Theorem, Problem solving using Master's Theorem Case 1, Case 2 and Case 3. Analysis of Strasser's algorithm for matrix multiplication, Analysis of Merge sort.

Unit III

Complexity- Complexity Classes: P, NP, NP Hard and NP Complete problems. NP Completeness reductions for Travelling Salesman Problem and Hamiltonian Cycle. P versus NP problem.

Unit IV

Design and Analysis of Parallel Algorithms: PRAM models – EREW, ERCW, CREW and CRCW, Relation between various models, Handling read and write conflicts, work efficiency, Brent's theorem. Analyzing Parallel Algorithms: Time Complexity, Cost, Number of Processors, Space Complexity, Speed up, Efficiency, Scalability, Amdahl's Law. Euler Tour Technique, Parallel prefix computation, Parallel merging and sorting.

References:

1. Thomas H Cormen, Charles E Leiserson, and Ronald L Rivest, Introduction to Algorithms, 3rd Edition, Prentice Hall of India Private Limited, New Delhi
2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, The Design and Analysis of Computer Algorithms, Addison Wesley
3. Pallaw, V K, Design and Analysis of Algorithms, Asian Books Private Ltd, 2012.
4. Razdan S, Fundamentals of Parallel Computing, Narosa Publishing House, 2014.
5. Pandey H M, Design and Analysis of Algorithms, University Science Press, 2013
6. Upadhyay, N, Design and Analysis of Algorithms, Sk Kataria & Sons, 2008.
7. U. Manber, Introduction to Algorithms: A Creative Approach, Addison Wesley,
8. Gilles Brassard and Paul Bratley, Fundamentals of Algorithmics, Prentice-Hall of India

9. Goodman S E and Hedetniemi, Introduction to the Design and Analysis of Algorithms, Mcgraw Hill
10. Horowitz E and Sahni S, Fundamentals of Computer Algorithms, Galgotia Publications Pvt. Ltd
11. Oded Goldreich, P,NP and NP- Completeness, Cambridge University Press, 2011.
12. Donald Knuth, The Art of Computer Programming, Fundamental Algorithms,Volume- 1, Addison Wesley, 1997.
13. Sanjeev Arora and Boaz Borak, Computational Complexity- A Modern Approach, Cambridge University Press; 2009.
14. Daniel Hills W and Bruce M Boghosian, Parallel Scientific Computation, Science, Vol 261, Pp. 856-863