# CURRICULUM AND DETAILED SYLLABI

FOR

## M.TECH DEGREE PROGRAMME

IN

## COMPUTER SCIENCE AND ENGINEERING

**2022 SCHEME**

**(AUTONOMOUS)**


**MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY**

(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)

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## CURRICULUM UNDER AUTONOMY STATUS

**Medium of Instruction: English**

### i) Knowledge Segments and Credits

Every course of M. Tech Programme is placed in one of the seven categories as listed in table below. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

| Sl. No. | Category | Category Code | Number of Courses | Total Credits |
|---|---|---|---|---|
| 1 | Discipline Core Courses | DCC | 2 | 6 |
| 2 | Programme Core Courses | PCC | 3 | 9 |
| 3 | Programme Elective Courses | PEC | 4 | 12 |
| | MOOC | | 1 | 2 |
| 4 | Industry/Interdisciplinary Elective | IEC | 1 | 3 |
| 5 | Mandatory Credit Course (Research Methodology) | RM | 1 | 2 |
| 6 | Laboratory Courses | LBC | 2 | 2 |
| 7 | Mini Project | PR | 1 | 2 |
| 8 | Project | | 2 | 27 |
| 9 | Internship | | 1 | 3 |
| **Total Mandatory Credits** | | | | **68** |

**ii) Semester-wise Credit Distribution**

| *Semester* | *I* | *II* | *III* | *IV* | *Total Credits* |
|---|---|---|---|---|---|
| *Credits for Courses* | *18* | *18* | *16* | *16* | ***68*** |

**iii) Weightage of the CIA and ESE for various categories of the courses**

| Sl. No. | Category | CIA weightage | ESE weightage | Pass minimum |
|---|---|---|---|---|
| 1 | Discipline Core Courses | 40% | 60% | 45% for ESE and 50% for (CIA & ESE) put together |
| 2 | Programme Core Courses | 40% | 60% | 45% for ESE and 50% for (CIA & ESE) put together |
| 3 | Programme Elective Courses | 40% | 60% | 45% for ESE and 50% for (CIA & ESE) put together |
| 4 | Lab Courses/ Mini Project | 100% | --- | 50% for CIA |
| 5 | MOOC | --- | --- | As stipulated by the agency conducting MOOC |
| 6 | Research Methodology & IPR | 40% | 60% | 45% for ESE and 50% for (CIA & ESE) put together |
| 7 | Internship | 50% | 50% | 45% for ESE and 50% for (CIA & ESE) put together |
| 8 | Dissertation/ Research Project Phase I | 100% | --- | 50% for CIA |
| 9 | Dissertation/ Research Project Phase II | 50% | 50% | 45% for ESE and 50% for (CIA & ESE) put together |

**iv)PATTERN OF ASSESSMENT**

## 1. CORE COURSES

### a) Continuous Internal Assessment: 40 Marks

| | |
|---|---|
| Micro project/ Course based project:<br>The project shall be done individually. Group projects not permitted. | **20 Marks** |
| Course based task/ Seminar/ Quiz: | **10 Marks** |
| One Continuous assessment Test (CAT):<br>(CAT shall include minimum 80% of the syllabus) | **10 Marks** |

| | |
|---|---|
| **Total** | **40 marks** |

**Pattern of Continuous Assessment Test**

- The maximum marks for Continuous assessment test is 50 and duration is 2 hours.
- The question paper will have two parts: Part A and Part B.

**Part A** contain 4 questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions.

**Part B** contains 6 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 6 marks. Total duration of the examination will be 120 minutes.

**b) Pattern of End Semester Examination**

- The maximum marks for End semester examination is 60 and duration is 2½ hours.
- The question paper will have two parts: Part A and Part B.

**Part A** contain 5 questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions.

**Part B** contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

## 2. ELECTIVE COURSES

**a) Continuous Internal Assessment : 40 Marks**

| | |
|---|---|
| Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred) : | **15 Marks** |
| Course based task/ Seminar/ Data collection and interpretation: | **15 Marks** |
| One Continuous assessment Test (CAT):<br>CAT shall include the first four modules of the syllabus | **10 Marks** |
| **Total** | **40 Marks** |

**Pattern of Continuous Assessment Test**

- The maximum marks for Continuous assessment test is 50 and duration is 2 hours.

- The question paper will have two parts: Part A and Part B.

**Part A** contain 4 questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions.

**Part B** contains 6 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 6 marks. Total duration of the examination will be 120 minutes.

**b) Pattern of End Semester Examination**

- The maximum marks for End semester examination is 60 and duration is 2½ hours.
- The question paper will have two parts: Part A and Part B.

Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

## 3. RESEARCH METHODOLOGY & IPR/AUDIT COURSE

**a) Continuous Internal Assessment : 40 Marks**

| | |
|---|---|
| Course based task: | **15 Marks** |
| Seminar/ Quiz: | **15 Marks** |
| Continuous assessment Test (CAT), 1 No:<br>CAT shall include the first four modules of the syllabus | **10 Marks** |
| **Total** | **40 Marks** |

**Pattern of Continuous Assessment Test**

- The maximum marks for Continuous assessment test is 50 and duration is 2 hours.

The question paper shall contain 6 questions, with minimum one question from each module, of which student should answer any four. Each question shall carry 12½ marks.

**b) Pattern of End Semester Examination**

- The maximum marks for End semester examination is 60 and duration is 2½ hours.

The question paper shall contain 7 questions, with minimum one question from each module, of which student should answer any five. Each question shall carry 12 marks.

## 4. INDUSTRY ELECTIVES

**a) Continuous Internal Assessment : 40 Marks**

| | |
|---|---|
| Preparing a review article based on peer reviewed Original publications (minimum 10 publications shall be referred) : | **20 Marks** |
| Course based task/ Seminar/ Data collection and interpretation: | **10 Marks** |
| One Continuous assessment Test (CAT):<br>CAT shall include the first four modules of the syllabus | **10 Marks** |
| **Total** | **40 Marks** |

**Pattern of Continuous Assessment Test**

- The maximum marks for Continuous assessment test is 50 and duration is 2 hours.
- The question paper will have two parts: Part A and Part B.

**Part A** contain 4 questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions.

**Part B** contains 6 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 6 marks. Total duration of the examination will be 120 minutes.

**The continuous internal evaluation will be done by the expert in the industry/ the faculty handling the course**

**c) Pattern of End Semester Examination**

- The maximum marks for End semester examination is 60 and duration is 2½ hours.
- The question paper will have two parts: Part A and Part B.

Part A will contain 5 short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills,

comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions.

Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

## 5. INTERNSHIP

### a) Continuous Internal Assessment : 50 Marks

| | |
|---|---|
| Student's diary/ Daily Log: | **25 Marks** |
| Evaluation done by the Industry: | **25 Marks** |
| **Total** | **50 Marks** |

### b) Pattern of End Semester Examination : 50 Marks

| | |
|---|---|
| Internship Report | **25 Marks** |
| Comprehensive Viva Voce | **25 Marks** |
| **Total** | **50 Marks** |

## b) LABORATORY COURSES

- The laboratory courses will be having only Continuous Internal Assessment and carries 100 marks.
- Final assessment shall be done by two examiners; one examiner will be a senior faculty from the same department.

## c) MINI PROJECT

### a) Interim Evaluation: 40 Marks

- 20 marks for each review

### b) Final Evaluation : 60 Marks

| | |
|---|---|
| Evaluation by a Committee:<br>(The committee will evaluate the level of completion and demonstration of functionality/specifications, clarity of presentation, oral examination, work knowledge and involvement). | **35 Marks** |

| | |
|---|---|
| Report:<br>(The committee will evaluate the technical content, adequacy of references, templates followed and permitted plagiarism level is not more than 25%). | **15 Marks** |
| Supervisor/ Guide: | **10 Marks** |
| **Total** | **60 Marks** |

### d) RESEARCH PROJECT/DISSERTATION

| | |
|---|---|
| Phase I: | Total marks: 100 marks, CIA = 100 marks |
| Phase II: | Total marks: 200 marks, CIA = 100 marks<br>ESE = 100 marks |
| **Total** | **300 Marks** |

### vi) Minimum Cumulative Credit Requirements for Registering to Higher Semesters

| Semester | Allotted credits | Cumulative credits | Minimum credits required |
|---|---|---|---|
| **M1** | 18 | 18 | Not Applicable |
| **M2** | 18 | 36 | Not Insisted |
| **M3** | 16 | 52 | 12 credits from M1 |
| **M4** | 16 | 68 | Not Insisted |

### vii) Grade and Grade Points

| Grades | Grade Point | % of Total marks obtained in the course |
|---|---|---|
| S | 10 | 90% and above |
| A+ | 9 | 85% and above but less than 90% |
| A | 8.5 | 80% and above but less than 85% |
| B+ | 8 | 75% and above but less than 80% |
| B | 7.5 | 70% and above but less than 75% |
| C+ | 7 | 65% and above but less than 70% |
| C | 6.5 | 60% and above but less than 65% |
| D | 6 | 55% and above but less than 60% |
| P (Pass) | 5.5 | 50% and above but less than 55% |
| F (Fail) | 0 | Below 50% (CIA + ESE) or Below 45% for ESE |
| FE | 0 | Failed due to lack of eligibility criteria |

| | | |
|---|---|---|
| AB | 0 | Could not appear for the ESE, but fulfils the eligibility criteria |
| I | 0 | Failure to submit the certificate of successful completion of MOOC by the end of Semester 3 |

**Semester I (M1)**

| Slot | Course Type | Course No | Course | Marks | | Hours L - T - P | Credits |
|---|---|---|---|---|---|---|---|
| | | | | CIA | ESE | | |
| A | DCC | 22MA060A | Mathematical Foundations of Computing Systems | 40 | 60 | 3 – 0 - 0 | 3 |
| B | PCC | 22CS161A | Parallel Computer Architecture | 40 | 60 | 3 – 0 - 0 | 3 |
| C | PCC | 22CS161B | Advanced Data Structures and Algorithms | 40 | 60 | 3 – 0 - 0 | 3 |
| D | PEC | 22CS1XXX | Program Elective 1 | 40 | 60 | 3 – 0 - 0 | 3 |
| E | PEC | 22CS1XXX | Program Elective 2 | 40 | 60 | 3 – 0 - 0 | 3 |
| S | RM | 22MC161A | Research Methodology & IPR | 40 | 60 | 2 – 0 - 0 | 2 |
| T | LBC | 22CS169A | Algorithm Design Laboratory | 100 | - | 0 – 0 - 2 | 1 |
| | | | **Total** | **340** | **360** | **19** | **18** |

**Teaching Assistance: 6 hours**

**Semester II (M2)**

| Slot | Course Type | Course No | Course | Marks | | Hours L - T - P | Credits |
|---|---|---|---|---|---|---|---|
| | | | | CIA | ESE | | |
| A | DCC | 22CS160A | Advanced Computer Networks | 40 | 60 | 3 – 0 - 0 | 3 |
| B | PCC | 22CS161C | Topics in Database Technology | 40 | 60 | 3 – 0 - 0 | 3 |
| C | PEC | 22CS1XXX | Program Elective 3 | 40 | 60 | 3 – 0 - 0 | 3 |
| D | PEC | 22CS1XXX | Program Elective 4 | 40 | 60 | 3 – 0 - 0 | 3 |
| E | IEC | 22CS1XXX | Industry/Interdisciplinary Elective | 40 | 60 | 3 – 0 - 0 | 3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| S | PR | 22CS167A | Mini project | 100 | - | 0 – 0 - 4 | 2 |
| T | LBC | 22CS169B | Network Systems Lab | 100 | - | 0 – 0 - 2 | 1 |
| | | | **Total** | **400** | **300** | **21** | **18** |

**Teaching Assistance: 6 hours**

**Semester III (M3)**

| **Slot** | **Course Type** | **Course No** | **Course** | **Marks** | | **Hours L - T - P** | **Credits** |
|---|---|---|---|---|---|---|---|
| | | | | **CIA** | **ESE** | | |
| **TRACK 1** | | | | | | | |
| A* | MOOC | | MOOC | To be successfully completed | | - | 2 |
| B | AC | 22AC071A | Audit Course | 40 | 60 | 3 – 0 - 0 | - |
| C | PR | 22CS178A | Internship | 50 | 50 | - | 3 |
| D | PR | 22CS178B | Dissertation Phase I | 100 | - | 0 – 0 - 17 | 11 |
| **TRACK 2** | | | | | | | |
| A* | MOOC | | MOOC | To be successfully completed | | - | 2 |
| B | AC | 22AC171A | Audit Course | 40 | 60 | 3 – 0 - 0 | - |
| C | PR | 22CS178A | Internship | 50 | 50 | - | 3 |
| D | PR | 22CS178B | Research project Phase I | 100 | - | 0 – 0 - 17 | 11 |
| | | | **Total** | **190** | **110** | **20** | **16** |

**Teaching Assistance: 6 hours**

*MOOC must be successfully completed before the commencement of fourth semester. This course can be carried out at any time from M1 to M3.

**Semester IV (M4)**

| Slot | Course Type | Course No | Course | Marks | | Hours L - T - P | Credits |
|---|---|---|---|---|---|---|---|
| | | | | CIA | ESE | | |
| **TRACK 1** | | | | | | | |
| D | PR | 22CS178C | Dissertation Phase II | 100 | 100 | 0 – 0 - 24 | 16 |
| **TRACK 2** | | | | | | | |
| D | PR | 22CS178C | Research project Phase II | 100 | 100 | 0 – 0 - 24 | 16 |
| **Total** | | | | **100** | **100** | **24** | **16** |

**Teaching Assistance: 5 hours**

**Program Elective courses**

| # | Course code | Course Name |
|---|---|---|
| **1.** | **22CS162A** | Data Mining &Warehousing |
| **2.** | **22CS162B** | Data Compression Techniques |
| **3.** | **22CS162C** | Advanced Topics in Distributed Systems |
| **4.** | **22CS162D** | Image and Video Processing |
| **5.** | **22CS162E** | Semantic Web Technology |
| **6.** | **22CS162F** | Principles of Information and Network Security |
| **7.** | **22CS162G** | Number Theory and Cryptology |
| **8.** | **22CS162H** | Parallel Algorithms |
| **9.** | **22CS162I** | Soft Computing Techniques in Bioinformatics |
| **10.** | **22CS162J** | Computational Geometry |

| | | |
|---|---|---|
| **11.** | **22CS162K** | Advanced Complier Design |
| **12.** | **22CS162L** | Fuzzy set Theory and Applications |
| **13.** | **22CS162M** | Applied Machine Learning |
| **14.** | **22CS162N** | Advanced Graph Theory |
| **15.** | **22CS162O** | Essentials of Cyber Security |
| **16.** | **22CS162P** | Information Retrieval |
| **17.** | **22CS162Q** | Block Chain |
| **18.** | **22CS162R** | Network on Chip |
| **19.** | **22CS162S** | Natural Language Processing |
| **20.** | **22CS162T** | Deep Learning |

**Interdisciplinary courses**

| # | Course code | Course Name | Offering Department |
|---|---|---|---|
| **1.** | **22CS165A** | Pattern Recognition | CSE |
| **2.** | **22CS165B** | Cloud computing and security | CSE |
| **3.** | **22CS165C** | Data Science | CSE |
| **4.** | **22CS165D** | Machine Learning | CSE |

**Industry Elective courses**

| # | Course code | Course Name | Offering Department |
|---|---|---|---|
| **1.** | **22CS166A** | Cyber Forensics Basics | CSE |
| **2.** | **22CS166B** | Stream Processing and Analytics | CSE |

# DISCIPLINE CORE COURSES (DCC)

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22MA060A | MATHEMATICAL FOUNDATIONS OF COMPUTING SYSTEMS | DCC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OVERVIEW**

Goal of this course is to expose the students to the fundamental concepts of counting techniques, theorem proving. It also introduces the idea of graphs, trees and graphs theoretic algorithms.

**ii)COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO 1 | Construct proofs using direct proofs, proof by contraposition, proof by contradiction and proof by cases | Apply |
| CO 2 | Solve problems using counting techniques and combinatorics. | Apply |
| CO 3 | Apply the concept of random variables, probability distributions in practical distributions. | Apply |
| CO 4 | Demonstrate the knowledge of fundamental concepts of graph theory | Apply |
| CO 5 | Identify and solve problems using different algebraic structures. | Apply |

**iii)SYLLABUS**

Techniques for theorem proving, Principle of mathematical induction, principle of complete induction. Recursive definitions, Generating functions, Fundamental principles of counting, pigeonhole principle, countable and uncountable sets, principle of inclusion and exclusion – applications, derangements, permutation and combination, theory – Properties of Probability, Methods of Enumeration, Conditional Probability, Independent Events, Bayes Theorem, Mathematical Expectation, Random variables Discrete Distribution, Binomial Distribution, Mean and variance The Poisson Distribution, Continuous Distribution. Uniform and Exponential Distributions, Normal Distribution, Graphneys and algorithms, Groups and subgroups, homomorphism theorems, cosets and normal subgroups, Lagrange's theorem, rings, finite fields.

**iv) REFERENCES**

1) J. P. Tremblay, R. Manohar, "Discrete Mathematical Structures with Application to Computer Science", Tata McGraw Hill, 2000.
2) Kenneth H. Rosen, "Discrete Mathematics and its Applications", 7/e, McGraw Hill Inc, 2011.
3) Robert V. Hogg, Elliot A. Tanis, Meda J. M. Rao,"Probability and Statistical Inference", 7/e,, Pearson Education India, 2006.

4) J. Truss, "Discrete Mathematics for Computer Scientists", 2/e, Addison Wesley, 1999. Bernard Kolman, Robert C Busby,SharonKutler Ross, "Discrete Mathematical Structures", 2/e, Prentice-Hall India Private Limited, 1996.

5) Ralph P. Grimaldi , B.V Ramana, Discrete and Combinatorial Mathematics, Fifth Edition, Pearson 2016

6) Doulgas B West, Introduction to Graph Theory, Prentice Hall India Ltd.

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| **I** | Techniques for theorem proving: Direct Proof, Proof by Contra position, Proof by exhausting cases and proof by contradiction , Principle of mathematical induction, principle of complete induction. Fundamental principles of counting, pigeonhole principle, countable and uncountable sets, principle of inclusion and exclusion – applications, derangements, permutation and combination, Pascal's triangles, binomial theorem | 9 |
| **II** | Recursive definitions, Generating functions, function of sequences calculating coefficient of generating function, solving recurrence relation by substitution and generating functions Solution methods. | 9 |
| **III** | Probability theory – Properties of Probability, Methods of Enumeration, Conditional Probability, Independent Events, Bayes Theorem, Mathematical Expectation, Random variables, Discrete Distribution, Binomial Distribution, Mean and variance , Poisson Distribution, Continuous Distribution, Uniform and Exponential Distributions, Normal Distribution | 9 |
| **IV** | Graphs, Terminology, Euler tours, planar graphs, Hamiltonian graphs, Euler's formula (proof), Warshall's algorithm, four colour problem (without proof) and the chromatic number of a graph, five colour theorem, chromatic polynomials. | 9 |
| **V** | Groups and subgroups, cyclic groups, permutation groups homomorphism theorems, cosets and normal subgroups, Lagrange's theorem, rings, Integral domains, ring homomorphisms. | 9 |
| | **Total Hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS160A | ADVANCED COMPUTER NETWORKS | DCC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OBJECTIVES**

This course imparts a deeper understanding of protocols, Switching, VPN, quality of service and congestion management. It also helps to analyze the issues of transmitting real time data. Also helps to identify the technologies that can transmit data efficiently.

**ii) COURSE OUTCOMES**

**After the completion of the course, the student will be able to:**

| | | |
|---|---|---|
| CO1 | Analyze existing techniques for developing new technologies for transmitting data in real time without congestion. | Analyze |
| CO2 | Apply the knowledge to design computer networks with optimal routing. | Apply |
| CO3 | Interpret and exemplify current QoS architectures and mechanisms, and the QoS support challenges in future networks | Analyze |
| CO4 | Compare and choose appropriate and advanced techniques to build the computer network | Analyze |

**iii)SYLLABUS**

Network Architecture - Internet Protocol - Packet switching- Internetworking devices-– Switching basics- Routers-Path Vectors and policies-Congestion Management - -Quality of Service - Peer to Peer Networks - Virtual Private Networks and tunnels –Network management-installation and maintenance

**iv)REFERENCES**


1. Larry L. Peterson, Bruce S. Davie, “Computer Networks – A Systems Approach”, Elsevier Fourth Edition, 2008.
2. William Stallings, “SNMP, SNMPv2, SNMPv3, and RMON 1 and 2,” AddisonWesley, 2005.
3. Douglas Comer, “Automated network management systems current and future capabilities,” Pearson Prentice-Hall, 2007
4. Jim Guichard, Ivan Pepelnjak, " MPLS and VPN Architectures: A Practical Guide to Understanding, Designing and Deploying MPLS and MPLS-Enabled VPNs," Cisco Press, October 2000
5. Packet Guide to Routing and Switching by Bruce Hartpence Released August 2011 Publisher(s): O'Reilly Media, Inc.

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Network Architecture: Reference models of OSI, TCP/IP, ATM. Protocol implementation issues. Physical address, Logical address.<br>Internet Protocol: Packet Format (IPV4 and IPV6), Features of IPv6, CIDR notation, Subnetting, Supernetting, DHCP.<br>Packet switching: Datagrams, Virtual circuit switching, Fragmentation of IP packets. Cell switching in ATM, Gigabit Networks.<br>Internetworking devices: Repeaters, Hubs, Bridges, LAN switches, Routers and Gateway.<br>*Experiment: Familiarization of Networking Devices* | 10 |
| II | Switching Basics. Managing the LAN switch as a networking device, basic switch configuration. Spanning Tree protocol (STP). Virtual LANs and frame-tagging. Routing between VLANs. Securing network devices using packet filters and firewall by applying access control lists (ACL).<br>Routers: Router functions, Classification of routers, Features of IP Routers, Filtering, Network Address Translation (NAT).<br>*Experiment: Configuring Routers and Switches* | 10 |
| III | Path Vectors and Policies - Computing Paths– Routing Information Protocol – OSPF - OSPF – Intermediate System to Intermediate System - Border Gateway Protocol - Multicast Routing -<br>Inter-Gateway Routing Protocol - Inter-Domain Routing Protocol<br>Congestion Management:<br>Congestion control in Data Networks and Internets, Random Early Detection (RED). TCP congestion control: Additive increase/Multiplicative decrease, Slow start, Fast retransmit and Fast recovery. Congestion-Avoidance Mechanisms – DECbit - Random Early Detection - Source-Based Congestion Avoidance – Tahoe- Reno- and Vegas | 9 |

| | | |
|---|---|---|
| IV | Quality of Service: Requirements and parameters of Quality of Service, Integrated Services, Resource Reservation Protocol (RSVP), Differentiated Services.<br>Peer to Peer Networks: Gnutella, BitTorrent. Node Lookup in Peer to Peer Networks<br>Introduction to Virtual Private Networks- Overlay and Peer-to-Peer VPN ,Major VPN Topologies ,MPLS VPN Architecture ,MPLS VPN Routing Model ,MPLS VPN Packet Forwarding ,MPLS VPN Spanning more than One AS | 9 |
| V | Network Management:<br>Managed Network: The History of SNMP Management, Internet Organizations and standards, Internet Documents. The SNMP communication Model – The SNMP Architecture, Administrative Model, SNMP Specifications, SNMP Operations, SNMP MIB Group, Functional Model.<br>Network Installation and Maintenance; Network and System Management, Network Management System platform, Current Status and Future of Network Management.<br>Emerging network types: Data Center, 4G mobile networks (LTE, Wi-Max), Online social networks (OSN), Software Defined Networking, Network virtualization, Delay Tolerant Network (DTN), Vehicular Ad-hoc Network, VoIP, Body area networks (BDN) and case studies. | 10 |
| | **Total Hours** | **45** |

# PROGRAM CORE COURSES (PCC)

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS161A | PARALLEL COMPUTER ARCHITECTURE | PCC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**

The goal of this course is to expose the students in-depth knowledge in measuring performance of processors, instruction level parallelism, vector architecture, multiprocessor systems and cache coherence, and Interconnection networks.

**ii) COURSE OUTCOMES**

**After the completion of the course the student will be able to:**

| | | |
|---|---|---|
| CO1 | Analyze the issues and techniques in improving performance of processors. | Analyze |
| CO2 | Analyze the different concepts of pipelining. | Analyze |
| CO3 | Demonstrate the pipelining mechanisms of superscalar processors. | Apply |
| CO4 | Implement the concepts of GPU and CUDA programming. | Apply |
| CO5 | Analyze the performance of cache coherence protocols. | Apply |

**iii) SYLLABUS**

Classes of parallelism and parallel architecture, computer architecture design issues, Performance measurements, quantitative principles of computer design, Instruction level parallelism concepts and challenges, Data dependencies and hazards, Basic compiler techniques for exposing ILP. Dynamic Scheduling-Tomasulo's approach, Hardware based speculation, ILP using multiple issues and static scheduling, ILP using dynamic scheduling, multiple issue and speculation, case study- Intel Core i7. Data level parallelism-Vector architecture-Vector instruction types, Vector-Access memory schemes. Super scalar processors, VLIW processors, vector processing and array processing. Basic concepts of GPU and CUDA programming. Organization of GPU based systems. Multiprocessor system interconnects-hierarchical bus system, Crossbar switch and multiport memory, multistage networks, Centralized shared memory architecture, Multiprocessor cache coherence, Schemes for enforcing coherence - Snooping protocol, Limitations, distributed shared memory and Directory based coherence. Concept of multithreading and hyper-threading.

**iv) REFERENCES**

1. Hennessy J. L., D. Patterson, “Computer Architecture A quantitative Approach”, 5/e, Morgan Kauffman 2012.

2.DezsoSima, Terence Fountain, Peter Kacsuk, “Advanced Computer Architectures A Design Space Approach”, Pearson Education India, 2009.

3. Kai Hwang, & Naresh Jotwani, "Advanced Computer Architecture, Parallelism, Scalability and Programmability", 2nd edition, McGraw Hill Publications, 2011

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Classes of parallelism and parallel architecture, Performance measurements, quantitative principles of computer design, Instruction level parallelism -concepts and challenges.<br>Data dependencies and hazards, Basic compiler techniques for exposing instruction-level parallelism. | 9 |
| II | Dynamic Scheduling- Tomasulo's approach, Hardware based speculation.<br>ILP using multiple issue and static scheduling, ILP using dynamic scheduling, multiple issue and speculation. | 9 |
| III | Data level parallelism-Vector architecture-Vector instruction types, Vector-Access memory schemes.<br>Super scalar processors, VLIW processors, vector processing and array processing. Basic concepts of GPU and CUDA programming. Organization of GPU based systems.<br>Case study- Intel Core i7. | 10 |
| IV | Multiprocessor system interconnects- hierarchical bus system, Crossbar switch and multiport memory.<br>Multistage networks. Centralized shared memory architecture. | 8 |
| V | Multiprocessor cache coherence, Schemes for enforcing coherence - Snooping protocol, Limitations.<br>Distributed shared memory and Directory based coherence.<br>Concept of multithreading and hyper-threading | 9 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS161B | ADVANCED DATA STRUCTURES AND ALGORITHMS | PCC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OVERVIEW**

Goal of this course is to introduce different advanced data structures and to analyze and establish correctness of algorithms. Also, this course aims to introduce various classes of algorithms.

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Apply various advanced data structures efficiently to solve problems. | Apply |
| CO2 | Analyze number theoretic algorithms and string-matching algorithms. | Analyze |
| CO3 | Apply flow networks to solve real world problems. | Apply |
| CO4 | Analyze various classes of algorithms. | Analyze |
| CO5 | Apply geometric algorithms to solve real world problems. | Apply |
| CO6 | Design, prove the correctness and analyze new algorithms. | Analyze |

**iii) SYLLABUS**

Amortized Analysis – aggregate, accounting and potential methods. Advanced data structures: binomial heap, Fibonacci heap, disjoint sets - applications. Number-Theoretic algorithms: maxflow-min-cut theorem, String matching: Overview of Complexity Classes Probabilistic algorithms: Numerical algorithms Las Vegas algorithms, Complexity classes in randomized algorithms – RP, PP, ZPP, BPP. Geometric Algorithms.

**iv) REFERENCES:**

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, “Introduction to algorithms”, Prentice-hall of India Private Limited, New Delhi, 2010.
2. Gilles Brassard and Paul Bratley, “Fundamentals of algorithms”, Prentice-hall of India Private Limited, New Delhi, 2001.
3. Rajeev Motwani, Prabhakar Raghavan, “Randomized Algorithms”, Cambridge University Press, 2000.

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Amortized Analysis – aggregate, accounting and potential methods. Advanced data structures: binomial heap, Fibonacci heap, Disjoint sets -Applications. | 10 |
| II | Number-Theoretic algorithms: GCD algorithm, Extended Euclid's Algorithm. Primality testing -Miller-Rabin test. Integer factorization - Pollard Rho heuristic. String matching: Rabin-Karp, Knuth-Morris-Pratt algorithms. | 7 |
| III | Network flow algorithms: flow properties, augmenting path, Ford-Fulkerson method, Edmonds-Karp heuristics, Maxflow-mincut theorem. Push-relabel, relabel-to-front algorithms | 9 |
| IV | Probabilistic algorithms: Numerical algorithms: Integration, Counting. Monte-Carlo algorithms - verifying matrix multiplication, min-cut in a network. Las Vegas algorithms, selection sort, quick sort, Dixon's factorization. Complexity classes in randomized algorithms – RP, PP, ZPP, BPP | 9 |
| V | Geometric Algorithms: Plane sweep technique, role of sweep- line status and event-point schedule, line segment intersection problem. Convex Hull: Graham's scan algorithm, Jarvis March algorithm. Finding the closest pair of points, proof of correctness. Overview of Complexity classes – P, NP, Co-NP, NP-hard, NP-complete. Space complexity. | 10 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS161C | TOPICS IN DATABASE TECHNOLOGY | PCC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**

Students will be able to understand the transaction processing and query optimization. The course focuses on the principles of special, temporal and distributed databases.

**ii) COURSE OUTCOMES**

**After the completion of the course the student will be able to:**

| | | |
|---|---|---|
| CO1 | Apply transaction processing concepts | Apply |
| CO2 | Apply query processing and optimization | Apply |
| CO3 | Design distributed and parallel database | Apply |
| CO4 | Distinguish temporal and spatial database | Apply |
| CO5 | Apply advances in database technology | Apply |

**iii) SYLLABUS**

Transaction Processing, Concurrency Control, Recovery. Query Processing & Optimization. Parallel and Distributed Database, Active Database, Temporal and Spatial Databases, Deductive Database, Object Oriented Database, Advanced Applications.

**iv) REFERENCES**


1. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, 5/e, Pearson Education/Addison Wesley, 2011.
2. Patrick O'Neil , Elizabeth O'Neil , “Database: Principles, Programming and Performance”, 2/e, Morgan Kaufmann, 2011.
3. Thomas Cannolly and Carolyn Begg, “Database Systems, A Practical Approach to Design, Implementation and Management”, 3/e, Pearson Education, 2010.
4. Henry F Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, 5/e, Tata McGraw Hill, 2006.
5. C.J. Date, A.Kannan and S. Swamynathan,”An Introduction to Database Systems”, 8/e, Pearson Education India, 2006.
6. Joe Fawcett, Danny Ayers, Liam R. E. Quin, Beginning XML, 5/e, John Wiley & Sons, 2012.
7. Grigoris Antoniou. Frank van Harmelen, “A Semantic Web Primer”, The MIT Press, Cambridge, Massachusetts, 2003.

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Transactions & Serializability: Concurrent executions, Serializability, Types, Deadlock, View and conflict serializability, Recoverability, Test for serializability, Concurrency Control: Lock based protocols, timestamp based protocols, Multiversion Concurrency Control Technique, validation concurrency control techniques | 9 |
| II | Query Processing and Optimization: (a) Relational algebra transformations (b) Query size and I/O cost estimation (c) I/O cost for basic data management algorithms, Heuristic Query Optimization | 8 |
| III | Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Distributed Database – Functions – Distributed RDB design- Transparency– Distributed Transactions - Commit Protocols – Concurrency Control –Deadlocks – Recovery | 9 |
| IV | Enhanced Data Models: Active Databases- Triggers, Design and Implementation Issues, Temporal Databases – Time in Databases, Spatial and geographical data management- geographical data, representation, spatial queries, indexing spatial data, k-d trees, quad trees and R-trees, Deductive Databases- Prolog/ Datalog Notation, XML Databases | 8 |
| V | Concepts for Object Databases: Object Identity – Object structure – Type Constructors – Encapsulation of Operations – Methods – Persistence – Type and Class Hierarchies – Inheritance – Complex Objects, ODMG, ODL, OQL, basic OQL queries.<br><br>Information Retrieval and Web Search: Information Retrieval (IR) Concepts, Retrieval Models, Types of Queries in IR Systems, Text Preprocessing, Inverted Indexing, Evaluation Measures of Search Relevance, Web Search and Analysis. | 8 |
| | **Total hours** | **45** |

# PROGRAM ELECTIVE COURSES (PEC)

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162A | DATA MINING & WAREHOUSING | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**

To understand and practice the fundamental and advanced concepts Data Warehousing and Data Mining.

**ii)COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of Data warehousing and mining activities for efficient data management | Apply |
| CO2 | Apply data mining algorithms for classification and clustering | Apply |
| CO3 | Apply association rule mining techniques | Apply |
| CO4 | Demonstrate the use of web mining and spatial mining | Apply |

**iii)SYLLABUS**

Data warehousing – OLAP, schema, Data architecture, Data Mining. Mining Tasks, Issues, Metrics, KDD Vs Data mining, DMQL, Classification Clustering, Association, Web mining, Spatial mining, temporal mining

**iv)REFERENCES**


1. Margaret H Dunham, "Data Mining – Introductory and Advanced Topics", Pearson India, 2005.
2. Ali, A. B. M. S. and Wasimi, S. A., "Data Mining - Methods and Techniques", Cengage Publishers.
3. Ian H. Witten, Eibe Frank, Mark A. Hall," Data Mining: Practical Machine Learning Tools and Techniques", 3/e, Morgan Kaufmann, 2011.
4. J. Han, M. Kamber, "Data Mining: Concepts and Techniques", 3/e, Morgan Kaufman, 2011.
5. Pramod J. Sadalage, Martin Fowler , "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", first edition, Addison-Wesley Professional, 2012
6. Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, Tenth Reprint 2007.
7. K.P. Soman, Shyam Diwakar and V. Ajay "Insight into Data Mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.

8. G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Data warehousing: Introduction, Operational data stores, ETL, Data warehouses – design guidelines for data warehouse implementation, Data warehouse metadata; OLAP –introduction, Characteristics, Multidimensional view and data cube, Data cube operations, Data Warehouse Governance: Best Practices at Blue Cross and Blue Shield of North Carolina: A Case Study. | 10 |
| II | Data pre-processing: Need, data summarization, data cleaning, data integration and transformation, data reduction techniques PCA, Singular Value Decomposition (SVD), data discretization and concept hierarchy generalization.<br>Classification and prediction: Decision tree-Tree Induction algorithm, Bayesian classification, rule based classification. | 9 |
| III | Classification by back propagation and support vector machines, associative classification, lazy learners, prediction, Performance measures. A case study | 9 |
| IV | Cluster analysis: Definition, similarity measures, clustering algorithms partitioning, hierarchical, density based, grid based and model based; Clustering high dimensional data, constraint based cluster analysis, outlier analysis. Efficient Clustering of Very Large Document Collections: A case study. | 5 |
| V | Mining frequent patterns, associations and correlations: Basic concepts, efficient and scalable frequent itemset mining algorithms, mining various kinds of association rules – multilevel and multidimensional, association rule mining versus correlation analysis, constraint based association mining.<br>Introduction to Multidimensional Analysis and Descriptive Mining of Complex Data Objects – Spatial Data Mining – Multimedia Data Mining – Text Mining – Mining the World Wide Web | 12 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162B | DATA COMPRESSION TECHNIQUES | PEC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OBJECTIVES**

Develop theoretical foundations of data compression, concepts and algorithms for lossy and lossless data compression, signal modelling and its extension to compression with applications to speech, image and video processing.

**ii)COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of concepts in data compression | Apply |
| CO2 | Analyze the compression techniques like Huffman Coding algorithm and Dictionary based techniques | Analyze |
| CO3 | Apply lossy compression techniques | Apply |
| CO4 | Apply vector quantization techniques for image compression | Apply |

**iii)SYLLABUS**

Data Compression Techniques, Huffman Coding, Dictionary Techniques, Lossy Coding, Vector Quantization

**iv) REFERENCES**

1) David Solomon, Data compression: the complete reference, 2/e, Springer-verlag, New York.,2000.
2) Stephen Welstead, Fractal and wavelet Image Compression techniques, PHI, 1999.
3) Khalid Sayood, Introduction to data compression, Morgan Kaufmann Publishers, 2003.
4) Sleinreitz ―Multimedia System‖ Addison Wesley.

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| **I** | Compression Techniques, Compression ratio, lossless & lossy compression, Huffman coding, Non binary Huffman Algorithms, Adaptive Coding, applications, Arithmetic Coding, applications, Finite Context Modeling. | 8 |

| | | |
|---|---|---|
| **II** | Huffman Coding: Minimum Variance Huffman Codes, Length of Huffman Codes, Adaptive Huffman Coding, Applications, Golomb codes, Rice codes, Tunstall codes. Arithmetic Coding: Coding a sequence, Generating a binary code, Comparison of Huffman and arithmetic coding, Applications | 7 |
| **III** | Dictionary Techniques: Static Dictionary, Digram coding, Adaptive Dictionary, LZ77, LZ78, LZW algorithms, Applications. Context-based Compression: Prediction with partial match (ppm), BurrowsWheeler Transform (BWT), CALIC, JPEG standard, JPEG-LS, Run-Length Coding, JBIG, JBIG2. | 9 |
| **IV** | Mathematical Preliminaries for Lossy Coding: Distortion Criteria, Rate Distortion Theory. Scalar Quantization: Quantization problem, Uniform Quantizer, LloydMax Quantizer, Adaptive Quantization, Nonuniform Quantization, Entropy-Coded Quantization, | 10 |
| **V** | Vector Quantization: LBG Algorithm, Tree Structured and Structured Vector Quantizers. Differential Coding: Basic algorithm, DPCM. Transform Coding: Transforms of Interest, JPEG. | 11 |
| | **Total** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162C | ADVANCED TOPICS IN DISTRIBUTED SYSTEMS | PEC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OBJECTIVES**:

To impart deeper understanding in Architecture and issues of distributed systems, Distributed algorithms, Hadoop system.

**ii) COURSE OUTCOMES**

| | | |
|---|---|---|
| CO1 | Make use of conceptual and practical aspects of distributed systems. | Apply |
| CO2 | Make use of distributed file systems. | Apply |
| CO3 | Analyze effectiveness of different distributed Algorithms. | Analyze |
| CO4 | Make use of algorithms in general synchronous networks. | Apply |

**iii)SYLLABUS**

Distributed System: System Architecture, Processes, Threads, Code migration, Communication, Naming, Hadoop: Map and Reduce, Hadoop Distributed File System, Map Reduce Types, Administering Hadoop, Distributed Algorithms: Causality, Modeling a Distributed Computation, Synchronization and Election, Distributed Mutual Exclusion, Algorithms in General Synchronous Networks.

**iv) REFERENCES**

1. Andrew S. Tanenbaum, Maarten Van Steen.” Distributed Systems – Principles and Paradigms “, 2/e, PHI, 2004.
2. Randy Chow Theodore Johnson, “Distributed Operating Systems and Algorithm Analysis”, Pearson Education, 2009.
3. Nancy A. Lynch, Morgan, ” Distributed Algorithms”, Kaufmann Publishers, Inc, 1996.
4. Tom White, “Hadoop: The Definitive Guide”, 1/e, O’reilly, 2012.
5. Eric Sammer, “Hadoop Operations: A Guide for Developers and Administrators”, O’reilly, 2012.
6. Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, John Wiley, 2013.

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Distributed System: Overview, System Architecture, Processes – Threads – Virtualization – Clients – Servers – Code migration,Communication – Message Oriented – Stream Oriented – Multicast Communication,Naming – Flat – Structured – Attribute Based Naming. | 8 |
| II | Hadoop: Introduction – Comparison with Other Systems, Analyzing Data with Hadoop – Map and Reduce – Scaling Out – Data Flow – Combiner Functions, Hadoop Distributed File System – Concepts and Basic Operations. | 9 |
| III | Map Reduce Types – Input and Output Formats, Map Reduce Features– Counters – Sorting – Joins – Side Data Distribution, Administering Hadoop – Monitoring – Maintenance.Distributed Algorithms: Models of Distributed Computation –Preliminaries – Causality – Distributed Snapshots | 9 |
| IV | Synchronization and Election – Distributed Mutual Exclusion – Timestamp Algorithms – Voting – Fixed Logical Structure – PathCompression, Election – The Bully Algorithm. | 9 |
| V | Algorithms in General Synchronous Networks – Leader Election – Breadth First Search – Minimum Spanning Tree – Shortest Path– Maximal Independent Set. | 10 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162D | IMAGE & VIDEO PROCESSING | PEC | 3 | 0 | 0 | 3 | 2022 |

**ii) COURSE OBJECTIVES**

To familiarize with the various image processing techniques and understand various video processing methods.

**iii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of concepts in image processing. | Apply |
| CO2 | Apply mathematical transforms necessary for image processing. | Apply |
| CO3 | Apply various image processing algorithms. | Apply |
| CO4 | Analyze motion in 2D in Video processing. | Analyze |

**iv) SYLLABUS**

Image processing techniques – enhancement – restoration – segmentation - object recognition - image compression - morphological image processing and video processing.

**v) REFERENCES**

1. K. Jain, “Fundamentals Of Digital Image Processing”, Prentice Hall Of India, 1989.

2. R. C. Gonzalez, R. E. Woods, “Digital Image Processing”, Pearson Education.

3. M. Tekalp, “Digital Video Processing”, Prentice-Hall.

4. Bovik, “Handbook of Image & Video Processing”, Academic Press, 2000

5. W. K. Pratt, “Digital Image Processing”, Prentice Hall

6.Rosenfeld, A. C. Kak, “Digital Image Processing”, vols. 1 and 2, Prentice Hall.

**vi) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Introduction to Digital image processing & Applications: Elements of visual perception, Mach band effect, sampling, quantization, Basic relationship between pixels, color image fundamentals-RGB-HIS models | 8 |
| II | Image transforms: Two dimensional transforms, orthogonal and unitary transforms, separable unitary transforms, basis images, 2D DFT, 2D DCT, Hadamard Transform | 7 |
| III | Image enhancement and restoration: Image enhancement: Point operations, Spatial operations and Transform operations, Histogram-based processing. Image restoration: Degradation models, PSF, Restoration using inverse filtering, Wiener filtering. | 8 |
| IV | Image segmentation: Edge detection and Boundary representation: Thresholding: Bi-level thresholding, Adaptive thresholding, Region growing, Splitting and merging, Edge detection and linking, Hough transform.<br><br>Morphological image processing: Erosion and dilation, Opening or closing, HIT or MISS transformation, Basic morphological algorithms. | 10 |
| V | Video Processing:<br>Statistical Features, Compressed Domain Features, Content Based Features. Video Representation- Scripted Content, Unscripted Content. Video Filtering- Motion Compensated Filtering, Noise filtering, Multiframe Super Resolution.<br>Video processing Time Varying Image Formation Models. Spatio-temporal sampling, 2D motion estimation-Optical flow methods, Block based methods | 12 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162E | SEMANTIC WEB TECHNOLOGY | PEC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OBJECTIVES**:

To understand the principles, practices and applications of Semantic Web Technology.

**ii)COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of technologies related Semantic Web | Apply |
| CO2 | Make use of RDF schema in semantic web technology | Apply |
| CO3 | Apply formal semantics used in semantic web technology | Apply |
| CO4 | Demonstrate process domains using ontology and associated tools. | Apply |

**iii)SYLLABUS**

Introduction to Semantic Web, RDF and RDF schema, SPARQL, Web Ontology Language, formal semantics, Description logic, automated reasoning, ontology rules and queries, ontology engineering, software tools and applications.

**iv)REFERENCES**

1.Liyang Yu, Introduction to the Semantic Web and Semantic Web Services, Chapman & hall/CRC, 2007.

2. Pascal Hitzler, MarkusKrötzsch, Sebastian Rudolph, Foundations of Semantic Web Technologies, Chapman & hall/CRC, 2010.

3. Peter Szeredi, GergelyLukacsy, TamasBenko, Zsolt Nagy, The Semantic Web Explained The Technology and Mathematics behind Web 3.0, Cambridge University Press, 2014.

REFERENCES

4. Dean Allemang, James Hendler, "Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL", Morgan Kaufmann, 2008.

5. David Wood, Marsha Zaidman, Luke Ruth, Michael Hausenblas, Linked Data, Manning Publication Company, 2014.

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Introduction to Semantic Web and semantic web technologies (Reading: L. Yu [Ch.1, 2], P. Szeredi [Ch.1], P.Hitzler [Ch. 1])–XML review, First order Logic (review) (Reading: P. Hitzler(Appendix 1, 2]) RDF: overview, elements of RDF, basic syntax, advanced features – Relationship between doubling core, XML and RDF (Reading: L. Yu [Ch.3], P.Hitzler [Ch. 2]) | 12 |
| II | RDF schema, syntax and semantics, examples Web ontology language (OWL): Syntax an semantics, reasoning power (informal treatment only), flavours of OWL, OWL2 standard. | 10 |
| III | Formal semantics: description Logic, model theoretic semantics of OWL, automated reasoning. | 10 |
| IV | Ontology Rules and Queries: combining OWL and DL, SPARQL, Query examples, conjuctive queries. Ontology Engineering: Requirement Analysis, Ontology creation, quality assurance, Modular ontology | 7 |
| V | Software tools: protégé, Jena, Applications | 6 |
| | Total hours | 45 |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162F | PRINCIPLES OF INFORMATION AND NETWORK SECURITY | PEC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OBJECTIVES**

Goal of this course is to understand the founding principles of Information security and various vulnerabilities. Also, to familiarize with network security concepts.

**iii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of the principles of information security, its significance and find solutions to domain specific security issues. | Apply |
| CO2 | Apply the principles of information security in exploring vulnerability. | Apply |
| CO3 | Analyze and evaluate software systems for its TCP/IP vulnerabilities. | Analyze |
| CO4 | Examine various IP security and intrusion detection mechanisms. | Analyze |

**iv) SYLLABUS**

Security Concepts, Security Models, Access control mechanisms, Attacks, Threats, Software vulnerabilities, Malwares, Cryptography Topics: El-Gamal encryption, Biometric Authentication, Network Security – IPsec, TCP/IP vulnerabilities, Firewalls, Wireless Security.

**v) REFERENCES**

1. Bernard Menezes, “Network security and Cryptography”, Cengage Learning India, 2010.
2. Behrouz A. Forouzan, “Cryptography and Network Security”, Special Indian Edition, Tata McGraw Hill, 2007
3. William Stallings, “Cryptography and Network Security: Principles and Practice”, 6/e Pearson Education, 2013.
4. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker,“Digital Watermarking and Steganography”, 2/e, Morgan Kaufmann, 2008.
5. Dieter Gollmann. “Computer Security”, John Wiley and Sons Ltd., 2006.
6. Whitman and Mattord, “Principles of Information Security”, Cengage Learning, 2006.
7. D. Bainbridge, “Introduction to Computer Law”, 5/e, Pearson Education, 2004.
8. C. Kaufman, R. Perlman and M. Speciner, “Network Security: Private Communication in a public World”, 2/e, Prentice Hall, 2002.

9. W. Mao, "Modern Cryptography: Theory & Practice", Pearson Education, 2004.

10. H. Delfs and H. Knebl, "Introduction to Cryptography: Principles and Applications", Springer Verlag, 2002.

11. Eric Rescoria, "SSL and TLS: Designing and Building Secure Systems, Addison Wesley Professional, 2000.

12. Stephen Kent, Charles Lynn, Joanne Mikkelson, and Karen Seo, Secure Border Gateway Protocol (S-BGP)-Real World Performance and Deployment Issues, NDSS, 2000.

**vi) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| **I** | Computer Security Concepts (CIA) and its case studies, Threats, Attacks. Security Models as basis for OS security, Access Control in OS Discretionary Access control, Mandatory Access control and Role-based access control, Introduction to DB Security. Software vulnerabilities- Phishing, Buffer and stack overflow, Heap overflow, OS command injection. | **7** |
| **II** | Mobile Malware, Viruses, Worms and Trojans. Internet scanning worms, Worm Propagation models, Topological worms- E-mail worms, P2P worms. Case study – Attacks are inevitable. | **8** |
| **III** | Cryptography Topics: Introduction to cryptography, El-Gamal encryption- Signature Scheme, One way and Mutual authentication, Dictionary attack.<br><br>Needham Schroeder protocol, Kerberos basics, Biometrics for authentication. | **9** |
| **IV** | Network security topics: Network layer security – IPsec – overview, IP and IPv6, IPsec Protocols: AH and ESP, Tunnel Mode and transport mode. Internet Key Exchange Protocol- IPsec cookies.<br><br>TCP/IP Vulnerabilities- TCP Overview - Connection Setup/Teardown, Packet Sniffing, Detecting Sniffers on your network, IP Spoofing, ARP Poisoning, UDP Hijacking, Fragmentation Attack- Ping of Death, Evasion attack. | **9** |

| | | |
|---|---|---|
| **V** | UDP Hijacking, TCP Spoofing, TCP Hijacking - Mitnick attack, Joncheray attack, SYN Flood Attack, Denial of Service Attack, Port Scanning Techniques DNS – DNS Zones, Zone Transfer, BIND, DNS Spoofing, DNS Cache Poisoning, Firewalls – Packet-filtering, Stateless and stateful, Intrusion Detection using SNORT, NAT Others – Email Spam and solutions, Wireless Security Overview, Ciphertext Attacks. | **12** |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162G | NUMBER THEORY AND CRYPTOLOGY | PEC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OBJECTIVES**

This course gives an insight of the fundamental security services that can be implemented with the methods of modern cryptography. It also helps students to understand how to apply sound principles to designing secure systems and to discovering. Also describes the current standardized network security protocols and mechanisms. Also gives an exposure to current methods for the formal analysis of security protocols and vulnerabilities in existing systems.

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of basic Mathematical Concepts of Cryptography | Apply |
| CO2 | Apply various number theory concepts in the field of cryptography. | Apply |
| CO3 | Demonstrate a general knowledge and understanding of data security and encryption with a special focus on techniques appropriate for communication systems. | Apply |
| CO4 | Make use of the concepts of Transport-Level Security like SSL, SSH and also to explain about firewalls. | Apply |

**iii) SYLLABUS**

Mathematical Concepts of Cryptography, Modular Arithmetic, Introduction to Number Theory, Classical Encryption Techniques, DES, AES, Public Key Cryptography, Elgamal Cryptographic System, TransportLevel Security, System Security, Firewalls.

**iv) REFERENCES**

1.William Stallings, "Cryptography and Network Security-Principles and Practices", Fifth Edition, Pearson Education, 2011

2. Behrouz A Forouzan, "Cryptography and Network Security", Tata McGraw Hill, 2008

3. Matt Bishop, "Computer Security: Art and Science", Addison-Wesley Professional, 2003

4. Wade Trappe, Lawrence C Washington, "Introduction to Cryptography with Coding Theory", Second Edition, Pearson Education, 2005

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Mathematical Concepts of Cryptography – Divisibility and Division Algorithm – Euclidean Algorithm, Modular Arithmetic- Groups - Rings – Fields, Finite Fields of the Form GF(p) – Polynomial Arithmetic – Finite Fields of the Form GF(2n) | 8 |
| II | NUMBER THEORY: Introduction Prime numbers – Fundamental theorem of arithmetic - Mersenne primes - Fermat numbers - Euclidean algorithm - Fermat's theorem - Euler totient function - Euler's theoerem. Testing for Primality – Discrete Logarithms- Chinese remainder theorem.<br>Case Study: Implement Encryption using binary Exclusive OR (XOR) | 8 |
| III | Classical Encryption Techniques – Substitution Techniques – Transposition Techniques –Steganography. Block Ciphers and Encryption Standards -- Block Cipher Principles -- Data Encryption Standard(DES). Advanced Encryption Standard(AES) – RC5 – Blowfish | 11 |
| IV | Public Key Cryptography – Principles of Public Key Cryptosystems -- RSA -- Other Public-Key Cryptosystems – Diffie-Hellman Key Exchange, Elgamal Cryptographic System – Elliptic Curve Arithmetic – Elliptic Curve Cryptography. Case Study: Analyze the attacks on public key cryptography | 9 |
| V | Transport-Level Security –Secure Socket Layer –Transport Layer Security – HTTPS - Secure Shell(SSH). System Security – Intruders – Intrusion Detection- Password Management. Malicious Softwares – Viruses – Virus Countermeasures – Worms – Distributed Denial of Service Attacks.<br>Firewalls – Need for Firewalls –Firewall Characteristics – Types of Firewalls. Firewall Basing –Firewall Location and Configurations. | 9 |
| | **Total Hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162H | PARALLEL ALGORITHMS | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**

The goal of this course is to expose the students gain in-depth theoretical and practical knowledge on parallel algorithms.

**ii) COURSE OUTCOMES**

**After the completion of the course the student will be able to:**

| | | |
|---|---|---|
| CO1 | Make use of the different models of parallel computation and interconnection architectures. | Apply |
| CO2 | Analyze the basic parallel algorithmic techniques. | Analyze |
| CO3 | Analyze commonly used algorithms in sorting, searching and merging and their complexity analysis. | Analyze |
| CO4 | Analyze the efficiency and complexity of commonly used parallel algorithms for matrix operations and graph. | Analyze |

**iii) SYLLABUS**

Models of Parallel Computation: SIMD, MIMD, PRAM (EREW, CREW,CRCW), Performance Measures, Performance metrics, Interconnection Architectures, Basic Parallel Algorithmic Techniques, PRAM Algorithms, Sorting, Searching and Merging, Matrix operations, Graph Algorithms, Parallel Complexity (Lower bounds, NC Class and P-Completeness).

**iv) REFERENCES:**

1. AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar "Introduction to Parallel Computing", Second Edition ,Addison Wesley
2. S.G.Akl, "Design and Analysis of parallel algorithms", PrenticeHall, Inc. 1989.
3. Joseph F Jájá, "An Introduction to Parallel Algorithms", Addison-Wesley, 1992.
4. S.G.Akl, "Parallel Sorting algorithm", Academic Press, 1985.
5. M.J.Quin, "Parallel computing – theory and Practice", McGrawHill, New York, 1994.
6. S. Lakshmivarahan and S.K.Dhall, "Analysis and design of Parallel Algorithms – Arithmetic & Matrix problems", McGrawHill, New York, 1990.
7. M .J. Quin, "Parallel Programming in C with MPI and openMP", Tata McGraw Hill, 2007.

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Introduction -From serial to parallel thinking: common gotchas Models of Parallel Computation: SIMD, MIMD, PRAM (EREW, CREW,CRCW), Performance Measures-Time, Processors, Space, Work Performance metrics - speedup, utilization, efficiency, scalability Interconnection Architectures (Linear Array, Meshes, Trees, Hyper cubes, Butterfly Networks, Cube Connected Cycles, Benes Networks); | 9 |
| II | Basic Parallel Algorithmic Techniques-Balancing, Pointer Jumping, Divide-and-Conquer, Partitioning, Pipelining, Accelerated Cascading, prefix computation, Systolic Computation PRAM Algorithms: Parallel Reduction, Min/Max, Prefix Sums, List Ranking, Pre-order Tree Traversal | 9 |
| III | Sorting – Sorting on a linear array – sorting on a mesh – sorting on EREW SIMD computer – MIMD enumeration sort – MIMD quick sort – sorting on other networks. Searching and Merging | 9 |
| IV | Matrix operations – matrix-by-matrix multiplications – mesh multiplications – cube multiplication - Matrix by vector multiplication, Linear array multiplication – tree multiplications, Solving numerical problems – solving systems of linear equations – SIMD algorithms and MIMD algorithms. | 9 |
| V | Graph Algorithms – computing connectivity matrix – finding connected components – Spanning trees, all pairs shortest path – traversing combinatorial spaces. Parallel Complexity (Lower bounds, NC Class and P-Completeness). | 9 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162I | SOFT COMPUTING TECHNIQUES IN BIOINFORMATICS | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**

The goal of this course is to introduce the basics of soft computing techniques and bioinformatics. It also includes how soft computing techniques are used in the field of bioinformatics.

ii) **COURSE OUTCOMES:**

After the completion of the course the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of the concepts of bioinformatics | Apply |
| CO2 | Analyze multiple sequences and find conserved regions | Analyze |
| CO3 | Analyze various neural network architectures | Analyze |
| C04 | Demonstrate the fuzzy systems | Apply |
| C05 | Apply the genetic algorithm concepts and their applications | Apply |
| C06 | Apply a suitable Soft Computing technology to solve problems | Apply |

**iii) SYLLABUS**

The central dogma of molecular biology, Sequence alignment, Scoring matrices, Fuzzy sets, relations & logics, Hidden Markov Models, Artificial Neural Networks, Genetic Algorithm.

**iv) REFERENCES:**

1. S.Rajesekeran & G.A. Vijoylaxshmi pai Neural network, Fuzzy logic and Genetic Algorithms. PHI-2003.
2. E. Keedorell & A.Neroyenen- Inteigent Bioinformatics-John Wiley-2005.
3. S. N. Sivanandam and S. N.Deepa, *Principles of soft computing* - Wiley India.
4. Timothy J. Ross, *Fuzzy Logic with engineering applications* – Wiley India.
5. L.Worg- The practical Bioinformaticien-world Scientific Publishing-2004
6. S C Rastogi, N Mendiratta and P Rastogi, Bioinformatics*: Methods and Applications*, ISBN: 978-81-203-4785-4, published by PHI Learning Private Limited, New Delhi, 2015.

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Bioinformatics and Computational Biology, Nature & Scope of Bioinformatics. The central dogma of molecular biology and bio-sequences associated with it, RNA classification – coding and non-coding RNA- mRNA, tRNA, miRNA and sRNA, RNAi. DNA and RNA structure – Nucleic Acid structure and function, Genetic Code, Genes and Evolution. | 7 |
| II | Sequence alignment – local/global, pairwise sequence alignment, scoring methods. Needleman and Wunsch algorithm, global and local alignments. Multiple sequence alignment. Scoring matrices: basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, principles based on which these matrices are derived. Differences between distance & similarity matrix. | 8 |
| III | Fuzzy sets & relations - properties and operations, Fuzzy membership functions, Methods of membership value assignments, Lambda –cuts for fuzzy sets, Defuzzification methods, Propositional logic and Predicate logic, fuzzy If-Then rules, fuzzy mapping rules and fuzzy implication functions, Fuzzy Inference Systems. Fuzzy logic system & application in of Clustering and classification Microarray and Protein Array data Analysis | 10 |
| IV | Hidden Markov Models: Markov processes and Markov Models, Hidden Markov Models, Parameter estimation for HMMs, Optimal model construction, Applications of HMMs, Artificial Neural Networks: Historic evolution – Perceptron, NN Architecture, supervised and unsupervised learning, Back Propagation Algorithm, Training and Testing, Self-organizing Feature Map and Radial Basis Function Network; Overview of Support Vector Machines, Bayesian network, classification and dimension ability reduction of gene expression date, Identifying protein sub cellular location, Techniques for recognition. | 10 |

| | | |
|---|---|---|
| V | Overview of Evolutionary computing: Genetic Algorithm, Swarm intelligence, Ant Colony Optimization, bioinformatics applications - Reverse engineering of regulatory networks, multiple Sequence alignment. Neural-genetic algorithms for analyzing gene expression data, Genetic Algorithm and nearest neighbor hybrid for biochemistry solution, Genetic programming neural networks for determining gene-gene interaction in epidemiology. | 10 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162J | COMPUTATIONAL GEOMETRY | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**

Goal of this course is to fill the gap between geometric properties and algorithm design. It also helps to familiarize data structures used for developing efficient algorithms and to learn efficient techniques for solving geometric problems.

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Develop efficient algorithms by exploiting geometric properties. | Apply |
| CO2 | Identify properties of objects, express them as lemmas and theorems and prove their correctness. | Apply |
| CO3 | Apply learned algorithms in diversified fields. | Apply |

**iii)SYLLABUS**

Geometric Preliminaries, Data Structures for geometric problems, Geometric Searching, applications, Range Searching using Kd-trees, Convex Hulls, Triangulation, Voronoi Diagrams, Delaunay Triangulation, Introduction to Visibility Problems, Visibility graph.

**iv)REFERENCES**


1. Franco P. Preparata, Michael Ian Shamos, “Computational Geometry- An Introduction”, Texts and Monographs in Computer Science , Springer – Verlag
2. Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars “ Computational Geometry, Algorithms & Applications” Springer.
3. Herbert Edelsbrunner, “Algorithms in Combinatorial Geometry”, EATCS Monographs on Theoretical Computer Science, Springer – Verlag.
4. Art Gallery Theorems, Joseph O’ Rourke, Oxford Press.
5. Joseph O’ Rourke, “ Computational Geometry in C”, Cambridge University Press.

## v) COURSE PLAN

| Module | Contents | No. of hours |
|---|---|---|
| I | Introduction to Computational Geometry. Visibility Problems - Definition of direct visibility, Point visibility and Edge visibility, Algorithm for computing point visible region inside a polygon. Art Gallery Theorem, Fisk's proof of Art Gallery theorem. Post Office Problem. | 8 |
| II | Convex Hulls, Convex Hull Algorithms in the Plane -- Graham's Scan Algorithm, Jarvi's March, Divide and Conquer Algorithm, Quick Hull Algorithm. Triangulation— Polygon Triangulation. Voronoi Diagrams- Properties, computing Voronoi diagram, Applications in the plane, Delaunay Triangulation. | 9 |
| III | Data Structures for geometric problems : DCEL ( Doubly Connected Edge List), Quad trees, Kd-trees and BSP (Binary Space Partition) trees. | 9 |
| IV | Geometric Searching - Planar Straight Line Graph (PSLG), Point Location Problem, Location of a point in a planar subdivision, Plane Sweep Technique – applications - line segment inter section using plane sweep, Slab method, Regularization of PSLG, Monotone polygons, Range Searching using Kd-trees. | 10 |
| V | Kernel of a simple polygon, Linear time algorithm for computing Kernel. Visibility graph, Shortest path for a point Robot. | 9 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162K | ADVANCED COMPILER DESIGN | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**

Goal of this course is to make aware the importance of code optimization in compiler design. It focus on various intermediate representations, data flow analyses and optimization techniques, register allocation technique, machine code generation techniques and back end design of compilers.

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Illustrate different code optimization techniques | Understand |
| CO2 | Explain the process involved in register allocation and machine code generation techniques | Understand |
| CO3 | Design synthesis phase of a compiler. | Apply |

**iii)SYLLABUS**

Control Flow Analysis, Data Flow Analysis, Dependence analysis & Dependence graphs, Alias analysis, Global Optimizations, Redundancy Elimination, Loop Optimizations, Procedure Optimization techniques, Machine Dependent tasks, Low Level Optimization techniques, Introduction to inter-procedural analysis and optimization, Introduction to Affine Transform Theory.

**iv)REFERENCES**


1. Steven S. Muchnick, “Advanced Compiler Design and Implementation”, Morgan Kauffmann, 1997.
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D. Ullman, “Compilers: Principles,Techniques and Tools”, Pearson Education, 2009.
3. Andrew W. Appel, “Modern Compiler Implementation in Java”, Cambridge University Press, 2009.
4. Keith D. Cooper, Linda Torczon, “Engineering a Compiler”, 2/e, Morgan Kauffmann, 2011.

## v) COURSE PLAN

| Module | Contents | No. of hours |
|---|---|---|
| I | Review of compiler phases, Informal Compiler Algorithm Notation (ICAN), Symbol Table Structure – local and global symbol tables, Intermediate Representations – HIR – MIR and LIR, Run Time Issues. Control Flow Analysis – basic blocks – DFS – dominators and Post dominators – loops – dominator tree, Data Flow Analysis – reaching definitions – available expressions, – live variable information, Dependence analysis & Dependence graphs, Alias analysis. | 10 |
| II | Global Optimizations – constant folding – algebraic simplification and reassociation– constant and copy propagation – dead code elimination, Redundancy Elimination – common sub expression elimination – loop invariant code motion – partial redundancy elimination – code hoisting, Value numbering. | 9 |
| III | Loop Optimizations – strength reduction and induction variable elimination, Procedure Optimization techniques, Static Single Assignment (SSA) form – dominance frontier – pi-functions – variable renaming. | 9 |
| IV | Machine Dependent tasks: Register Allocation – graph coloring – coalescing, Code Scheduling – Instruction Scheduling – Speculative Scheduling – Software pipelining. | 8 |
| V | Low Level Optimization techniques, Introduction to inter-procedural analysis and optimization, Machine code generation, Optimizing for Parallelism and Locality – Introduction to Affine Transform Theory. | 9 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162L | FUZZY SET THEORY AND APPLICATIONS | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES:**

The course helps students to understand Fuzzy Set Theory and the basis of fuzzy logic and its applications such as fuzzy control and fuzzy decision making.

**ii) COURSE OUTCOMES:**

After the completion of the course the student will be able to:

| | | |
|---|---|---|
| CO1 | Solve problems related to fuzzy sets and fuzzy relations. | Apply |
| CO2 | Make use of membership functions, fuzzification and defuzzification process | Apply |
| CO3 | Implementation of defuzzification methods | Apply |
| CO4 | Apply fuzzy logic control to real time systems. | Apply |
| CO5 | Apply fuzzy inference to solve problems that include uncertainity | Apply |

**iii) SYLLABUS**

Classical & Fuzzy Sets, Relations – Properties and Operations, Fuzzy Membership Functions, Defuzzification to Scalars, Classical Logic, Fuzzy Logic, Applications of Fuzzy Systems.

**iv) REFERENCES:**


1. Timothy J Ross, *Fuzzy Logic with Engineering Applications*, Wiley Publications.
2. George J Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic: Theory and Applications*, PHI.
3. H J Zimmerman, *Fuzzy Set Theory and its Applications*, Kluwer Academic Publishers.
4. John Yen and Reza Langari, *Fuzzy Logic: Intelligence, Control and Information*, Pearson Education.


**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | The case for imprecision, Utility and Limitations of Fuzzy Systems, Fuzzy Sets and Membership, Classical Sets – | 10 |

| | | |
|---|---|---|
| | Properties, Operations, Fuzzy Sets – Properties and Operations, Classical Relations – Cartesian Product, Operations and Properties of Crisp Relations, Composition, Fuzzy Relations – Cardinality, Operations, Properties, Fuzzy Cartesian Product and Composition, Tolerance and Equivalence Relations – Crisp and Fuzzy, Similarity Methods – Cosine, Min-max. | |
| II | Fuzzy Membership Functions – Features, Fuzzification, Defuzzification to Crisp Sets, λ-CUTS FOR FUZZY RELATIONS, Development of Membership Functions – Intuition, Inference, Rank ordering, Inductive reasoning. | 9 |
| III | Defuzzification to Scalars - Max membership principle, Centroid method, Weighted average method, Mean max membership, Center of sums, Center of largest area, First (or last) of maxima, Implementation of defuzzification methods Linguistic Hedges, Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Introduction to Matlab/Python, Study of fuzzy logic toolbox, Implementation of defuzzification methods. | 10 |
| IV | Classical Logic, Fuzzy Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges, Approximate Reasoning, Fuzzy (Rule-Based) Systems - Multiple conjunctive antecedents, Multiple disjunctive antecedents Aggregation of fuzzy rules, Graphical Techniques of Inference, Simple implementation of fuzzy logic. | 8 |
| V | Applications of Fuzzy Systems - Fuzzy Classification, Fuzzy Pattern Recognition, Fuzzy Control Systems, Fuzzy Systems and Neural Networks, Fuzzy Clustering, Fuzzy Databases and Information retrieval systems, Case Study – ANFIS. | 8 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162M | APPLIED MACHINE LEARNING | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES:**

Machine learning research aims to build computer systems that learn from experience. The course enables students to develop new algorithms, and to understand which algorithms should be applied in which circumstances

**ii) COURSE OUTCOMES:**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of traditional and new methods of Machine Learning | Apply |
| CO2 | Demonstrate the working of classifier models like SVM, Neural Networks and identify classifier model for typical machine learning applications | Apply |
| CO3 | Develop ML models for prediction, regression and clustering | Apply |
| CO4 | Apply unsupervised machine learning techniques | Apply |

**iii) SYLLABUS**

Classification, Regression, Support Vector Machines, Artificial Neural Networks, Hidden Markov models, Decision Tree, Ensemble classification, Clustering ,Case studies

**iv) REFERENCES:**

1) Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning (3rd Edition), Cambridge University Press, 2015. ISBN 978-1107512825.
2) Trevor Hastie, Robert Tibshirani and Jerome Friedman, The Elements of Statistical Learning (ESL) (2nd Edition), Springer, 2016. ISBN 978-0387848570.
3) Ian Goodfellow, Yoshua Bengio, Aaron Courville, and Francis Bach, Deep Learning Adaptive Computation and Machine Learning series Hardcover (1st Edition), MIT Press, 2017. ISBN 978-0262035613.
4) Yuxi (Hayden) Liu, Python Machine Learning by Example Paperback Import (1st Edition), Packt Publishing, 2017. ASIN: B01MT7ATL5.
5) Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning (ESL) (1st Edition), Springer, 2009. ISBN 978-0387848587.
6) Kevin Murphy, Machine Learning: A Probabilistic Perspective (MLAPP) (1st Edition), MIT Press, 2012. ISBN 978-0262018029.

7) Machine Learning with MATLAB/Octave: A MATLAB/Octave based collection of many ML algorithms (a supplement to the book "Machine Learning: A Probabilistic Perspective").

## v) COURSE PLAN

| Module | Contents | No. of hours |
|---|---|---|
| **I** | Introduction to learning, types of learning, role of learning, Machine learning, supervised learning, unsupervised learning, semi-supervised learning, Applications of machine learning. Types of data, attributes, types- nominal, ordinal, interval, ratio<br>Similarity measures: Euclidian, Manhattan distance, Cosine similarity. Dimensionality reduction techniques- Principal Component Analysis, Attribute Subset Selection, Parametric data reduction, Histograms | 7 |
| **II** | Classification- Concepts, Classifier performance- Accuracy, Error rate, Precision, Recall<br>Decision trees, Information Gain, Gain Ratio, Gini Index, ID3 Algorithm, C 4.5 algorithm, Bayes Theorem, Naive Bayesian Classification | 9 |
| **III** | Support Vector Machines- Maximum margin hyperplanes, Linear SVM, Non-linear SVM, Kernel Trick<br>Association Learning, Basics of Association, Apriori Algorithm, Eclat Algorithm, FP Growth Algorithm.<br>Ensemble Methods –Bagging, Boosting, AdaBoost, Random Forests<br>Real world Application | 10 |
| **IV** | Artificial Neural Networks- basics, learning perception model, Multi layer feed forward network, back propagation. Deep Neural Networks. Case study | 9 |
| **V** | Unsupervised learning- Clustering – Partitioning Method-K-Means, KMedoids, Hierarchical Methods- Agglomerative versus Divisive clustering, Single link algorithm, Complete link algorithm, Distance measures in algorithmic methods, BIRCH- Multiphase Hierarchical clustering using clustering feature trees. Introduction Reinforcement learning. Case Study | 10 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162N | ADVANCED GRAPH HEORY | PEC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OVERVIEW:** Goal of this course is to impart deeper understanding in advanced concepts in graph theory and their practical applications.

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Apply Graph Theory concepts in practical scenarios. | Apply |
| CO2 | Apply the concepts of Metrics, Convexity and Distance sequences on graphs. | Apply |
| CO3 | Apply the concepts of Eulerian digraphs and hamiltonicity. | Apply |
| CO4 | Solve problems based on graph coloring and flow graphs. | Apply |
| CO5 | Apply the concepts of P, NP and NP completeness in real scenarios. | Apply |

**iii) SYLLABUS**

Graphs, Connectivity and Hamiltonicity, Connectivity, The Center and Edge connectivity- Self Central Graphs - The Median – Central Paths - Other Generalized Centers, Extremal Distance Problems, Distance sequences, Matrices, Symmetry, Digraphs, Graph Algorithms, Critical Path Method.

**iv) REFERENCES**


1. Franco P. Preparata, Michael Ian Shamos, “Computational Geometry- An Introduction”, Texts and Monographs in Computer Science , Springer – Verlag
2. Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars “ Computational Geometry, Algorithms & Applications” Springer.
3. Herbert Edelsbrunner, “Algorithms in Combinatorial Geometry”, EATCS Monographs on Theoretical Computer Science, Springer – Verlag.
4. Art Gallery Theorems, Joseph O’ Rourke, Oxford Press.
5. Joseph O’ Rourke, “ Computational Geometry in C”, Cambridge University Press.

## v) COURSE PLAN

| Module | Contents | No. of hours |
|---|---|---|
| I | Graphs: Graphs as models- Paths and cycles - Graph Classes: Multi graphs - Complement graphs – Regular graphs – Complete graphs - Line graphs – Bipartite graphs –Planar graphs and properties – Wheel graphs – Tree and its properties – Subgraphs - Isomorphic graphs - Geodetic graphs - Graph operations. Graph Connectivity – Cut nodes and Blocks – Bridges -Vertex connectivity and edge connectivity - Menger's theorem - Properties of n-connected graphs – Circulant graphs. | 9 |
| II | Metrics on Graphs – Geodesic path- Eccentricity- Radius – Diameter- Center- Self-centered Graphs- The Median – Central Paths – Path Centers - Distance Heredity Graphs –The Center and Edge connectivity.<br><br>Convexity: Closure Invariants - Symmetry: Groups- Symmetric - Distance Symmetry in graphs.<br><br>Distance sequences: Degree Sequence- The Eccentric Sequence - Path Sequence - Other Sequences. | 9 |
| III | Digraphs: Digraphs and connectedness - Acyclic Digraphs.Matrices: The Adjacency Matrix - The incidence Matrix - The Distance Matrix. | 7 |
| IV | Eulerian Digraphs- Long paths in Digraphs- Tournaments. Graph Hamiltonicity: Necessary or sufficient conditions- Connectivity and Hamiltonicity- Graph operations and Hamiltonicity - Generations of Hamiltonicity. | 10 |
| V | Algorithms: Polynomial Algorithms and NP completeness - Maximum Matchings –Minimum Independent Set Problem – Minimum Vertex Cover Problem – Graph coloring. Networks: The Max- Flow Min-Cut Theorem | 10 |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS1620 | ESSENTIAL OF CYBER SECURITY | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**:

This course provides an insight into various information security aspects and vulnerabilities. It also provides students basic knowledge and skills in detecting and defending threat to web Applications and network vulnerability.

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of broad set of technical, social & political aspects of Cyber Security | Apply |
| CO2 | Identify various attacker techniques and motivations. | Apply |
| CO3 | Differentiate various malicious codes | Analyze |
| CO4 | Interpret the various ways for securing devices | Analyze |
| CO5 | Compare various defense and analysis techniques | Analyze |

**iii) SYLLABUS**

Cyber Security Fundamentals- Attacker Techniques and Motivations- Malicious Code- Securing Devices- Defense and Analysis Techniques

**iv) REFERENCES**

1. Cybersecurity Essentials James Graham, Richard Howard, Ryan Olson, CRC Press
2. Cybersecurity Essentials Charles J. Brooks, Christopher Grow, Philip Craig, Donald Short ISBN: 978-1-119-36239-5 November 2018

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Cyber Security Fundamentals - Network and security concepts - Information Assurance Fundamentals - Basic Cryptography -Symmetric Encryption - Public Key Encryption - DNS - Firewalls. Case Study - Windows Firewall. | 8 |
| II | Attacker Techniques and Motivations - How hackers cover their tracks - Tunneling Techniques - Fraud Techniques - Threat Infrastructure. | 9 |
| III | Malicious Code - Self- Replicating Malicious Code - Stealing Information and Exploitation -Form Grabbing - Man in the Middle Attack- DLL Injection - Browser Helper Objects | 9 |
| IV | Securing Devices - The three layers of Security - Securing Host Devices - Securing Outer Perimeter Portals | 9 |
| V | Defense and Analysis Techniques - Memory Forensics - Honey Pots - Malicious Code Naming - Automated Malicious Code Analysis Systems – IDS | 10 |
| | **Total Hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162P | INFORMATION RETRIEVAL | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES:**

To provide with foundation knowledge in information retrieval and to equip with sound skills to solve computational search problems.

**ii) COURSE OUTCOMES:**

After the completion of the course the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of different information retrieval techniques in various application areas. | Apply |
| CO2 | Apply IR principles to locate relevant information from large collections of data | Apply |
| CO3 | Analyze performance of retrieval systems when dealing with unmanaged data sources | Analyze |
| CO4 | Implement retrieval systems for web search tasks. | Apply |

**iii) SYLLABUS**

Introduction to the Concepts of Information Retrieval, Retrieval models, Text processing, Text representation, Text categorization and clustering, Experimental evaluation of Information Retrieval system, Searching the web, Applications to information filtering, Recommender Systems.

**iv) REFERENCES:**

1. C. Manning, P. Raghavan, and H. Schütze, “Introduction to Information Retrieval”, Cambridge University Press, 2008.
2. C.J. Van Rijsbergen , Information Retrieval:, http://www.dcs.gla.ac.uk/Keith/Preface.html
3. Ricardo Baexa-Yates and Berthier Ribeiro-Neto, “Modern Information Retrieval”, Addison Wesley Longman, 1999.
4. Bruce Croft, Donald Metzler and Trevor Strohman, “Search Engines: Information Retrieval in Practice”, 1st Edition Addison Wesley, 2009.
5. Manu Konchady, “Building Search Applications: Lucene, Ling Pipe”, First Edition, Gate Mustru Publishing, 2008.

6. Mark Levene, "An Introduction to Search Engines and Web Navigation", 2nd Edition Wiley, 2010.
7. Ophir Frieder, "Information Retrieval: Algorithms and Heuristics: The Information Retrieval Series", 2nd Edition, Springer, 2004.
8. Stefan Buettcher, Charles L. A. Clarke, Gordon V. Cormack, "Information Retrieval: Implementing and Evaluating Search Engines", The MIT Press, 2010.

## v) COURSE PLAN

| Module | Contents | No. of hours |
|---|---|---|
| I | Introduction: Goals and history of IR. The impact of the web on IR. The role of artificial intelligence (AI) in IR.<br>Basic IR Models: Boolean and vector-space retrieval models; ranked retrieval; text-similarity metrics; TF-IDF (term frequency/inverse document frequency) weighting; cosine similarity. | 7 |
| II | Basic Tokenizing Indexing, and Implementation of Vector- Space Retrieval: Simple tokenizing, stop-word removal, and stemming; inverted indices; efficient processing with sparse vectors; python implementation.<br>Experimental Evaluation of IR: Performance metrics: recall, precision, and F-measure; Evaluations on benchmark text collections. | 9 |
| III | Query Operations and Languages: Relevance feedback; Query expansion; Query languages.<br>Text Representation: Word statistics; Zipf's law; Porter stemmer; morphology; index term selection; using thesauri. Metadata and mark-up languages (SGML, HTML, XML). | 9 |
| IV | Web Search, Search engines; spidering; metacrawlers; directed spidering; link analysis (e.g. hubs and authorities, Google PageRank); shopping agents.<br>Text Categorization and Clustering: Categorization algorithms: naive Bayes; decision trees; and nearest neighbor. Clustering algorithms: agglomerative clustering; k-means; expectation maximization (EM). | 10 |

| | | |
|---|---|---|
| V | Applications to information filtering; organization; and relevance feedback. Recommender Systems: Collaborative filtering and content-based recommendation of documents and products. Information Extraction and Integration: Extracting data from text; XML; semantic web; collecting and integrating specialized information on the web. | 10 |
| | Total hours | 45 |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162Q | BLOCK CHAIN TECHNOLOGIES AND ITS APPLICATIONS | PEC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OVERVIEW**

This course gives an insight to basic Cryptographic primitives used in Blockchain and Basic Blockchains like blockchain1.0, blockchain 2.0,blockchain 3.0.It also gives research directions in block chain technology.

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Demonstrate the need for distributed record keeping and its adversaries | Apply |
| CO2 | Illustrate various crypto primitives used for realising the blockchain | Apply |
| CO3 | Demonstrate the technologies used for implementing the bitcoin and etherium | Apply |
| CO4 | Illustrate the primitives and technologies used in hyperledger fabric | Apply |
| CO5 | Analyze the privacy and security issues in blockchain and use proper preventive measures . | Apply |

**iii) SYLLABUS**

Need for Distributed Record Keeping, Modeling faults and adversaries, Basic Distributed Computing, Basic Crypto primitives, Blockchain 1.0, Blockchain 2.0, Blockchain 3.0, Privacy, Security issues in Blockchain

**iv) REFERENCES:**

1.Draft version of "S. Shukla, M. Dhawan, S. Sharma, S. Venkatesan, 'Blockchain Technology: Cryptocurrency and Applications', Oxford University Press, 2019.

2.Josh Thompson, 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming', Create Space Independent Publishing Platform, 2017.

3. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016. (Free download available)

4. Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and Privacy, 2015 ( article available for free download)

## v) COURSE PLAN

| Module | Contents | No. of hours |
|---|---|---|
| I | Need for Distributed Record Keeping, Modeling faults and adversaries Byzantine Generals problem, Consensus algorithms and their scalability problems, Blockchain based cryptocurrency, Technologies Borrowed in Blockchain – hash pointers, consensus, byzantine fault-tolerant distributed computing, digital cash .<br>Basic Distributed Computing, Atomic Broadcast, Consensus, Byzantine Models of fault tolerance, | 9 |
| II | Basic Crypto primitives-<br>Hash functions, Puzzle friendly Hash, Collison resistant hash, digital signatures, public key crypto, verifiable random functions, Zero-knowledge systems<br>Blockchain 1.0: Bitcoin blockchain, the challenges, and solutions, proof of work, Proof of stake, alternatives to Bitcoin consensus, Bitcoin scripting language and their use | 10 |
| III | Blockchain 2.0: Ethereum and Smart Contracts, The Turing Completeness of Smart Contract Languages and verification challenges, Using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart contracts | 10 |
| **IV** | Blockchain 3.0 :Hyperledger fabric, the plug and play platform and mechanisms in permissioned blockchain | **10** |
| **V** | Privacy, Security issues in Blockchain : Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains – such as Sybil attacks, selfish mining, 51% attacks - - | **8** |

| | | |
|---|---|---|
| | advent of algorand, and Sharding based consensus algorithms to prevent these | |
| | **Total** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162R | NETWORK ON CHIP | PEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**:

This course introduces the deisgn concepts of Networks-on-a-chip (NoC). NoCs are the communication infrastructure between the many cores of a multi-processor system-on-a-chip (MPSoC), such as 1) a quad-core, eight-core, eighty-core and the futuristic 1000-core processors that target exa-scale computing or 2) multi-core systems that target high-performance mobile computing. Systematic understanding, design and analysis of NoCs will be covered

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Make use of basic concepts of NoC design for architecture, topologies and router design | Apply |
| CO2 | Examine basic Flow Control and Deadlock mechanisms used in NOC. | Analyze |
| CO3 | Illustrate the role of system-level design and performance metrics in choosing a NoC design | Analyze |
| CO4 | Demonstrate the Router Micro-architecture | Apply |

**iii) SYLLABUS**

Basic Concepts of Network-on-Chip- Flow Control and Deadlock- Router Micro-architecture- Network Performance Analysis and Reliability- NoC Based System Integration

**iv) REFERENCES**


1. William J Dally, Principles and Practices of Interconnection Networks (The Morgan Kaufmann Series in Computer Architecture and Design) , Morgan Kaufmann; 1 edition (January 1, 2004)
2. Sao-Jie Chen , Ying-Cherng Lan , Wen-Chung Tsai ,Yu-Hen Hu, Reconfigurable Networks-on-Chip, Springer; 2012 edition (December 15, 2011)
3. Tim Kogel, Rainer Leupers , Heinrich Meyr , Integrated System-Level Modeling of Network-on-Chip enabled Multi-Processor Platforms, Springer, 1st ed. 2006 edition (November 19, 2010)

4. Giovanni De Micheli , Luca Benini , Networks on Chips: Technology and Tools (Systems on Silicon), Morgan Kaufmann; 1 edition (August 3, 2006)

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Basic Concepts of Network-on-Chip: Introduction to interconnection networks, Walk through of a simple network, Topology basics, Constraints and measures, Butterfly networks, Cube networks. Concentration and slicing, Non-blocking topologies, Topology overflow and wrapup, Routing basics and taxonomy, Oblivious routing. Adaptive routing, Routing mechanics | 10 |
| II | Flow Control and Deadlock: Flow control basics. Resources and allocation strategies, Circuit switching. Store and forward. Dropping flow control. Misrouting. Cut through. Wormhole flow control, Virtual channels. Deadlock and livelock. Principles of deadlock. Buffer deadlock and channel deadlock. Deadlock in cyclic networks. Inter-dimension deadlock. Avoiding deadlock with virtual channels. The turn models. | 8 |
| III | Router Micro-architecture : Basic router. Input buffers and buffer organization. Internal switch organization: crossbars, dimension-ordered, and multistage, Router datapath components, router pipelining, router delay Models, Allocators. Arbiters. The allocation problem - allocating VCs to packets and bandwidth to flits. Bipartite matching. Naïve allocation. Separable allocators. Wavefront allocation. | 10 |
| IV | Network Performance Analysis and Reliability: Network performance analysis, Analysis of networks with dropping flow control. Analysis of blocking, The effects of buffers, Simulation vs. analysis, The effect of traffic patterns, Load balance and route diversity, Definition of Reliability and Availability, Failure mechanisms and fault models, Path diversity, Pragmatics and self-healing | 9 |
| V | NoC Based System Integration – NOC Interface Design and Clock Distribution – Case Study on NoC Architecture for Mobile Application. | 8 |
| | Total Hours | 45 |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162S | NATURAL LANGUAGE PROCESSING | PEC | 3 | 0 | 0 | 3 | 2022 |

## i) COURSE OBJECTIVES:

The purpose of this course is to introduce the fundamentals of Language processing from the algorithmic viewpoint. It aims to discuss various issues that make natural language processing a hard task and discuss some applications of Natural Language Processing (NLP).

## ii) COURSE OUTCOMES

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Demonstrate the various text mining concepts and language processing principles. | Apply |
| CO2 | Apply techniques for syntax parsing and sentence level construction | Apply |
| CO3 | Implement useful systems for sentiment analysis from text. | Apply |
| C04 | Implement systems for natural language processing | Apply |

## iii) SYLLABUS

Introduction to Natural Language Processing, Statistical Modelling and Classification Finite State methods Grammar for Natural Language Processing; Syntax Parsing; Context-Free Grammars for English; Sentence-level constructions; Text Mining: Named Entity Recognition, Categorization – Information Extraction ; Clustering- Hierarchical Clustering Document Classification and routing; Document Summarization; Sentiment Analysis; Opinion Mining, Basic Rules of Opinions and Compositional Semantics; Polysemy and synonymy, Word Sense Disambiguation, Coreference resolution; handling sparsity, domain adaptation and representations; Markov logic and NLP; Generic Issues: Multilinguality, Multimodality, Text and Images – Modality Integration -: Machine Translation Discourse Processing; Case Study: Lemmatization, Stemming, Tokenization and Tagging using NLTK Tool Kit

## iv) REFERENCES

1. Daniel Jurafsky and James H. martin, " Speech and Language Processing" ,2000.

2. Ron Cole, J.Mariani, et.al "Survey of the State of the Art in Human Language Technol ogy", Cambridge University Press, 1997.

3. Michael W. Berry " Survey of Text Mining: Culstering, Classification and Retrieval", Springer Verlag, 2003.

4. Christopher D.Manning and HinrichSchutze, " Foundations of Statistical Natural Language Processing ", MIT Press, 1999.

5. James Allen " Natural Language Understanding ", Benjamin/ Cummings Publishing Co. 1995.

6. Sentiment Analysis and Opinion Mining, Bing Liu.Morgan&Claypool Publishers, May 2012.

7. Gerald J. Kowalski and Mark.T. Maybury, "Information Storage and Retrieval systems", Kluwer academic Publishers, 2000.

8. TomekStrzalkowski" Natural Language Information Retrieval ", Kluwer academic Publishers, 1999.

9. Christopher D.Manning and HinrichSchutze, "Foundations of Statistical Natural Language Processing ", MIT Press, 1999.

10. Natural Language Processing with Python, Steven Bird, Ewan Klein and Edward Loper O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.

11. Charniak, Eugene, Introduction to Artificial intelligence, Addison-Wesley, 1985.

12. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, Modern Information Retrieval, Addison-Wesley,1999.

13. U. S. Tiwary and Tanveer Siddiqui, Natural Language Processing and Information Retrieval, Oxford University Press, 2008.

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Introduction: Natural Language Processing – Linguistic Background-Spoken language input and output Technologies – Written language Input - Mathematical Methods. Statistical Modelling and Classification Finite State methods. Grammar for Natural Language Processing – Parsing – Semantic and Logic Form – Ambiguity Resolution – Semantic Interpretation. Finite-State Morphological parsing The porter stammer Syntax Parsing: Document Collection, Tokenization, Generate Vectors, Term Frequencies-Inverse Document Frequencies (tf-idf), | 9 |
| II | Word Classes and part-of-speech tagging: English word classes – Tag sets for English -Part-of-speech tagging, Context-Free Grammars for English: Constituency - Context-Free rules and trees, Sentence-level | 9 |

| | | |
|---|---|---|
| | constructions - The noun phrase - The verb phase and sub categorization Finite-State and Context-Free grammars - Grammars and human processing. Parsing with Context-Free Grammars. | |
| III | Text Mining: Named Entity Recognition, Categorization – Information Extraction, Extraction based Categorization Decision trees, Naive Bayes, Support Vector Machines, Nearest Neighbour. , Evaluation metrics Clustering- Hierarchical Clustering Document Classification and routing- finding and organizing answers from Text search – use of categories and clusters for organising retrieval results, Document Summarization using Lexical Chains – Pattern Extraction | 10 |
| IV | Sentiment Analysis- Sentiment Classification Using Supervised Learning and Unsupervised Learning, Sentiment Rating Prediction, Cross Domain Sentiment Classification Opinion Mining, Basic Rules of Opinions and Compositional Semantics, Aspect Extraction, Simultaneous Opinion Lexicon Expansion and Aspect Extraction, Grouping Aspects into Categories, Entity, Opinion Holder and Time Extraction. | 10 |
| V | Word Sense Disambigution, Coreference resolution; handling sparsity, domain adaptation and representations; combining logic and probability, Markov logic and NLP, ontology extension. Generic Issues: Multilinguality, Multimodality, Text and Images – Modality Integration -: Machine Translation –-Discourse Processing Case Study: Lemmatization, Stemming, Tokenization and Tagging using NLTK Tool Kit | 10 |
| | Total hours | 45 |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS162T | DEEP LEARNING | PEC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OBJECTIVES**

This course introduces the key concepts in neural networks, its architecture and learning paradigms, optimization techniques, basic concepts in deep learning, Convolutional Neural Networks and Recurrent Neural Networks. The students will be able to provide best solutions to real world problems in domains such as computer vision and natural language processing.

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Demonstrate the basic concepts of machine learning models and performance measures. | Apply |
| CO2 | Apply the basic concepts of neural networks and its practical issues | Apply |
| CO3 | Outline the standard regularization and optimization techniques for deep neural networks | Apply |
| CO4 | Build CNN and RNN models for different use cases. | Apply |
| CO5 | Apply the concepts of modern RNNs like LSTM, GRU | Apply |

**iii) SYLLABUS**

Machine Learning basics - Learning algorithms, Estimators -Bias and Variance. Challenges in machine learning. Simple Linear Regression, Logistic Regression, Performance measures. Single layer perceptrons, Multi LayerPerceptrons (MLPs), Activation functions. Risk minimization, Loss function, backpropagation, Practical issues in neural network training - Computational Challenges. Applications of neural networks. Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques. Convolutional Neural Networks Efficient convolution algorithms. Practical use cases for CNNs, Case study - Building CNN model AlexNet with handwritten digit dataset MNIST. Recurrent neural networks, deep recurrent

networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Case study - Natural Language Processing.

**iv) REFERENCES**


1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018
3. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.


**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Machine Learning basics - Learning algorithms - Supervised, Unsupervised, Reinforcement, Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance. Challenges in machine learning. Simple Linear Regression, Logistic Regression, Performance measures - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, Receiver Operating Characteristic curve( ROC), Area Under Curve(AUC). | **5** |
| II | Introduction to neural networks -Single layer perceptrons, Multi Layer Perceptrons (MLPs), Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks. | **6** |
| III | Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization. | **8** |

| | | |
|---|---|---|
| IV | Convolutional Neural Networks – Convolution operation, Motivation, Pooling, Convolution and Pooling as an infinitely strong prior, Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms. Transfer learning. Practical use cases for CNNs. Autoencoders and its variants.<br>Case study - Building CNN model. | **13** |
| V | Generative Adversarial Network, Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Advanced Topics in deep learning- Deep Belief Networks, Attention models,<br>Case study - Natural Language Processing. | **13** |
| | Total hours | 45 |

# LABORATORY COURSE

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS169A | ALGORITHM DESIGN LABORATORY | LBC | 0 | 0 | 2 | 1 | 2022 |

**i) COURSE OBJECTIVES:** The course aims to offer students a hands-on experience on different advanced data structures

**ii) COURSE OUTCOMES**

After the completion of the course the student will be able to:

| | | |
|---|---|---|
| CO1 | Implement different advanced data structures. | Apply |
| CO2 | Implement a primality testing algorithm. | Apply |
| CO3 | Implement algorithm to find factors of a given number. | Apply |
| CO4 | Implement pattern matching algorithms. | Apply |
| CO5 | Analyze flow in a network using different algorithms. | Apply |
| CO6 | Apply randomized algorithms to find mincut in a network and to perform selection sort. | Apply |
| CO7 | Implement algorithms to find convex hull from a set of points. | Apply |

**iii)SYLLABUS**

Advanced data structures: binomial heap, Fibonacci heap, disjoint sets, String matching algorithm, Randomized algorithms, Geometric Algorithms, Network flow algorithms, Integer factorization, Primality testing.

**iv) REFERENCES**

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, “Introduction to algorithms”, Prentice-hall of India Private Limited, New Delhi, 2010.

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|

| | | |
|---|---|---|
| I | Binomial heap | 2 |
| II | Fibonacci heap | 2 |
| III | Disjoint sets | 2 |
| IV | Primality testing | 2 |
| V | Integer factorization | 2 |
| VI | Rabin-Karp algorithm | 2 |
| VII | Knuth-Morris-Pratt algorithm | 2 |
| VIII | Dinic's algorithm | 2 |
| IX | Push-relabel algorithm | 2 |
| X | Relabel-to-front algorithm | 2 |
| XI | Pseudo random generator | 2 |
| XII | Randomized min-cut algorithm | 2 |
| XIII | Randomized selection algorithm | 2 |
| XIV | Graham's scan algorithm | 2 |
| XV | Jarvis march algorithm | 2 |
| | **Total hours** | 30 |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS169A | NETWORK SYSTEMS LAB | LBC | 0 | 0 | 2 | 1 | 2022 |

**i) COURSE OBJECTIVES:**

To make students to setup a LAN and configure different server services, analyzing network traffic using different tools,

**ii) COURSE OUTCOMES:**

After the completion of the course the student will be able to:

| | | |
|---|---|---|
| CO1 | Use network related commands and configuration files in Linux Operating System | Apply |
| CO2 | Analyze network traffic using network monitoring tools. | Analyze |
| CO3 | Configure different network services | Apply |
| CO4 | Design a LAN and configure different server services | Apply |
| CO5 | Develop network application programs using sockets. | Apply |

**iii) SYLLABUS:**

Familiarization of Linux/Unix network commands **,**Familiarization of Wireshark ,Detailed Study of protocols in TCP/IP model using Wireshark,Deploy Server services,Network administration and defence,Socket Programming Experiments

**iv) REFERENCES:**

1. WALE SOYINKA, Linux Administration:A Beginner's Guide, Fifth Edition, McGraw-Hill

2. Tom Adelstein, Bill Lubanovic , Linux System Administration, O'Reilly

3. Richard Stevens, Bill Fenner, "UNIX network programming Volume-1 –The Sockets Networking API".

**v) COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Familiarization of following Linux/Unix network commands<br>a. Ping<br>b. traceroute<br>c. arp<br>d. route | 1 |

| | | |
|---|---|---|
| | e. netstat<br>f. About /etc folder<br>g. IP Setting /Subnet Masking<br>h. Setting up Hostname/Setting local name resolution | |
| II | Detailed Study of Subnetting and Supernetting | 2 |
| III | Familiarization of Wireshark | 2 |
| IV | Detailed Study of protocols in TCP/IP model using Wireshark | 3 |
| V | Deploy Web, Postgre SQL, Email, DNS, DHCP, SSH,FTP,SAMBA and Proxy Servers. Deploy it using virtual machines. | 4 |
| VI | Build your own ISP. It should include a DNS, DHCP, Leased Line, PPP, Webserver, Internet Backbone with appropriate routing protocols. Experiment may be implemented using real systems/Simulators | 4 |
| VII | Develop your own LAN with WAN for offshore connectivity. It should employ a firewall/proxy to redirect all external traffic. Use CIDR for forming departments. Experiment may be implemented using real systems/Simulators | 3 |
| VIII | Network administration and defence<br>a. Measuring Internet topology with BGP Updates<br>b. Characterizing traffic aggregates with Netflow<br>c. Analyzing packet-level traffic with tcpdump | 3 |
| IX | Build your own firewall using IPTables. | 3 |
| XII | Socket Programming Experiments on<br>a. TCP Echo Server, TCP Echo Client<br>b. UDP Echo server, UDP Echo Client<br>c. File Server<br>d. Broadcast, Multicast<br>e. Simple Network Time Protocol<br>f. TCP Iterative Server<br>g. TCP Concurrent Server | 5 |
| | **Total hours** | **30** |

# INDUSTRY ELECTIVE

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS166A | CYBER FORENSICS BASICS | IEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES:**

- To understand concepts, developments, challenges, and directions in cyber Forensics
- Understanding Laws relating to computer crime investigations
- An in-depth study of each phases involved in a forensics investigation processes.

**ii) COURSE OUTCOMES:**

After the completion of the course the student will be able to:

| | | |
|---|---|---|
| CO1 | Analyze the importance of digital forensics | Analyze |
| CO2 | Make use of standard procedures to conduct a forensics investigation | Apply |
| CO3 | Analyze hardware and software tools. | Analyze |

**iii) SYLLABUS**

Introduction to Computer Forensics, Understanding Computer Investigations , Requirements for forensic lab certification , Data Acquisition , Processing Crime and Incident Scene, Working with windows and DOS systems, Analysis and validation , Recovering Graphics Files, Network Forensics , Email Investigations , Report writing for high tech investigations, Expert Testimony in High Tech Investigations , Ethics for the Expert Witness.

**iv)REFERENCES**

1. Bill Nelson, Amelia Phillips, Frank Enfinger, Christofer Steuart , “Computer Forensics and Investigations”, Second Indian Reprint , Cengage Learning India Private Limited,2009.

2. Eoghan Casey , “Digital Evidence and Computer Crime “, Edition 3, Academic Press, 2011.

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Introduction to Digital Forensics, History of Digital Forensics, Understanding Case Law, Developing Digital Forensics Resources, Preparing for Digital Investigations, Understanding Law Enforcement Agency Investigations, Maintaining Professional Conduct, Procedures for Private-Sector High-Tech Investigations, Understanding Data Recovery Workstations and Software, Conducting an Investigation, Determining the Physical Requirements for a Digital Forensics Lab | 9 |

| | | |
|---|---|---|
| II | Understanding Storage Formats for Digital Evidence, Determining the Best Acquisition Method, Contingency Planning for Image Acquisitions, Using Acquisition Tools, Validating Data Acquisitions, Performing RAID Data Acquisitions, Using Remote Network Acquisition Tools, Using Other Forensics Acquisition Tools | 9 |
| III | Working with Windows and CLI Systems, Understanding File Systems, Exploring Microsoft File Structures, Examining NTFS Disks, Understanding Whole Disk Encryption, Understanding the Windows Registry, Understanding Microsoft Startup Tasks, Understanding Virtual Machines, Digital Forensics Software and Hardware Tools, Validating and Testing Forensics Software, Examining Linux File Structures, Understanding Macintosh File Structures | 9 |
| IV | Determining What Data to Collect and Analyze, Validating Forensic Data, Addressing Data-Hiding Techniques, Recognizing a Graphics File, Understanding Data Compression, Identifying Unknown File Formats, Understanding Copyright Issues with Graphics, Performing Live Acquisitions, Network Forensics | 9 |
| V | Role of E-mail in Investigations, Roles of the Client and Server in E-mail, Investigating E-mail Crimes and Violations, Understanding E-mail Servers, Using Specialized E-mail Forensics Tools, Mobile Device Forensics, Acquisition Procedures for Mobile Devices, Cloud Forensics, Report Writing for High-Tech Investigations, Guidelines for Writing Reports | 9 |
| | Total Hours | 45 |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS166A | STREAM PROCESSING AND ANALYTICS | IEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**

This course introduces the students with the architecture of streaming data processing systems. This course also enables students to understand the complete end-to-end solution for cost-effective analysis and visualization of streaming data with the help of various open source solutions available in this space. This course also helps students to learn the implementation and application of algorithms and data structures required for the streaming applications.

**ii)COURSE OUTCOMES**

| | | |
|---|---|---|
| CO1 | Make use of streaming data systems | Apply |
| CO2 | Analyze the architecture of streaming data systems | Analyze |
| CO3 | Apply the algorithmic techniques used in streaming data systems | Apply |
| CO4 | Analyze tools and techniques required for streaming data analytics | Analyze |

**iii)SYLLABUS**

Scalable Streaming Data Systems, Streaming Data Systems Architecture, Streaming Data Frameworks, Streaming Analytics, Advanced Streaming Applications

**iv)REFERENCES**

1. Streaming Data: Understanding The Real-Time Pipeline, Andrew G.Psaltis, 2017, Manning Publications

2.Real-Time Analytics: Techniques to Analyze and Visualize Streaming Data, Byron Ellis, 2014, Wiley

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|

| | | |
|---|---|---|
| I | Thinking about Data Systems, Reliable, Scalable and Maintainable Data Applications, Properties of Data, Scaling with the traditional databases, Big Data Systems, Desired properties of Big Data Systems, Data Model for Big Data, Generalized Big Data System Architecture, Real time systems, Difference between Batch processing and Stream Processing, Difference between real time and streaming systems | 9 |
| II | Generalized Streaming Data Architecture, Lambda Architecture<br>Kappa Architecture, Streaming Data system Component, Features of Real time Architecture, A real time architecture checklist, Service Configuration and Coordination Systems, Maintaining the state, Apache ZooKeeper, Data Flow Manager, Managing distributed data flows with Apache Kafka, Apache Flume | 10 |
| III | Kafka Fundamentals, Overview, Use-Cases and applications, Architecture, Kafka Topics, Producer and Consumer Using CLI, Programming Kafka, Simple Kafka Producer, Simple Kafka Consumer Producer, Consumer Configuration, Producer, Consumer Execution, Kafka Consumer Groups | 9 |
| IV | Streaming Data Processor Concepts, Timing Concepts, Windowing, Joins, Storage for Streaming Data, NoSQL storage Systems, Choosing a Storage technology, Delivery of Streaming Metrics | 8 |
| V | Apache Spark Streaming, Spark Streaming fundamentals, Motivation, Difference between Spark Streaming API and Spark API, Architecture, Components of Spark Engine, Spark Application Architecture, Fault Tolerance, Comparison with Traditional Streaming Systems | 9 |
| | **Total hours** | **45** |

## INTER DISCIPLINARY ELECTIVE

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS165A | Pattern Recognition | IEC | 3 | 0 | 0 | 3 | 2022 |

**COURSE OVERVIEW**: To familiarize with the various for perception of 2D images and mapping of 2D to 3D images.

**COURSE OUTCOMES**

After the completion of the course the student will be able to:

| | | |
|---|---|---|
| CO 1 | Design and construct a pattern recognition system | Apply |
| CO 2 | Make use of approaches in statistical and syntactic pattern recognition. | Apply |
| CO 3 | Design and construct a pattern recognition system | Apply |
| CO 4 | Implement pattern recognition techniques | Apply |

**SYLLABUS**

Review of Probability Theory and Probability distributions, Introduction to Pattern Recognition and its applications, Bayesian decision theory, Bayesian estimation: Gaussian distribution, ML estimation, EM algorithm, Supervised and unsupervised learning, Feature selection, Linear Discriminant Functions, Non-parametric methods, Hidden Markov models for sequential data classification, Linear models for regression and classification, Clustering

**REFERENCES**

1. C M Bishop, Pattern Recognition and Machine Learning, Springer
2. R O Duda, P.E. Hart and D.G. Stork, Pattern Classification and scene analysis, John Wiley
3. Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, New York, 1993.
4. Robert J. Schalkoff, Pattern Recognition : Statistical, Structural and Neural Approaches, John Wiley & Sons Inc., New York, 2007.
5. S.Theodoridis and K. Koutroumbas, Pattern Recognition, 4/e, Academic Press, 2009.

**COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| **I** | Introduction: Basics of pattern recognition system, various applications, Machine Perception, classification of pattern recognition systems .Design of Pattern recognition system, Pattern recognition Life Cycle<br><br>Statistical Pattern Recognition: Review of probability theory, Gaussian distribution, Bayes decision theory and Classifiers, Optimal solutions for minimum error and minimum risk criteria, Normal density and discriminant functions, Decision surfaces | **10** |
| **II** | Parameter estimation methods: Maximum-Likelihood estimation, Expectation-maximization method, Bayesian parameter estimation Concept of feature extraction and dimensionality, Curse of dimensionality, Dimension reduction methods - Fisher discriminant analysis, Principal component analysis Hidden Markov Models (HMM) basic concepts, Gaussian mixture models. | **9** |
| **III** | Non-Parameter methods: Non-parametric techniques for density estimation - Parzen-window method, K-Nearest Neighbour method.<br>Non-metric methods for pattern classification: Non-numeric data or nominal data Decision trees: Concept of construction, splitting of nodes, choosing of attributes, overfitting, pruning | **8** |
| **IV** | Linear Discriminant based algorithm: Perceptron, Multilayer perceptrons, Back Propagation algorithm, Artificial Neural networks ,Support Vector Machines. | **9** |
| **V** | Classifier Ensembles: Bagging, Boosting / AdaBoost<br>Unsupervised learning: Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods, Cluster validation | **9** |
| | **Total hours (Approx.)** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS165B | Cloud computing and security | IEC | 3 | 0 | 0 | 3 | 2022 |

**i)COURSE OBJECTIVES**:

To understand and practice the fundamental and advanced concepts Data Warehousing and Data Mining.

**ii)COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO1 | Analyze various cloud system models and evolving computing paradigms | Analyze |
| CO2 | Make use of concepts, characteristics, technologies and the processes required when deploying web services | Apply |
| CO3 | Apply the security aspects in cloud and the services offered by a cloud. | Apply |
| CO4 | Apply classic security techniques to today's cloud security problems. | Apply |

**iii)SYLLABUS**

Cloud Computing Fundamentals: Cloud Computing definition, private, public and hybrid cloud. Cloud types Technologies and the processes required when deploying web services :Cloud Security Overview: Cloud Security Challenges, Cloud Computing Software Security Fundamentals Virtualization Security, Multi-tenancy Issues:

**iv)REFERENCES**


1. Distributed and Cloud Computing, Kaittwang Geoffrey C.Fox and Jack J Dongrra, Elsevier India 2012.
2. GautamShroff, "Enterprise Cloud Computing Technology ArchitectureApplications", Cambridge University Press; 1 edition [ISBN: 978-0521137355], 2010.
3. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", Tata McGraw-Hill Osborne Media; 1 edition 22, [ISBN:0071626948], 2004.
4. Tim Mather, SubraKumaraswamy, ShahedLatif, "Cloud Security andPrivacy: An Enterprise Perspective on Risks and Compliance", O'ReillyMedia; 1 edition, [ISBN: 0596802765], 2004.
5. Ronald L. Krutz, Russell Dean Vines, "Cloud Security", Wiley [ISBN:0470589876], , 2010
6. Securing The Cloud: Cloud Computing Security Techniques and Tactics by Vic (J.R.) Winkler (Syngress/Elsevier) - 978-1-59749-592-9
7. Cloud Computing Design Patterns by Thomas Erl (Prentice Hall) - 978-0133858563

8. John W Rittinghouse and James F Ransome , "Cloud Computing: Implementation – Management – and Security", CRC Press, 2010.

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| I | Cloud Computing Fundamentals: Cloud Computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing. Public vs private clouds role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture | 7 |
| II | Technologies and the processes required when deploying web services: Deploying a web service from inside and outside a cloud architecture, advantages and disadvantages.Development environments for service development; Amazon, Azure, Google App. | 9 |
| III | Cloud Security Overview: Cloud Security Challenges– Software-as-a-Service Security – Security Governance – Risk Management – Security Monitoring – Security Architecture Design – Data Security – Application Security – Virtual Machine Security. | 9 |
| IV | Cloud Computing Software Security Fundamentals Security Concepts - Confidentiality, privacy, integrity, authentication, nonrepudiation, availability , access control, defence in depth, least privilege- how these concepts apply in the cloud and their importance in PaaS, IaaS and SaaS. e.g. User authentication in the cloud | 8 |
| V | Virtualization Security,Multi-tenancy Issues: Isolation of users/VMs from each other- How the cloud provider can provide this. Virtualization System Security Issues: e.g. ESX andESXi Security, ESX file system security- Storage considerations backup and recovery- Virtualization System Vulnerabilities. Security management in the cloud – security management standards- SaaS, PaaS, IaaS availability management | 12 |
| | Total hours | 45 |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS165C | DATA SCIENCE | IEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OBJECTIVES**

To obtain a comprehensive knowledge of various tools and techniques for Data transformation and visualisation. To learn the probability and probabilistic models of data science. To learn the basic statistics and testing hypothesis for specific problems

**ii)COURSE OUTCOMES:**

After the completion of the course, the student will be able to:

| # | Description | Level |
|---|---|---|
| CO1 | Apply exploratory data analysis and create insightful visualisations to identify patterns | Apply |
| CO2 | Make use of statistical foundations of data science and analyse the degree of certainty of predictions using statistical test and models | Analyse |
| CO3 | Apply the basic probability principles and techniques | Apply |

**iii)SYLLABUS**

Data Science process, Memorization methods, Unsupervised models, Univariate data exploration, Data visualisation, Prediction and filtering, Probability theory and Statistics.

**iv)REFERENCES:**

**1.**Boris Lublinsky, Kevin T. Smith. Alexcy Yakubovich, "Professional Hadoop Solutions", Wiley, 2015
2. Jure Leskovec, Anand Rajaraman, Jeffrey D. Ullman, "Mining of Massive Datasets". Cambridge University Press, 2014
3. Nathan Yau, "Visualize This: The Flowing Data Guide to Design, Visualization and Statistics",
Wiley, 2011
4. Nina Zumel, John Mount "Practical Data Science with R··. Manning Publications. 2014
5. Sameer Madhavan , “Mastering Python for Data Science”, Packt Publishing Limited, 2015

**v)COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| **I** | Data Science process - Roles and stages in a data science project, Working with files and databases, Exploring and managing data. Exploratory Data Analysis, Selecting models for data science problems, Evaluation and validation of models, Documentation and deployment, Presenting results to stakeholders. | 7 |
| **II** | Memorization methods - single variable and multivariable models, | 9 |

| | | |
|---|---|---|
| | Linear and logistic regression. Unsupervised methods – Cluster analysis, K-means algorithm, clusterboot method, Association rules. Exploring Univariate Data - Histograms - Stem-and Leaf Quantile Based Plots - Continuous Distributions -Quantile Plots- QQ Plot- Box Plots | |
| **III** | Python based data visualization, Prediction using linear regression - single variable and multi-variable models, Collaborative filtering – user based filtering and item based filtering. | 9 |
| **IV** | Probability Concepts -Axioms of Probability - Conditional Probability and Independence - Bayes Theorem - Expectation - Mean and Variance Skewness Kurtosis; Common Distributions - Binomial Poisson Uniform - Normal Exponential Gamma-Chi-Square Weibull Beta | 8 |
| **V** | Introduction to Statistics - Sampling, Sample Means and Sample variance sample moments, covariance, correlation, Sampling Distributions - Parameter Estimation Bias - Mean Squared Error - Relative Efficiency - Standard Error - Maximum Likelihood Estimation. Comparing Two Samples - A/B Testing - ANOVA. | 9 |
| | Total hours | 42 |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS165D | Machine Learning | IEC | 3 | 0 | 0 | 3 | 2022 |

**i) COURSE OVERVIEW**: To understand the basic concepts of machine learning. Students will learn different machine learning algorithms and apply those techniques to solve real life problems.

**ii) COURSE OUTCOMES**

After the completion of the course, the student will be able to:

| | | |
|---|---|---|
| CO 1 | Make use of machine learning Techniques | Apply |
| CO 2 | Apply concept of decision trees to solve machine learning problems. | Apply |
| CO 3 | Demonstrate the working of classifier models for typical machine learning applications | Apply |
| CO 4 | Demonstrate clustering algorithms and identify its applicability in real life problems. | Apply |

**iii) SYLLABUS**

Introduction to machine learning, Decision Trees, Classifier Performance, kNN, Multi-class Classification, Naive Bayes, Support Vector Machines, Neural Networks, Clustering, Dimensionality Reduction Techniques

**iv) REFERENCES**


i. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.
ii. The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.
iii. Foundations of Data Science. Avrim Blum, John Hopcroft and Ravindran Kannan. January 2017


**COURSE PLAN**

| Module | Contents | No. of hours |
|---|---|---|
| **I** | Introduction to Machine Learning, Learning applications - Learning associations, Classification, Regression, Unsupervised Learning, Supervised learning- Input representation | **8** |
| **II** | Classification- Decision Trees- Entropy, Information Gain, Tree construction, ID3, Issues in Decision Tree learning- Avoiding Over-fitting, Reduced Error Pruning, The problem of Missing Attributes, Gain Ratio, Measuring classifier performance- Precision, recall, ROC curves, K-fold cross validation. | **9** |

| | | |
|---|---|---|
| **III** | Classification by Regression (CART), Multi-class Classification kNN , Bayes Theorem, Bayesian classifier, Maximum Likelihood estimation, Density Functions, Support Vector Machines. | **10** |
| **IV** | Neural Networks- The Perceptron, Activation Functions, Training Feed Forward Network by Back Propagation. | **8** |
| **V** | Unsupervised Learning - Clustering Methods: Partitioning clustering, Hierarchical Clustering, Density based clustering, Dimensionality reduction techniques. | **10** |
| | **Total hours** | **45** |

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| | Research Methodology & IPR | RM | 2 | 0 | 0 | 2 | 2022 |

**1) Course Objectives:**

This course is intended to prepare the M. Tech students to carry out their dissertation/ research project work effectively, with a research bias. The student will be able to formulate a viable research problem, do a critical analysis of publications in the area of research, and identify a research method suitable for the work. The student will achieve the capability to write a technical paper based on his/her dissertation/ research project.

**2) Course Outcomes:**

After the completion of the course the student will be able to:

| # | Description | Level |
|---|---|---|
| CO1 | Explain research ethics, Citation, Impact factor and Plagiarism. | Apply |
| CO2 | Formulate a research problem, make a suitable research design, and identify the data collection methods. | Apply |
| CO3 | Analyse the collected data. | Analyse |
| CO4 | Explain the role of IPR and Patent law in fostering research work, leading to creation of improved products, thus supporting economic growth and social benefits. | Apply |
| CO5 | Write a technical paper for publication. | Apply |

**3) Syllabus:**

Introduction to Research Methodology- motivation for research, types of research, ethical issues. Identifying a research area and collecting related literature. Research problem- scope-objectives, literature review, identifying research gaps, and formulate the research problem. Research design and methods, data collection and analysis. Copy right – royalty - IPR and patent law. Process of patenting and development, Procedure for grant of patents. Copy left-open access, citation, plagiarism, iImpact factor. Writing a technical paper.

**4) References:**

**i)** Stuart Melville and Wayne Goddard, *Research methodology: an introduction for science & engineering students.*
**ii)** Ranjit Kumar, 2nd Edition, *Research Methodology: A Step by Step Guide for beginners.*
**iii)** Ramappa T., *Intellectual Property Rights Under WTO,* S. Chand, 2008.
**iv)** Robert P. Merges, Peter S. Menell, Mark A. Lemley, *Intellectual Property in New Technological Age*, 2016.

**v)** Mayall, *Industrial Design,* McGraw Hill, 1992. Niebel, "Product Design", McGraw Hill, 1974.

**5) Course Plan:**

| Module | Contents | Hours |
|---|---|---|
| **I** | Introduction to Research Methodology: Motivation towards research, Types of research. Professional ethics in research: Ethical issues, ethical committees. Identification of major conferences and important journals in a chosen area of interest. Collection of at least 10 published papers on a research problem in the chosen area. | **6** |
| **II** | Defining and formulating the research problem: Literature Survey, Analysing the collected papers to understand how the authors haveidentified the research gaps, arrived at their objectives, and formulated their research problem. Understanding how their research work is different from the previous works in the chosen area. | **6** |
| **III** | Research design and methods: Analyzing the collected papers to understand how the authors have formulated the research methods, both analytical methods and experimental methods. Data Collection and analysis: Analyzing the collected papers to understand the methods of data collection, data processing, analysis strategies, and tools used for analyzing the data. | **6** |
| **IV** | Copy right - royalty - Intellectual property rights and patent law – Process of Patenting and Development, Procedure for grant of patents. Reproduction of published material: Copy left- Open access, Citation and acknowledgement. Plagiarism, Impact factor. | **6** |
| **V** | Technical writing - Structure and components of a typical technical paper, abstract and conclusion, illustrations and tables, bibliography, referencing and footnotes. Writing a technical paper – based on the identified research problem, and using the collected papers, Literature survey, Problem formulation, and Research design, and a hypothetical result. | **6** |
| | **Total hours** | **30** |

# PROJECT

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS167A | MINI PROJECT | PR | 0 | 0 | 4 | 2 | 2022 |

**COURSE OBJECTIVES**

To make students

1) Collect the recent publications related to the identified Mini project.
2) Do a detailed study of the Mini project based on current journals, published papers and books.
3) Present a seminar based on the Mini project.
4) Improve the writing and presentation skills.
5) Design and develop a system or application in the area of their specialization.

**APPROACH**

1) Students shall make a presentation for 20-25 minutes based on the detailed study on the project and submit a report of the study.
2) There will be two interim progress review of the Mini project work. The first review will focus on the topic, objectives, methodology, design and expected results.
3) The second review shall focus on the work/ Implementation and results obtained.

**EXPECTED OUTCOME**

Upon successful completion of the Mini project and Seminar, the student should be able to

1) Identify and solve various problems associated with designing and implementing a system or application.
2) Test the designed system or application.
3) Improve the writing and presentation skills.
4) Explore domains of interest so as to pursue the course project.

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS178B | DISSERTATION PHASE I | PR | 0 | 0 | 17 | 11 | 2022 |

To make students

1) Do an original and independent study on the area of specialization.
2) Explore in depth a subject of his/her own choice.
3) Start the preliminary background studies towards the project by conducting literature survey in the relevant field.
4) Broadly identify the area of the project work, familiarize with the tools required for the design and analysis of the project.
5) Plan the experimental platform, if any, required for project work.

**APPROACH**

1) There will be three interim progress review of the Project (Phase I). The first review shall focus on the topic, and objectives. This review will be conducted within one month of the commencement of third semester classes.
2) The second review shall focus on the methodology. This review will be conducted within two months of the commencement of third semester classes.
3) The third review shall focus on the design and expected results, and scope of the work which has to be accomplished in the fourth semester. This review will be conducted towards the close of the third semester.

**EXPECTED OUTCOME**

Upon successful completion of the Project (Phase I), the student should be able to

1) Identify the topic, objectives and methodology to carry out the project.
2) Finalize the project plan for their course project.

| Course Code | Course Name | Category | L | T | P | Credit | Year of Introduction |
|---|---|---|---|---|---|---|---|
| 22CS178C | DISSERTATION PHASE II | PR | 0 | 0 | 24 | 16 | 2022 |

To continue and complete the project work identified in Project (Phase I).

**APPROACH**

1) There will be three interim progress review of the Project (Phase II). The first review shall focus on the progress of the implementation of the design made in Project (Phase I). This review will be conducted within one month of the commencement of third semester classes.
2) The second review shall focus on the quality and quantum of the work completed. This review will be conducted within two months of the commencement of third semester classes.
3) The third review shall focus on the completed implementation and the results. This review will be conducted towards the close of the third semester.
4) At least one technical paper has to be prepared and published in journals conferences based on their project work.

**EXPECTED OUTCOME**

Upon successful completion of the Project (Phase II), the student should be able to

1) Get a good exposure to a domain of interest.
2) Get a good domain and experience to pursue future research activities.