VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

## School of Computer Science and Engineering

# CURRICULUM AND SYLLABI

# (2023-2024)

**M. Tech Computer Science and Engineering**

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# M. Tech Computer Science and Engineering

## VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

## MISSION STATEMENT OF VELLORE INSTITUTE OFTECHNOLOGY

**World class Education**: Excellence in education, grounded in ethics andcritical thinking, for improvement of life.

**Cutting edge Research**: An innovation ecosystem to extend knowledge andsolve critical problems.

**Impactful People**: Happy, accountable, caring and effective workforce andstudents.

**Rewarding Co-creations**: Active collaboration with national & international industries & universities for productivity and economic development.

**Service to Society**: Service to the region and world through knowledge andcompassion.

## VISION STATEMENT OF THE SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

To be a world-renowned centre of education, research and service in computing andallied domains.

## MISSION STATEMENT OF THE SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

- To offer computing education programs with the goal that the students become technically competent and develop lifelong learning skill.
- To undertake path-breaking research that creates new computing technologies and solutions for industry and society at large.
- To foster vibrant outreach programs for industry, research organizations, academiaand society.

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# M. Tech Computer Science and Engineering

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering professionals who will engage in technology development anddeployment with social awareness and responsibility.

2. Graduates will function as successful practicing engineer / researcher / teacher / entrepreneurin the chosen domain of study.

3. Graduates will have holistic approach addressing technological, societal, economic and sustainability dimensions of problems and contribute to economic growth of the country.

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# M. Tech Computer Science and Engineering

## PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_03: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_04: Having an ability to design and conduct experiments, as well as to analyze and interpret data, and synthesis of information

PO_05: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_06: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_07: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_08: Having a clear understanding of professional and ethical responsibility

PO_11: Having a good cognitive load management skills related to project management and finance

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# M. Tech Computer Science and Engineering

## ADDITIONAL PROGRAMME OUTCOMES (APOs)

APO_02: Having Sense-Making Skills of creating unique insights in what is being seen or observed (Higher level thinking skills which cannot be codified)

APO_03: Having design thinking capability

APO_04: Having computational thinking (Ability to translate vast data in to abstract concepts and to understand database reasoning

APO_07: Having critical thinking and innovative skills

APO_08: Having a good digital footprint

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## M. Tech Computer Science and Engineering

# PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. Ability to design and develop computer programs/computer-based systems in the advanced level of areas including algorithms design and analysis, networking, operating systems design etc.

2. Ability to provide socially acceptable technical solutions to complex computer science engineering problems with the application of modern and appropriate techniques for sustainable development relevant to professional engineering practice.

3. Ability to bring out the capabilities for research and development in contemporary issues and to exhibit the outcomes as technical report.

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# M.Tech Computer Science and Engineering

## CURRICULAM AND SYLLABUS
## 2023-2024

| Category Credit Detail | | | |
|---|---|---|---|
| **Sl.No.** | **Description** | **Credits** | **Maximum Credit** |
| 1 | DC - Discipline Core | 24 | 24 |
| 2 | DE - Discipline Elective | 12 | 12 |
| 3 | PI - Projects and Internship | 26 | 26 |
| 4 | OE - Open Elective | 3 | 3 |
| 5 | SE - Skill Enhancement | 5 | 5 |
| **Total Credits** | | 70 | |

**Discipline Core**

| sl.no | Course Code | Course Title | Course Type | Version | L | T | P | J | Credits |
|---|---|---|---|---|---|---|---|---|---|
| 1 | MCSE501L | Data Structures and Algorithms | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 2 | MCSE501P | Data Structures and Algorithms Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 3 | MCSE502L | Design and Analysis of Algorithms | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 4 | MCSE502P | Design and Analysis of Algorithms Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 5 | MCSE503L | Computer Architecture and Organisation | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 6 | MCSE503P | Computer Architecture and Organisation Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 7 | MCSE504L | Operating Systems | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 8 | MCSE504P | Operating Systems Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 9 | MCSE505L | Computer Networks | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 10 | MCSE505P | Computer Networks Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 11 | MCSE506L | Database Systems | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 12 | MCSE506P | Database Systems Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |

**Discipline Elective**

| sl.no | Course Code | Course Title | Course Type | Version | L | T | P | J | Credits |
|---|---|---|---|---|---|---|---|---|---|
| 1 | MCSE601L | Artificial Intelligence | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 2 | MCSE602L | Machine Learning | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 3 | MCSE602P | Machine Learning Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 4 | MCSE603L | Deep Learning | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 5 | MCSE603P | Deep Learning Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 6 | MCSE604L | Speech and Natural Language Processing | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 7 | MCSE605L | Machine Vision | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 8 | MCSE606L | Cognitive Robotics | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 9 | MCSE607L | Game Programming | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |

## M.Tech Computer Science and Engineering

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10 | MCSE607P | Game Programming Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 11 | MCSE608L | Information Security and Risk Management | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 12 | MCSE609L | Cryptosystems | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 13 | MCSE609P | Cryptosystems Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 14 | MCSE610L | Penetration Testing and Vulnerability Assessment | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 15 | MCSE610P | Penetration Testing and Vulnerability Assessment Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 16 | MCSE611L | Malware Analysis | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 17 | MCSE611P | Malware Analysis Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 18 | MCSE612L | Cyber Security | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 19 | MCSE613L | Digital Forensics | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 20 | MCSE614L | Big Data Frameworks and Technologies | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 21 | MCSE614P | Big Data Frameworks and Technologies Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 22 | MCSE615L | Data Analytics | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 23 | MCSE615P | Data Analytics Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 24 | MCSE616L | Data Visualization | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 25 | MCSE616P | Data Visualization Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 26 | MCSE617L | Domain Specific Predictive Analytics | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 27 | MCSE617P | Domain Specific Predictive Analytics Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 28 | MCSE618L | Social Network Analytics | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 29 | MCSE618P | Social Network Analytics Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 30 | MCSE619L | Text and Speech Analytics | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 31 | MCSE619P | Text and Speech Analytics Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 32 | MCSE620L | Analytics for Internet of Things | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 33 | MCSE620P | Analytics for Internet of Things Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 34 | MCSE621L | Control Engineering | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 35 | MCSE621P | Control Engineering Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 36 | MCSE622L | Framework of Cyber Physical Systems | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 37 | MCSE623L | Cyber Physical Systems Design | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 38 | MCSE623P | Cyber Physical Systems Design Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 39 | MCSE624L | Real Time Systems | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 40 | MCSE625L | Fault Tolerant Systems | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 41 | MCSE626L | Industry 4.0 | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |

**Projects and Internship**

| sl.no | Course Code | Course Title | Course Type | Version | L | T | P | J | Credits |
|---|---|---|---|---|---|---|---|---|---|
| 1 | MCSE698J | Internship I/ Dissertation I | Project | 1.0 | 0 | 0 | 0 | 0 | 10.0 |
| 2 | MCSE699J | Internship II / Dissertation II | Project | 1.0 | 0 | 0 | 0 | 0 | 12.0 |
| 3 | MSET695J | Project Work | Project | 1.0 | 0 | 0 | 0 | 0 | 4.0 |

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# M.Tech Computer Science and Engineering

| Open Elective | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **sl.no** | **Course Code** | **Course Title** | **Course Type** | **Version** | **L** | **T** | **P** | **J** | **Credits** |
| 1 | MFRE501L | Francais Fonctionnel | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 2 | MGER501L | Deutsch fuer Anfaenger | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 3 | MSTS601L | Advanced Competitive Coding | Soft Skill | 1.0 | 3 | 0 | 0 | 0 | 3.0 |

| Skill Enhancement | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **sl.no** | **Course Code** | **Course Title** | **Course Type** | **Version** | **L** | **T** | **P** | **J** | **Credits** |
| 1 | MENG501P | Technical Report Writing | Lab Only | 1.0 | 0 | 0 | 4 | 0 | 2.0 |
| 2 | MSTS501P | Qualitative Skills Practice | Soft Skill | 1.0 | 0 | 0 | 3 | 0 | 1.5 |
| 3 | MSTS502P | Quantitative Skills Practice | Soft Skill | 1.0 | 0 | 0 | 3 | 0 | 1.5 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE501L | Data Structures and Algorithms | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To familiarize the concepts of data structures and algorithms focusing on space and time complexity.
2. To provide a deeper insight into the basic and advanced data structures.
3. To develop the knowledge for the application of advanced trees and graphs in real-world scenarios.

**Course Outcomes**

1. Understand and analyze the space and time complexity of the algorithms.
2. Identification of suitable data structure for a given problem.
3. Implementation of graph algorithms in various real-life applications.
4. Implementation of heaps and trees for querying and searching.
5. Use of basic data structures in advanced data structure operations.
6. Use of searching and sorting in various real-life applications.

| | | |
|---|---|---|
| **Module:1** | **Growth of Functions** | **3 hours** |
| Overview and importance of algorithms and data structures- Algorithm specification, Recursion, Performance analysis, Asymptotic Notation - The Big-O, Omega and Theta notation, Programming Style, Refinement of Coding - Time-Space Trade Off, Testing, Data Abstraction. | | |
| **Module:2** | **Elementary Data Structures** | **6 hours** |
| Array, Stack, Queue, Linked-list and its types, Various Representations, Operations & Applications of Linear Data Structures | | |
| **Module:3** | **Sorting and Searching** | **7 hours** |
| Insertion sort, merge sort, sorting in linear Time-Lower bounds for sorting, Radix sort, Bitonic sort, Cocktail sort, Medians and Order Statistics-Minimum and maximum, Selection in expected linear time, Selection in worst-case linear time, linear search, Interpolation search, Exponential search. | | |
| **Module:4** | **Trees** | **6 hours** |
| Binary trees- Properties of Binary trees, B-tree, B-Tree definition- Operations on B-Tree: Searching a B-tree, Creating, Splitting, Inserting and Deleting, B+-tree. | | |
| **Module:5** | **Advanced Trees** | **8 hours** |
| Threaded binary trees, Leftist trees, Tournament trees, 2-3 tree, Splay tree, Red-black trees, Range trees. | | |
| **Module:6** | **Graphs** | **7 hours** |
| Representation of graphs, Topological sorting, Shortest path algorithms- Dijkstra's algorithm, Floyd-Warshall algorithm, Minimum spanning trees - Reverse delete algorithm, Boruvka's algorithm. | | |
| **Module:7** | **Heap and Hashing** | **6 hours** |
| Heaps as priority queues, Binary heaps, binomial and Fibonacci heaps, Heaps in Huffman coding, Extendible hashing. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

1. Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022.

**Reference Books**

1. Skiena, Steven S. "The Algorithm Design Manual (Texts in Computer Science)." 3rd

| | |
|---|---|
| | edition, 2020, Springer. |
| 2. | Brass, Peter. Advanced data structures. Vol. 193. Cambridge: Cambridge University Press, 2008. |

| | | | |
|---|---|---|---|
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE501P | Data Structures and Algorithms Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To familiarize the concepts of data structures and algorithm focusing on space and time complexity.
2. To provide a deeper insight on the basic and advanced data structures.
3. To develop the knowledge for application of the advanced trees and graphs in real world scenarios.

**Course Outcome**

1. Understand and analyze the space and time complexity of the algorithms.
2. Identification of suitable data structure for a given problem.
3. Implementation of graph algorithms in various real-life applications.
4. Implementation of heaps and trees for querying and searching.
5. Use of basic data structures in advanced data structure operations.
6. Use of searching and sorting in various real-life applications.

**Indicative Experiments**

| | |
|---|---|
| 1. | Analyzing the complexity of iterative and recursive algorithms |
| 2. | Implement Linear data structures (Stacks, Queues, Linked Lists) |
| 3. | Linear time sorting techniques |
| 4. | Interpolation search & Exponential search |
| 5. | Binary tree & Tree traversals |
| 6. | B-trees & B+ trees |
| 7. | Advanced Trees: 2-3 tree, splay tree, red black tree etc. |
| 8. | Advanced Trees: Threaded Binary trees, tournament trees |
| 9. | Graph traversals (BFS, DFS, Topological sorting) |
| 10. | Determining the Shortest path between pair of nodes in the given graph |
| 11. | Minimum Spanning trees- reverse delete & Boruvka's algorithm |
| 12. | Heaps & Hashing |
| | **Total Laboratory Hours** \| **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022. |

**Reference Books**

| | |
|---|---|
| 1. | Skiena, Steven S. "The Algorithm Design Manual (Texts in Computer Science)." 3rd edition, 2020, Springer. |
| 2. | Brass, Peter. Advanced data structures. Vol. 193. Cambridge: Cambridge University Press, 2008. |

Mode of Evaluation: CAT / Mid-Term Lab/ FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE502L | Design and Analysis of Algorithms | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To provide a mathematical framework for the design and analysis of algorithms.
2. To disseminate knowledge on how to create strategies for dealing with real-world problems.
3. To develop efficient algorithms for use in a variety of engineering design settings.

**Course Outcomes**

On completion of this course, student should be able to:

1. Apply knowledge of computing and mathematics to algorithm design.
2. Apply various algorithm paradigms to solve scientific and real-life problems.
3. Demonstrate the string matching and network flow algorithms relating to real-life problems.
4. Understand and apply geometric algorithms.
5. Apply linear optimization techniques to various real-world linear optimization problems.
6. Explain the hardness of real-world problems with respect to algorithmic design.

| | | |
|---|---|---|
| **Module:1** | **Greedy, Divide and Conquer Techniques Introduction** | **6 hours** |
| Overview and Importance of Algorithms - Stages of algorithm development: Describing the problem, Identifying a suitable technique, Design of an algorithm, Illustration of Design Stages - Greedy techniques: Graph Coloring Problem, Job Sequencing Problem with Deadlines- Divide and Conquer: Karatsuba's fast multiplication method, the Strassen algorithm for matrix multiplication | | |
| **Module:2** | **Dynamic Programming, Backtracking and Branch & Bound Techniques** | **9 hours** |
| Dynamic programming: Matrix Chain Multiplication, Longest Common Subsequence. Backtracking: N-Queens problem, Subset Sum, Graph Coloring- Branch & Bound: A-Star, LIFO-BB and FIFO BB methods. | | |
| **Module:3** | **Amortized analysis and String Matching Algorithms** | **6 hours** |
| Stack operation and Incrementing Binary counter -The aggregate method, the accounting method, the potential method, and Dynamic tables. Naïve String matching Algorithms, KMP algorithm, Rabin-Karp Algorithm, String matching with Finite Automata. | | |
| **Module:4** | **Network Flow Algorithms** | **6 hours** |
| Flow Networks, Maximum Flows: Ford-Fulkerson, Edmond-Karp, Push relabel Algorithm, The relabel-to-front algorithm, Minimum Cost flows – Cycle Cancelling Algorithm. | | |
| **Module:5** | **Computational Geometry** | **5 hours** |
| Line Segments – properties, intersection; Convex Hull finding algorithms- Graham's Scan, Jarvis's March Algorithm. | | |
| **Module:6** | **Linear Optimization and Randomized algorithms** | **5 hours** |
| Linear Programming problem - Simplex Method-Big M Method, LP Duality- The hiring problem, Finding the global Minimum Cut. | | |
| **Module:7** | **NP Completeness and Approximation Algorithms** | **6 hours** |
| The Class P - The Class NP - Reducibility and NP-completeness - Circuit Satisfiability problem-SAT 3CNF, Independent Set, Clique, Approximation Algorithm: Vertex Cover, Set Cover and Travelling salesman. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

| | | |
|---|---|---|
| **Text Book(s)** | | |
| 1. | Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022. | |
| **Reference Books** | | |
| 1. | Rajeev Motwani, Prabhakar Raghavan; “Randomized Algorithms, Cambridge University Press, 1995 (Online Print — 2013). | |
| 2. | Ravindra K. Ahuja, Thomas L. Magnanti, and James B. Orlin, Network Flows: Theory, Algorithms, and Applications, 1st Edition, Pearson Education, 2014. | |
| 3. | Jon Kleinberg and EvaTardos, Algorithm Design, Pearson Education, 1“Edition, 2014. | |
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | | |
| Recommended by Board of Studies | 26-07-2022 | |
| Approved by Academic Council | No. 67 | Date 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE502P | Design and Analysis of Algorithms Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To provide a mathematical framework for the design and analysis of algorithms.
2. To disseminate knowledge on how to create strategies for dealing with real-world problems.
3. To develop efficient algorithms for use in a variety of engineering design settings.

**Course Outcome**

On completion of this course, student should be able to:

1. Apply knowledge of computing and mathematics to algorithm design.
2. Apply various algorithm paradigms to solve scientific and real-life problems.
3. Demonstrate the string matching and network flow algorithms relating to real-life problems.
4. Understand and apply geometric algorithms.
5. Apply linear optimization techniques to various real-world linear optimization problems.
6. Explain the hardness of real-world problems with respect to algorithmic design.

**Indicative Experiments**

| | |
|---|---|
| 1. | Greedy Strategy : Graph Coloring Problem, Job Sequencing Problem with Deadlines |
| 2. | Divide and Conquer : Karatsuba's fast multiplication method, the Strassen algorithm for matrix multiplication |
| 3. | Dynamic Programming: Matrix Chain Multiplication, Longest Common Subsequence, 0-1 Knapsack |
| 4. | Backtracking: N-queens, Subset sum |
| 5. | Branch and Bound: Job selection |
| 6. | String Matching Algorithms: Rabin Karp Algorithm, KMP Algorithm |
| 7. | Network Flows : Ford -Fulkerson and Edmond – Karp, Cycle cancelling algorithm |
| 8. | Minimum Cost flows – Cycle Cancelling Algorithm |
| 9. | Linear programming: Simplex method |
| 10. | Randomized Algorithms: Las Vegas and Monte carlo |
| 11. | Polynomial time algorithm for verification of NPC problems |
| 12. | Approximation Algorithm: Vertex cover ,Set cover and TSP |
| | **Total Laboratory Hours** **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Cormen, Thomas H., Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to algorithms. MIT press, 2022. |

**Reference Books**

| | |
|---|---|
| 1. | Rajeev Motwani, Prabhakar Raghavan; Randomized Algorithms, Cambridge University Press, 1995 (Online Print — 2013). |
| 2 | Ravindra K. Ahuja, Thomas L. Magnanti, and James B. Orlin, Network Flows: Theory, Algorithms, and Applications, 1st Edition, Pearson Education, 2014. |
| 3 | Jon Kleinberg and EvaTardos, Algorithm Design, Pearson Education, 1“Edition, 2014. |

Mode of Evaluation: CAT / Mid-Term Lab/ FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE503L | Computer Architecture and Organisation | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To provide knowledge on the basics of computer architectures and organization that lays the foundation to study high-performance architectures
2. To design and develop parallel programs using parallel computing platforms such as OpenMP, CUDA
3. To evaluate the performance using profiling tools and optimize parallel codes using various optimization techniques

**Course Outcomes**

1. Outline the developments in the evolution of computer architectures and parallel programming paradigms
2. Comprehend the various programming languages and libraries for parallel computing platforms
3. Use of profiling tools to analyze the performance of applications by interpreting the given data
4. Evaluate efficiency trade-offs among alternative parallel computing architectures for an efficient parallel application design
5. Develop parallel programs using OpenMP and CUDA and analyze performance parameters such as speed-up, and efficiency for parallel programs against serial programs

| Module:1 | Computer Evolution And Performance | 5 hours |
|---|---|---|

Defining Computer Architecture and Organization, Overview of Computer Components, Von Neumann architecture, Harvard Architecture CISC & RISC, Flynn's Classification of Computers, Moore's Law, Multi-threading, Comparisons of Single Core, Multi Processors, and Multi-Core architectures, Metrics for Performance Measurement

| Module:2 | Memory Hierarchy | 8 hours |
|---|---|---|

Key Characteristics of Memory systems, Memory Hierarchy, Cache Design policies, Cache Performance, Cache Coherence, Snoopy Protocols, Cache coherence protocols, MSI, MESI, MOESI

| Module:3 | Parallel Computers | 8 hours |
|---|---|---|

Instruction Level Parallelism(ILP), Compiler Techniques for ILP & Branch Prediction, Thread Level Parallelism (TLP), Threading Concepts, Shared Memory, Message Passing, Vectorization

| Module:4 | Multithreaded Programming using OpenMP | 6 hours |
|---|---|---|

Introduction to OpenMP, Parallel constructs, Runtime Library routines, Work-sharing constructs, Scheduling clauses, Data environment clauses, atomic, master Nowait Clause, Barrier Construct

| Module:5 | Programming for GPU | 6 hours |
|---|---|---|

Introduction to GPU Computing, CUDA Concepts, CUDA Programming Model, Program Structure of CUDA & Execution, Methods for operations on Device Memory, Thread Organization, Examples

| Module:6 | Performance Analyzers | 6 hours |
|---|---|---|

Performance Evaluation, performance bottlenecks, Profiling categories; Profiling tools: Trace analyzer and collector (ITAC), VTune Amplifier XE, Energy Efficient Performance, Integrated Performance Primitives (IPP)

| Module:7 | Energy Efficient Architectures | 5 hours |
|---|---|---|

Overview of power issues, CMOS Device-level Power dissipation basics, Sources of energy Consumption, Strategies to save power or Energy, Low power designs, Power management

| | | | |
|---|---|---|---|
| techniques | | | |
| **Module:8** | **Contemporary Issues** | | 1 hours |
| | | | |
| | **Total Lecture hours:** | | 45 hours |
| Text Book(s) | | | |
| 1. | William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson, 2022, 11th Edition, Pearson | | |
| 2 | Gerassimos Barlas, Multicore and GPU Programming: An Integrated Approach, 2022, 2nd edition, Morgan Kaufmann | | |
| Reference Books | | | |
| 1. | J.L. Hennessy and D.A. Patterson. Computer Architecture: A Quantitative Approach. 5th Edition, 2012, Morgan Kauffmann Publishers. | | |
| 2. | Shameem Akhter, Jason Roberts, Multi-core Programming: Increasing Performance Through Software Multi-threading, 2010, Intel Press, BPB Publications | | |
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE503P | Computer Architecture and Organisation Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To provide knowledge on basics of computer architectures and organization that lays foundation to study high performance architectures
2. To design and develop parallel programs using parallel computing platforms such as OpenMP, CUDA
3. To evaluate the performance using profiling tools and optimize parallel codes using various optimization techniques

**Course Outcome**

1. Outline the developments in the evolution of computer architectures and parallel programming paradigms
2. Comprehend the various programming languages and libraries for parallel computing platforms
3. Use of profiling tools to analyze the performance of applications by interpreting the given data
4. Evaluate efficiency trade-offs among alternative parallel computing architectures for an efficient parallel Application design.
5. Develop parallel programs using OpenMP and CUDA and analyze performance parameters such as speed-up, efficiency for parallel programs against serial programs

**Indicative Experiments**

| | |
|---|---|
| 1. | Set-up an environment for OpenMP Programming:<br>Activities: create a Project using Visual Studio, Writing Sample OpenMp Program, Setting up properties, compile & Execute OpenMP program, OpenMP manual study, Creation of Login credential on Intel for Intel Parallel Studio |
| 2. | OpenMP program using following construct and describe scenario for the need of construct<br>Use of Parallel Construct, Determine the Number of processors in a parallel Region, Find the thread ID of each processor |
| 3. | Computation of Execution Time<br>Using OpenMP clock, Using windows clock |
| 4. | OpenMP Program using various Environment Routines to access the processor run-time information and write interesting observations by comparing various routines |
| 5. | OpenMP program using following Worksharing Constructs and describe scenario for the need of construct<br>loop construct, sections construct, single construct |
| 6. | OpenMP program using following schedule clauses and describe scenario for the need of clause<br>Static, Dynamic, Guided |
| 7. | Develop parallel programs for given serial programs and profile the program using Vtune Analysis tool<br>Matrix-Matrix multiplication, Matrix-Vector multiplication |
| 8. | Develop parallel programs for given serial programs and profile the program using Vtune Analysis tool<br>Quicksort, Minimum Spanning Tree |
| 9. | CUDA-platform setup on NVIDIA / Google Colab |
| 10. | Write a CUDA C/C++ program that add two array of elements and store the result in third array |
| 11. | Write a CUDA C/C++ program that Reverses Single Block in an Array; CUDA C/C++ |

| | | | | |
|---|---|---|---|---|
| 12. | Write a CUDA C program for Matrix addition and Multiplication using Shared memory | | | |
| | | | **Total Laboratory Hours** | **30 hours** |
| **Text Book(s)** | | | | |
| 1. | Gerassimos Barlas, Multicore and GPU Programming: An Integrated Approach, 2022, 2nd edition, Morgan Kaufmann | | | |
| **Reference Books** | | | | |
| 1. | Shameem Akhter, Jason Roberts, Multi-core Programming: Increasing Performance Through Software Multi-threading, 2010, Intel Press, BPB Publications | | | |
| Mode of Evaluation: CAT / Mid-Term Lab/ FAT | | | | |
| Recommended by Board of Studies | | 26-07-2022 | | |
| Approved by Academic Council | | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE504L | Operating Systems | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To focus the core functionalities required to develop and manage operating systems.
2. To encompass process management, synchronization strategies, memory management, file systems, device management, and virtualization.
3. To introduce the concepts and features of real-time operating systems as well as virtualization.

**Course Outcomes**

1. Understand the fundamental operating system abstractions, including processes, threads, semaphores, and file systems.
2. Implement scheduling, devising and addressing synchronization issues.
3. Gain an understanding of memory management tasks.
4. Develop real-time working prototypes of different small-scale and medium-scale embedded systems.
5. Comprehend the basics of virtualization and differentiate types of virtualization.

| Module:1 | Introduction to Operating Systems | 4 hours |
|---|---|---|

Computer Organization and Architecture - OS definition – OS history – OS Operations – OS design issues - Operating systems structures - Library files - Systems calls – Interrupts - Kernel approaches – Building and booting an OS.

| Module:2 | Process and Scheduling | 6 hours |
|---|---|---|

Process states – State transitions with suspend and resume - Process control block - Context-switching - Processes operations - Process scheduling - CPU scheduling: Non-preemptive, preemptive - Multi-queue scheduling - Multi-level feedback queue scheduling.

| Module:3 | Synchronization | 9 hours |
|---|---|---|

IPC: Shred memory, message passing - Race condition – Critical section problem - Peterson's solution – Bakery Algorithm - Mutex locks - Semaphores – Classical synchronization problems – Monitors - Thread synchronization – Multi-threading Models, Deadlocks – Resource allocation graphs – Deadlock: prevention, avoidance, detection and recovery.

| Module:4 | Memory Management | 5 hours |
|---|---|---|

Address binding – Fragmentation - Pinning Memory – Paging – Structure of the page table – Swapping - Segmentation - Demand Paging – Copy-on-write - Replacement – Thrashing – Working set – Memory compression – Allocating kernel memory.

| Module:5 | Managing Devices, Files, Security and Protection | 9 hours |
|---|---|---|

I/O Management – DMA - Delayed write - Disk scheduling algorithms: Seek-time and rotational latency based - File control block – Inode – Access method – Directory structure - Directory implementation – File allocation methods - Free space management – Program and network threats – Cryptography as a security tool – Domains of protection – Access matrix – Capability based systems

| Module:6 | Real-time Operating Systems | 5 hours |
|---|---|---|

RTOS Internals - Real-Time Scheduling - Task Specifications - Performance Metrics of RTOS - Schedulability Analysis – RTOS Programming Tools.

| Module:7 | Virtualization | 5 hours |
|---|---|---|

Need for virtualization - Virtual machines and architectures – Hypervisors - Virtualization Technologies: Para Virtualization, Full Virtualization - Virtualization types: Server virtualization, Application virtualization, Storage virtualization.

| Module:8 | Contemporary Issues | 2 hours |
|---|---|---|

| | | |
|---|---|---|
| | **Total Lecture hours:** | **45 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Abraham Silberschatz, Peter B. Galvin, Greg Gagne, “Operating System Concepts”, 2018, 10th Edition, Wiley, United States. |
| **Reference Books** | |
| 1. | Arpaci-Dusseau, R. H., & Arpaci-Dusseau, A. C, “Operating Systems: Three easy pieces, 2018, 1st Edition, Boston: Arpaci-Dusseau Books LLC. |
| 2. | Kamal, R, Embedded Systems: Architecture, Programming and Design, 2011, 1st Edition, Tata McGraw-Hill Education. |
| 3. | Portnoy, M, “Virtualization Essentials”, 2012, 2nd Edition, John Wiley & Sons, New Jersey, USA. |

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| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No.67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE504P | Operating Systems Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To encompass process management, synchronization strategies, memory management, file systems, device management, and virtualization.
2. To introduce the concepts and features of real-time operating systems as well as virtualization.

**Course Outcome**

1. Implement scheduling, devising and addressing synchronization issues.
2. Gain an understanding of memory management tasks.
3. Develop real-time working prototypes of different small-scale and medium-scale embedded systems.
4. Comprehend the basics of virtualization and differentiate types of virtualization.

**Indicative Experiments**

| | |
|---|---|
| 1. | Investigate the fundamental Unix/Linux commands. |
| 2. | Obtaining the OS system data file and its associated information. |
| 3. | Shell Programming. |
| 4. | Create utility programs that use I/O system calls to simulate operations such as ls, cp, grep, and others. |
| 5. | Create child, Orphan and Zombie processes using suitable system calls such as fork(), exec(), wait(), kill(), sleep() and exit() system calls. |
| 6. | Create a program that mimics the CPU Scheduling algorithms including multi-level queue scheduling algorithm. Ex: Assume that all processes in the system are divided into two categories: system processes and user processes. System processes are to be given higher priority than user processes. Use FCFS scheduling for the processes in each queue. |
| 7. | Implement the deadlock-free solution to Dining Philosophers problem using Semaphore. |
| 8. | Simulation of Bankers algorithm to check whether the given system is in safe state or not. Also check whether addition resource requested can be granted immediately. |
| 9. | Parallel Thread management using Pthreads library. Implement a data parallelism using multi-threading. Ex: An application should have a thread created with synchronization and thread termination. Every thread in the sub-program must return the value and must be synchronized with the main function. Final consolidation should be done by the main (main function). |
| 10. | Dynamic memory allocation algorithms – First-fit, Best-fit, Worst-fit algorithms. |
| 11. | Page Replacement Algorithms FIFO, LRU and Optimal |
| 12. | Implement a file locking mechanism. |
| 13. | RTOS Based Parameter Monitoring and Controlling System – Monitoring: Collecting data from sensors and interface display devices/actuators using a microcontroller. Controlling: Provide an alert when the received data reaches a certain threshold value. |
| 14. | Virtualization Setup: Type-1, Type-2 Hypervisor (Detailed Study Report). |
| | **Total Laboratory Hours** \| **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Vijay Mukhi, “The C Odyssey: UNIX: v. 3”, 2004, 3rd Edition, BPB Publications, New Delhi, India. |

| **Reference Books** | | | |
|---|---|---|---|
| 1. | Stevens, W. R., & Rago, S. A. (2013). Advanced Programming in the UNIX Environment: Advanc Progra UNIX Envir_p3. Addison-Wesley. | | |
| 2. | Love, Robert, “Linux System Programming: talking directly to the kernel and C library”, 2013, 2nd Edition, O’Reilly Media, Inc, United States. | | |
| Mode of Evaluation: CAT / Mid-Term Lab/ FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE505L | Computer Networks | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To learn various network models, layers and their protocols.
2. To gain a fundamental understanding of routing algorithms.
3. To comprehend the basics of wireless as well as mobile networks and their characteristics.

**Course Outcomes**

1. Explore the basics of Computer Networks and various performance metrics.
2. Interpret the application layer services and their protocols.
3. Evaluate the requirements for reliable services and implications of congestion at the transport layer services.
4. Analyse various functionalities required in the control and data plane at network layer services.
5. Infer the characteristics of wireless as well as mobile networks and their security standards.

| Module:1 | Computer Networks and the Internet | 7 hours |
|---|---|---|

Internet: A Nuts-and-Bolts Description - Network Protocols - The Network Edge: Access Networks and Physical Media - The Network Core: Packet Switching, Circuit Switching - Network of Networks - Delay, Loss and Throughput in Packet-Switched Networks - Protocol Layers and Their Service Models

| Module:2 | Application Layer | 5 hours |
|---|---|---|

Principles of Network Applications: Architectures, Processes and Transport Services - The Web and HTTP - Electronic Mail in the Internet - DNS—The Internet's Directory Service - Peer-to-Peer File Distribution - Socket Programming: Creating Network Applications

| Module:3 | Transport Layer | 7 hours |
|---|---|---|

Relationship Between Transport and Network Layers - Overview of the Transport Layer in the Internet - Multiplexing and Demultiplexing - Connectionless Transport: UDP - Reliable Data Transfer: Go-Back-N (GBN) and Selective Repeat (SR) - Connection-Oriented Transport: TCP, Flow Control and Congestion Control

| Module:4 | Network Layer: Data Plane | 5 hours |
|---|---|---|

Network Layer – Router - The Internet Protocol (IP): IPv4, Addressing and IPv6 - Generalized Forwarding and SDN

| Module:5 | Network Layer: Control Plane | 5 hours |
|---|---|---|

Control Plane: Per-router control and logically centralized control - Routing Algorithms - Link-State (LS) Routing Algorithm, Distance-Vector (DV) Routing Algorithm, Intra-AS Routing in the Internet: OSPF and Routing Among the ISPs: BGP - SDN Control Plane

| Module:6 | Link Layer and LANs | 8 hours |
|---|---|---|

Overview of Link Layer Services - Error-Detection and -Correction Techniques: Parity Checks, Checksum and CRC - Multiple Access Links and Protocols: Channel Partitioning Protocols and Random-Access Protocols - Switched Local Area Networks: Link-Layer Addressing and ARP - Virtual Local Area Networks

| Module:7 | Wireless and Mobile Networks-Security | 6 hours |
|---|---|---|

Elements of a wireless network - Wireless Links and Network Characteristics - WiFi: 802.11 Wireless LANs - Mobility Management: Principles - Wireless and Mobility: Impact on Higher-Layer Protocol- Security in Computer Network- Message Integrity and Digital Signatures - Network-Layer Security: IPsec and Virtual Private Networks

| Module:8 | Contemporary Issues | 2 hours |
|---|---|---|

| | | |
|---|---|---|
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | James F. Kurose, Keith W. Ross, “Computer Networking: A Top-Down Approach”, 2022, 8th Edition(Paperback), Pearson, United Kingdom. |
| **Reference Books** | |
| 1. | Larry Peterson and Bruce Davie, “Computer Networks: A Systems Approach”, 2019, 6th Edition, Morgan Kaufmann, United States of America. |
| 2. | Andrew S. Tanenbaum, “Computer Networks”, 2013, 6th Edition, Pearson, Singapore. |
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | |

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|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE505P | Computer Networks Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the computer network concepts and provide skills required to trouble shoot the network devices.
2. To describe the basic knowledge of VLAN.
3. To develop the knowledge for application of software defined networks.

**Course Outcome**

1. Understand the types of network cables and practical implementation of cross-wired and straight through cable.
2. Design and implementation of VLAN.
3. Analyze and apply network address translation using packet tracer and network simulators.
4. Design and develop software defined networks.

**Indicative Experiments**

| | |
|---|---|
| 1. | Hardware Demo(Demo session of all networking hardware and Functionalities)<br>OS Commands(Network configuration commands ) |
| 2. | Error detection and correction mechanisms<br>Flow control mechanisms |
| 3. | IP addressing Classless addressing |
| 4. | Network Packet Analysis using Wireshark<br>i. Packet Capture Using Wire shark<br>ii. Starting Wire shark<br>iii. Viewing Captured Traffic<br>iv. Analysis and Statistics & Filters. |
| 5. | Socket programming(TCP and UDP) Multi client chatting |
| 6. | Networking Simulation Tool –Wired and Wireless |
| 7. | SDN Applications and Use Cases |
| 8. | Security in Network- Use cases |
| 9 | Performance evaluation of routing protocols using simulation tools. |

**Total Laboratory Hours** | **30 hours**

**Reference Books**

1. James F. Kuross, Keith W. Ross, “Computer Networking, A Top-Down Approach”, 8th Edition( Paperback), Pearson Education, 2022.

Mode of Evaluation: CAT / Mid-Term Lab/ FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE506L | Database Systems | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the underlying principles of Relational Database Management Systems
2. To focus on the modeling and design of secured databases and usage of advanced data models
3. To implement and maintain the structured, semi-structured, and unstructured data in an efficient database system using emerging trends

**Course Outcomes**

On completion of this course, students must be able to

1. Design and implement a database depending on the business requirements, considering various design issues
2. Understand the concepts of Indexing, Query optimization, transaction management, concurrency control, and recovery mechanisms
3. Learn to apply parallel and distributed databases in Real-time scenarios
4. Categorize and design the structured, semi-structured, and unstructured databases
5. Characterize the database threats and their countermeasures

| Module:1 | Design and Implementation of Relational Model | 6 hours |
|---|---|---|

Database System Concepts and Architecture, Entity-Relationship (ER) Modelling, Relational Model-Keys, and Integrity Constraints, Mapping ER model to Relational Schema, Normalization, Boyce Codd Normal Form, Multi-valued dependency and Fourth Normal form

| Module:2 | Query Processing and Transaction Management | 6 hours |
|---|---|---|

Storage and File Structure, Indexing, Query processing, and Query Optimization, Transaction Management, Concurrency Control, Recovery

| Module:3 | Parallel Databases and Distributed Databases | 8 hours |
|---|---|---|

Parallel Database Architecture, Data partitioning strategy, Inter-Query, and Intra-Query Parallelism, Distributed Database Features, Distributed Database Architecture, Fragmentation, Replication, Distributed Query Processing, Distributed Transactions Processing

| Module:4 | Spatial and Multimedia Databases | 6 hours |
|---|---|---|

Spatial database concepts, Spatial data types, and models, Spatial operators and queries, Indexing in spatial databases, Multimedia database concepts, Automatic Analysis of Images, Object Recognition in Images, Semantic Tagging of Images

| Module:5 | Semi-Structured Databases | 6 hours |
|---|---|---|

Semi Structured databases- XML Schema-DTD- XPath- XQuery, Semantic Web, RDF, RDFS

| Module:6 | Cloud and NoSQL Databases | 6 hours |
|---|---|---|

Cloud databases- Data Storage Systems on the Cloud, Data Representation, Partitioning and Retrieving Data, Challenges with Cloud-Based Databases- NoSQL Data model: Aggregate Models, Document Data Model, Key-Value Data Model, Columnar Data Model, Graph-Based Data Model

| Module:7 | Database Security | 5 hours |
|---|---|---|

Database Security Issues, Security Models, Different threats to databases, Challenges to maintaining database security

| Module:8 | Contemporary Issues | 2 hours |
|---|---|---|

| | | |
|---|---|---|
| | **Total Lecture hours:** | **45 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1 | Abraham Silberschatz, Henry F. Korth, and S. Sudharsan, "Database System Concepts", 7h Edition, McGraw Hill, 2019. |
| 2 | R. Elmasri and S. Navathe, Fundamentals of Database Systems, 7th Edition, Addison-Wesley, 2016 |
| **Reference Books** | |
| 1 | Fawcett, Joe, Danny Ayers, and Liam RE Quin. "Beginning XML", Wiley India Private Ltd., 5th Edition, 2012 |
| 2 | Rigaux, Ph, Michel Scholl, and Agnes Voisard. "Spatial databases: with application to GIS". Morgan Kaufmann, 2002. |
| 3 | Dunckley L. Multimedia databases: An object relational approach. Addison-Wesley Longman Publishing Co., Inc.; 2003 Jan 1. |
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | |

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|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE506P | Database Systems Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the underlying principles of Relational Database Management System.
2. To focus on the modeling and design of secure databases and usage of advanced data models.
3. To implement and maintain the structured, semi structured and unstructured data.

**Course Outcome**

1. Construct database queries using Structured Query Language (SQL)
2. Design and implement applications that make use of distributed fault-tolerant databases.
3. Apply Spatial and Multimedia Database concepts to solve real-world problems.
4. Implement applications that work with structured, semi-structured, and unstructured databases
5. Create applications that use cloud storage technologies and relevant distributed file systems

**Indicative Experiments**

| | |
|---|---|
| 1. | Study of Basic SQL Commands.<br>Model any given scenario into ER/EER Model |
| 2. | Table creation with constraints, alter schema, insert values, aggregate functions, simple and complex queries with joins, Views, Subqueries. |
| 3. | PL/SQL-Procedures, Cursors, Functions, Triggers |
| 4. | Partition a given database based on the type of query and compares the execution speed of the query with/without parallelism. |
| 5. | Create a distributed database scenario, insert values, fragment and replicate the database Query the distributed database |
| 6. | Consider a schema that contains the following table with the key underlined:<br><br>Employee (Eno, Ename, Desg, Dno). Assume that we horizontally fragment the table as follows:<br><br>Employee1(Eno; Ename; Desg; Dno), where 1<= Dno <=10<br>Employee2(Eno; Ename; Desg; Dno), where 11 <= Dno <=20<br>Employee3(Eno; Ename; Desg; Dno), where 21 <= Dno <=30<br><br>In addition, assume we have 4 sites that contain the following fragments:<br>• Site1 has Employee1<br>• Site2 has Employee2<br>• Site3 has Employee2 and Employee3<br>• Site4 has Employee1<br>Implement at least 5 suitable queries on Employee fragments. Add relations to the database as per your requirements. |
| 7. | Plot points, lines, and polygons using Spatial Databases such as Oracle Spatial, PostgreSQL, Microsoft SQL Server etc |
| 8. | • Use Spatial Databases to store data using Latitude and Longitude, find the distance between two spatial objects, find the area of a polygon<br>• Store and retrieve images from a multimedia database |
| 9. | Create an XML document and validate it against an XML Schema/DTD.<br>Use XQuery to query and view the contents of the database |

| | | | | |
|---|---|---|---|---|
| 10. | Execute XPATH expressions on a database. | | | |
| 11. | Perform the following using a MongoDB Database<br>• Create an Employee Collection and insert a few documents ( sample document given below for reference)<br>{ "name" : "Satish", "salary" : 30000, "address" : "Vellore", "school" : "SCOPE“ }<br>• Display all employees whose address is vellore and salary is greater than 30000<br>• Update the salary for an employee by name ‘Ram’ as 40000<br>• Display only name and salary for all employees in the collection<br>• Display all employees who are not from ‘SCOPE’ school<br>• Display only documents that contains the address property | | | |
| 12. | Create an application that interacts with a cloud database. | | | |
| | | | **Total Laboratory Hours** | **30 hours** |
| **Text Book(s)** | | | | |
| 1. | D Abraham Silberschatz, Henry F. Korth, S. Sudarshan “Database System Concepts” 7th Edition McGraw Hill, 2021 | | | |
| **Reference Books** | | | | |
| 1. | Elmasri and Navathe “Fundamentals of Database Systems”, 7th Edition Addison Wesley, 2014 | | | |
| 2. | Thomas Connolly, Carolyn Begg “Database Systems: A Practical Approach to Design, Implementation and Management” 6th Edition, Pearson India, 2015 | | | |
| 3. | Mishra, Sanjay, and Alan Beaulieu. Mastering Oracle SQL: Putting Oracle SQL to Work. O'Reilly Media, Inc., 2004. | | | |
| Mode of Evaluation: CAT / Mid-Term Lab/ FAT | | | | |
| Recommended by Board of Studies | 26-07-2022 | | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 | |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE601L | Artificial Intelligence | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To establish theoretical knowledge and understanding in the field of Artificial Intelligence and identify its possible applications.
2. To plan and formulate a non-trivial problem as a state space and apply intelligent search algorithms to identify optimal solutions.
3. To develop and design methods to make decisions in complex uncertain environments.

**Course Outcomes**

At the end of the course the student will be able to

1. Understand the foundation of AI and apply various search algorithms to identify optimal solutions in state spaces.
2. Represent and reason with knowledge and uncertainty to identify solutions for real world problems.
3. Formulate plan as a state space and apply algorithms to find solutions.
4. To develop data driven learning agents.

| Module:1 | Intelligent Agents and Uninformed Search | 6 hours |
|---|---|---|

Foundations of Artificial Intelligence - Definitions - Evolution of AI - Applications of AI - Intelligent Agents - Agents and Environments - Nature of Environments - Structure of Agents- Solving Problem by Searching- Blind Search Techniques – Breadth First Search, Depth First Search, Uniform Cost Search, Iterative Deepening Search, Bidirectional search.

| Module:2 | Informed Search Algorithms | 5 hours |
|---|---|---|

Informed Search - Introduction to Heuristics – Greedy Breadth First Search, A* - Local Search Optimization Algorithms - Hill Climbing, Simulated Annealing.

| Module:3 | Optimal Search Algorithms | 6 hours |
|---|---|---|

Global optimization algorithms - Genetic Algorithms, Particle Swarm Optimization Algorithm, Ant Colony Optimization, Gravitational Search Algorithm - Games - Optimal Decisions in Games - Minimax Algorithm, Alpha-Beta Pruning Algorithm.

| Module:4 | Knowledge Representation and Reasoning | 9 hours |
|---|---|---|

Logical systems – Knowledge Based systems - Representing knowledge using Propositional Logic – Inference in Propositional Logic using Laws of Inference, Forward Chaining, Backward Chaining, Resolution. Representing knowledge using First Logic Order Logic- Inference in First Order Logic using Unification, Forward Chaining, Backward Chaining, Resolution.

| Module:5 | Quantifying Uncertainty | 6 hours |
|---|---|---|

Acting under Uncertainty, -Conditional Independence- Bayes Rule –Naïve Bayes Classifier - Bayesian Belief Network- Inference in Bayesian Belief Network- Making Decisions in Complex Environments- Markov Decision Processes.

| Module:6 | Classical Planning | 6 hours |
|---|---|---|

Planning Problem –STRIPS representation- Complexity of planning- Algorithms for Planning as State Space Search – Partial order Planning –Hierarchical Planning.

| Module:7 | Data Driven Learning Agents | 5 hours |
|---|---|---|

Forms of learning – Supervised Learning - Decision Trees – CART - Univariate Linear

| | | |
|---|---|---|
| Regression, Multivariate Linear Regression. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Russell, S and Norvig, P, 2015, Artificial Intelligence – A Modern Approach, 3rd Edition, Prentice Hall. |
| **Reference Books** | |
| 1. | Min Xin-She Yang., "Nature-Inspired Computation and Swarm Intelligence Algorithms, Theory and Applications", Elsevier, Academic Press, 2020. |
| 2. | Elaine Rich, Kevin Knight, Shivashankar B Nair., "Artificial Intelligence", 3rd Edition, McGraw Hill Education, 2017. |
| 3. | Charu C. Aggarwal, "Data Classification: Algorithms and Applications", CRC Press, 2014. |

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| Mode of Evaluation: CAT, Assignment, Quiz and FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE602L | Machine Learning | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Acquire theoretical Knowledge on setting hypothesis for pattern recognition
2. Apply suitable machine learning techniques for data handling and knowledge extraction
3. Evaluate the performance of algorithms and to provide solutions for various real-world applications

**Course Outcomes**

1. Recognize the characteristics of machine learning strategies
2. Analyze and Apply the suitable supervised learning methods for real-world problems
3. Identify and integrate more than one technique to enhance the performance of learning
4. Create a suitable unsupervised learning model for handling unknown patterns
5. Design a model to handle large datasets with online learning

| | | |
|---|---|---|
| **Module:1** | **Introduction** | **4 hours** |
| PAC Learning-Consistent and inconsistent hypothesis, FIND-S, Candidate Elimination, deterministic and stochastic generalities, error, VC Dimensions, lower bounds-Convex optimization review- Probability review | | |
| **Module:2** | **Dimensionality Reduction** | **4 hours** |
| Feature representation in different domains: text, image, video and audio, Feature selection: Filter, wrapper and embedded models, Feature Reduction: PCA, t-SNE | | |
| **Module:3** | **Model Selection and Validation** | **3 hours** |
| Estimation and approximation errors: ERM-SRM- Validation- Regularization-based algorithms | | |
| **Module:4** | **Classification Models** | **5 hours** |
| Supervised Learning , Perceptron – Single layer & Multi-layer – Linear SVM – Hard, Soft Margins, kernel Methods, Lazy SVM for Instance Based Learning, Handling imbalanced data: One Class SVM | | |
| **Module:5** | **Ensemble Learning** | **3 hours** |
| Bagging-Committee Machines and Stacking-Boosting-Ranking based aggregation | | |
| **Module:6** | **Clustering** | **5 hours** |
| Unsupervised Learning, Partitional Clustering-K-Means-Linkage-Based Clustering Algorithms-Birch Algorithm-CURE Algorithm-Density-based Clustering- Spectral Clustering. | | |
| **Module:7** | **Online Learning** | **5 hours** |
| Online Classification in the Realizable Case- Online Classification in the Unrealizable Case-Online Convex Optimization- The Online Perceptron Algorithm- On-line to batch conversion – Federated Learning | | |
| **Module:8** | **Contemporary Issues** | **1 hours** |
| | | |
| | **Total Lecture hours:** | **30 Hours** |

**Text Book(s)**

| | |
|---|---|
| 1 | S. Shalev-Shwartz, S.Ben-David, “Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2014. |

**Reference Books**

| | |
|---|---|
| 1 | Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine Learning", MIT Press, 2nd Edition, 2018. |
| 2 | Duda, Richard, Peter Hart, and David Stork, "Pattern Classification," 2nd Edition, John Wiley & Sons, Hoboken, 2000. |
| 3 | Tom Mitchell, "Machine Learning", McGraw Hill, 3rd Edition, 1997. |

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|---|---|---|---|
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE602P | Machine Learning Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Acquire theoretical knowledge on setting hypothesis for pattern recognition.
2. Apply suitable machine learning techniques for data handling and knowledge extraction.
3. Evaluate the performance of algorithms and to provide solutions for various real-world applications.

**Course Outcome**

1. Identify suitable data pre-processing technique to apply on raw data to provide suitable input to various algorithms used for different purposes
2. Apply the suitable supervised learning methods for real-world problems
3. Identify and integrate more than one technique to enhance the performance of learning
4. Create a suitable unsupervised learning model for handling unknown pattern
5. Design a model to handle large datasets with online learning

**Indicative Experiments**

| | |
|---|---|
| 1. | Study of Machine Learning libraries in python |
| 2. | Data exploration and preprocessing in machine learning |
| 3. | Evaluate the classifier using various performance measures |
| 4. | Implement a probabilistic model to detect Spam Email with Naive Bayes |
| 5. | Implement regression algorithms to predict Stock Price |
| 6. | Implement PCA and classify the hand-written digits. |
| 7. | Implement a tree-based algorithm to predict ad click |
| 8. | Classify newsgroup Topics with Support Vector Machines |
| 9. | Implement multiclass classification for hand-written digits. |
| 10. | Implement Bagging using Random Forests for hand written digits. |
| 11. | Mining the 20 Newsgroups Dataset with Clustering and Topic Modeling Algorithms |
| 12. | Training on large datasets with online learning |
| | **Total Laboratory Hours** \| **30 hours** |

**Text Book(s)**

1. Liu Yuxi, “Python Machine Learning By Example: Build intelligent systems using Python, TensorFlow 2, PyTorch, and scikit-learn”, 2020, 3rd Edition, Packt Publishing, UK.

**Reference Books**

1. Aurélien Géron, “Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems ", 2019, 2nd Edition, O'Reilly Media, Inc, United States.
2. Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", 2017, 2nd Edition, O'Reilly Media, Inc, United States.

Mode of Evaluation: CAT / Mid-Term Lab/ FAT

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| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE603L | Deep Learning | 2 | 0 | 0 | 2 |
| Pre-requisite | Nil | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Introduce major deep neural network frameworks and issues in basic neural networks
2. To solve real-world applications using Deep learning
3. Providing insight into recent Deep Learning architectures

**Course Outcomes**

At the end of this course, students will be able to:

1. Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-nets.
2. Identify and improve Hyper parameters for better Deep Network Performance
3. To understand and visualize Convolutional Neural Network for real-world applications
4. To demonstrate the use of Recurrent Neural Networks and Transformer based for language modeling
5. To distinguish different types of Advanced Neural Networks

| Module:1 | Neural Networks | 3 hours |
|---|---|---|

The Neuron –Expressing Linear Perceptrons as Neurons – Feed-Forward Neural Networks – Linear Neurons and their Limitations – Sigmoid, Tanh and Relu Functions – Softmax Output Layers

| Module:2 | Neural Learning | 4 hours |
|---|---|---|

Measuring Errors - Gradient Descent – Delta Rule and Learning Rate – Backpropagation – Stochastic and Minibatch Gradient – Test Sets, Validation Sets and Overfitting – Preventing Overfitting in Deep Neural Networks – Other Optimization Algorithms: Adagrad, RMSProp, Adadelta, Adam

| Module:3 | Convolution Neural Networks | 5 hours |
|---|---|---|

Neurons in Human Vision – Shortcomings of Feature Selection –Scaling Problem in Vanilla Deep Neural Networks – Filters and Feature Maps – Description of Convolutional Layer – Maxpooling – Convolution Network Architecture – Image Classification

| Module:4 | Pre-Trained Models | 3 hours |
|---|---|---|

Self-Supervised Pretraining, AlexNet, VGG, NiN, GoogleNet, Residual Network (ResNet), DenseNet, Region-Based CNNs (R-CNNs) – Transfer Learning - FSL

| Module:5 | Recurrent Neural Networks | 6 hours |
|---|---|---|

Sequence-to-Sequence Modeling – Embedding - Recurrent Neural Networks - Bidirectional RNNs, Analyzing Variable Length Inputs – Tackling seq2seq Problem – Beam Search and Global Normalization – Recurrent Neural Networks (RNN)– Hidden States – Perplexity – Character-level Language Models –Modern RNNs: Gated Recurrent Units (GRU), Long Short Term Memory (LSTM), Bidirectional Long Short Term Memory (BLSTM), Deep Recurrent Neural Network, Bidirectional RNN

| Module:6 | Attention Models and Transformers | 4 hours |
|---|---|---|

Attention Mechanism: Attention Cues, Attention Pooling, Scoring Functions, Self-Attention and Positional Encoding;–Bidirectional Encoder Representations from Transformers (BERT) – Generative Pre-trained Transformers

| Module:7 | Advanced Neural Networks | 4 hours |
|---|---|---|

Generative Adversarial Networks – Generator, Discriminator, Training, GAN variants; Autoencoder: Architecture, Denoising and Sparcity; DALL-E, DALL-E 2 and IMAGEN

| **Module:8** | **Contemporary Issues** | **1 hour** |
|---|---|---|
| | | |
| | **Total Lecture hours:** | **30 Hours** |

| **Text Book(s)** | |
|---|---|
| 1. | Fundamentals of Deep Learning, Nikhil Buduma and Nicholas Locasio, O-Reilly, 2017 |
| 2. | Dive into Deep Learning, Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Amazon Senior Scientists – Open source and Free Book, March 2022 |
| **Reference Books** | |
| 1. | Deep Learning, Ian Goodfellow Yoshua Bengio Aaron Courville, MIT Press, 2017 |
| 2. | Deep Learning: A Practitioner's Approach, Josh Patterson, Adam Gibson, O'Reilly Media, 2017 |

| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | | | |
|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE603P | Deep Learning Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand deep neural network frameworks and learn to implement them
2. To learn to use pretrained models effectively and use them to build potential solutions

**Course Outcomes**

At the end of this course, student will be able to:

1. Understand the methods and terminologies involved in deep neural network, differentiate the learning methods used in Deep-neural nets.
2. Identify and apply suitable deep learning approaches for given application.
3. Design and develop custom Deep-nets for human intuitive applications
4. Design of test procedures to assess the efficiency of the developed model.
5. Apply and evaluate Pre-trained models to improve the models' performance.

**Indicative Experiments**

| | | |
|---|---|---|
| 1. | Python Primer<br>Revisiting Data Preprocessing<br>Setting up Deep-Learning workstations<br>Working with different data types and file formats | 6 hours |
| 2. | Simple Classification Tasks<br>Working with MNIST – IMDB Datasets | 4 hours |
| 3. | Training a CNN from Scratch<br>Using pretrained CNNs | 6 hours |
| 4. | Visualizing what CNNs are learning – Intermediate Activations, Convnet Filters, Heatmaps | 2 hours |
| 5. | Exploring Multi-Input, Multi-output Models<br>Hyper-parameter Tuning | 2 hours |
| 6. | Language Modeling using RNN<br>Practicing of Stacking Layers in Bidirectional RNNs | 3 hours |
| 7. | Transfer Learning models for classification problems<br>Exploring Hugging-face API | 2 hours |
| 8. | Text Generation Using LSTM | 2 hours |
| 9. | Image generation from Text using GAN | 3 hours |
| | **Total Laboratory Hours** | **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Deep Learning Step by Step with Python, N D Lewis, 2016 |
| 2 | Neural Networks and Deep Learning, Michael Nielsen,, Determination Press |

**Reference Books**

| | |
|---|---|
| 1. | Deep Learning: A Practitioner's Approach, Josh Patterson, Adam Gibson, O'Reilly Media, 2017 |
| 2. | Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks, Umberto Michelucci, Apress, 2018. |
| 3. | Deep Learning with TensorFlow: Explore neural networks with Python, Giancarlo Zaccone, Md. RezaulKarim, Ahmed Menshawy, Packt Publisher, 2017. |

Mode of Evaluation: CAT / Mid-Term Lab/ FAT

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|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE604L | Speech and Natural Language Processing | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the concepts and techniques of Natural language processing for analyzing word sense based on part of speech and Constituency parsing.
2. To analyze speech signal in time and frequency domain.
3. To implement deep learning models covering a range of applications in speech recognition and text processing.

**Course Outcomes**

1. Describe the mathematical and linguistic foundations underlying approaches for NLP modules in Text processing and speech recognition.
2. Demonstrate the working of sequence models for text processing.
3. Use signal processing techniques to analyze and represent the speech signal.
4. Discuss statistical approach for automatic speech recognition including feature extraction, acoustic modeling and language modeling.
5. Develop a deep learning models associated with the design, implementation, training and deployment of speech and text processing.

| Module:1 | Language Model and Part-of-Speech | 7 hours |
|---|---|---|

Different Levels of NLP -Text Normalization - Minimum Edit Distance - N-gram Language Models – Smoothing - Huge Language Models - Perplexity's Relation to Entropy - Part-of-Speech Tagging – HMM for Part-of-Speech Tagging - Viterbi algorithm - Named Entities and Named Entity Tagging - Conditional Random Fields (CRFs ) - Evaluation of Named Entity Recognition.

| Module:2 | Constituency Parsing and Lexical Semantics | 6 hours |
|---|---|---|

Introduction to Parsing - Linguistic Constituents and Constituency tests - Partial or Shallow Parsing - Dependency Parsing - Word Senses - Relations Between Senses - WordNet: A Database of Lexical Relations, Methods for Word Sense Disambiguation.

| Module:3 | Feature Representation for Natural Language Processing | 6 hours |
|---|---|---|

Vector Semantics - Words and Vectors - Cosine for measuring similarity -TF-IDF: Weighing terms in the vector - Pointwise Mutual Information (PMI) -Neural Language Models - Word Embedding's: Word2Vec, Glove and Fast text.

| Module:4 | Deep learning architecture for NLP | 6 hours |
|---|---|---|

RNNs as Language Models - Stacked and Bidirectional RNN architectures- LSTM - Self-Attention Networks: Transformers, Transformers as Language Models – Applications of NLP: Sentiment analysis, Question and answering, Chat Bot.

| Module:5 | Automatic Speech Recognition | 7 hours |
|---|---|---|

Introduction-Acoustic feature: Speech production, Raw Waveform, MFCC – Phones - Statistical Speech Recognition: Acoustic Models, Language Model, HMM Decoding – Error Metrics – DNN/HMM Hybrid – Text to Speech – WaveNet for Text to Speech.

| Module:6 | Transfer Learning and Domain Adaption | 5 hours |
|---|---|---|

Transfer Learning – Self-Taught Learning – Multitask Learning – Domain Adaption: Techniques, Theory - Applications in Speech Recognition- Zero-Shot Learning – One-Shot Learning - Few-Shot Learning.

| Module:7 | Deep Reinforcement Learning (DRL) for Text and Speech | 6 hours |
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|---|---|---|
| Connectionist Temporal Classification - Seq-to-Seq – End-to-End Decoding – Speech Embedding and Unsupervised Speech Recognition - Deep Reinforcement Learning – Reinforcement learning fundamentals – Deep Reinforcement Learning Algorithms – DRL for Text: Text Summarization, Machine Translation – DRL for Speech: Speech Enhancement and Noise Suppression. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Dan Jurafsky, James H. Martin "Speech and Language Processing", Draft of 3rd Edition, Prentice Hall 2022. |
| 2. | Uday Kamath, John Liu, James Whitaker "Deep Learning for NLP and Speech Recognition", 1st Edition, Springer 2019. |
| **Reference Books** | |
| 1. | Ben Gold, Nelson Morgan, Dan Ellis "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", 2nd Edition, John Wiley & Sons, 2011. |
| 2. | Jacob Benesty, M. M. Sondhi,Yiteng Huang "Springer Handbook of Speech Processing" , 1st Edition, Springer, 2008 |
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | |

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| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

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| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE605L | Machine Vision | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To impart the knowledge on image processing, segmentation and morphological operations on images.
2. To develop the ability to apprehend and implement various object identification, multi-camera views and depth estimation techniques.
3. To facilitate students to comprehend on various pattern and motion analysis schemes for machine vision applications.

**Course Outcomes**

At the end of this course, student will be able to:

1. Discover and understand enhancement, segmentation and morphological operations on images for further analysis.
2. Acquire the knowledge of various image transforms, wavelets and multiresolution analysis for better interpretation.
3. Experiment the various object identification techniques on images.
4. Design and implement various pattern analysis schemes for images.
5. Analyze and explore various multi-camera views and depth estimation techniques for motion analysis on video streams.

| Module:1 | Fundamentals of Image Processing and Enhancement | 7 hours |
|---|---|---|

Image Formation physics, Image Digitization – Sampling and Quantization, Digital Image Properties, Pixel relationship, Image Enhancement- Spatial filtering.

| Module:2 | Image Segmentation and Morphological operations | 7 hours |
|---|---|---|

Thresholding - Edge Based Segmentation – Region Based Segmentation- Active Contour Models.Dilation and Erosion – Opening, Closing – Hit or Miss Transform-Thinning-Thickening-Skeletons and object marking.

| Module:3 | Frequency domain and Multiresolution Analysis | 5 hours |
|---|---|---|

Frequency Domain filtering, Image transforms - Frequency domain transformations - DCT, DFT, FFT, DWT – Haar Wavelet - Multiresolution analysis - Scale-invariant features.

| Module:4 | Depth estimation and Multi-camera views | 6 hours |
|---|---|---|

Perspective, Binocular Stereopsis: Image Fusion, Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.

| Module:5 | Object Detection | 7 hours |
|---|---|---|

Detection of known objects by linear filters - Detection of unknown objects - The Hough transform for the detection of lines - Corner detection. Surface Descriptions, Shape from Contours, Shape from Shading, Shape from Texture.

| Module:6 | Pattern Analysis | 6 hours |
|---|---|---|

Clustering - K-Means - K-Medoids - Mixture of Gaussians, Classification - Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers – Bayes – KNN - ANN models; Application in Defect Analysis

| Module:7 | Motion Analysis | 5 hours |
|---|---|---|

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|---|---|---|
| Optical Flow – Detection and Correspondence of Interest Points - Detection of Motion Patterns – Video Tracking – Motion Models to aid tracking: Kalman Filters. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 Hours** |
| **Text Book(s)** | | |
| 1. | Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision", 4th Edition, Cengage Learning, USA, 2014 | |
| 2. | Jurgen Beyerer, Fernando Puente Leon, Christian Frese,"Machine Vision Automated Visual Inspection: Theory, Practice and Applications", 2016, Springer. | |
| **Reference Books** | | |
| 1. | Oge Marques, Practical Image and Video Processing using MATLAB, IEEE Press, Wiley Publications, 2011 | |
| 2. | R. C. Gonzalez and R. E. Woods, "Digital Image Processing (4th Edition), 2018. | |
| 3. | Computer Vision, A modern Approach by Forsyth and Ponce, Pearson Education, 2003. | |
| 4. | R. Szeliski, "Computer vision: algorithms and applications", ISSN 1868-095X, 2nd Edition,Springer Nature Switzerland AG, 2022. | |
| 5. | Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press, March 2004. | |
| 6. | Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006. | |
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | | |
| Recommended by Board of Studies | 18-11-2022 | |
| Approved by Academic Council | No. 68 | Date 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE606L | Cognitive Robotics | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the science and technology behind cognitive thinking and to apply it on autonomous robots.
2. To understand advanced methods for creating efficient and dynamic cognitive robots.
3. To understand the recent literature, and collectively synthesize, clearly explain and evaluate the state of the art in cognitive robotics.

**Course Outcomes**

1. Understand the philosophy of cognition and architecture of cognitive systems used in robotics.
2. Apply various machine learning techniques to design, develop and control intelligent autonomous robots.
3. Design models to achieve autonomy of robots with the help of path planning, map building and localization techniques.
4. Develop robotic applications using various robot programming languages and tools.

| Module:1 | Introduction | 6 hours |
|---|---|---|

The nature of cognition Thinking, Aspects of Modelling Cognitive Systems Cognition, and Intelligence, Defining Intelligence and autonomy , Embodiment and Its Implications, Synthetic Methodology for Intelligence. Levels of Abstraction in Modelling Cognitive Systems.

| Module:2 | Cognitive Architectures and perception | 6 hours |
|---|---|---|

Definition, perspective of cognitive architecture, Desirable Characteristics, Designing a Cognitive Architecture, Example Cognitive Architectures, Introduction to the Model of Cognition, Visual Perception, Visual Recognition, Machine Learning, and Robot Cognition, Introduction to sensors and actuators.

| Module:3 | Intelligent System Design, Cognition Development and control | 8 hours |
|---|---|---|

Properties of Complete Agents, Agent Design Principle, Agent architectures, Developmental Robot Design, Matching brain and Body Dynamics, Artificial Neural Networks (ANN), Fuzzy Logic, Genetic Algorithms and Other Nature Inspired Methods, Optimal Control using ANN, Introduction to CNN.

| Module:4 | Autonomy and Map Building | 7 hours |
|---|---|---|

Types of Autonomy, Autonomic Systems, Different Scales of Autonomy, Measuring Autonomy, Autonomy and Cognition, A Menagerie of Autonomies ,Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Map Building.

| Module:5 | Randomized Path Planning | 7 hours |
|---|---|---|

Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Voronoi diagrams, Potential Fields and Cell Decomposition, Planning with moving obstacles, Probabilistic Roadmaps, Rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program.

| Module:6 | Simultaneous Localization and Mapping (SLAM) | 5 hours |
|---|---|---|

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|---|---|---|
| Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization Techniques, Particle Methods Relation of Paradigms. | | |
| **Module:7** | **Robot Programming methods** | **4 hours** |
| Python Robot Programming Methods-: Go-to-Goal Behavior, Avoid-Obstacles Behavior, Hybrid Automata (Behavior State Machine), Follow-Wall Behavior. A Complete Program for autonomous mobile robot. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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| **Text Book(s)** | |
| 1. | David Vernon, "Artificial Cognitive Systems: A Primer" ,The MIT Press, 1st Edition,2014 |
| 2. | Patnaik, Srikanta, "Robot Cognition and Navigation – An Experiment with Mobile Robots", Springer Verlag Berlin and Heidelberg, 2007 |
| **Reference Books** | |
| 1. | HoomanSomani, "Cognitive Robotics", CRC Press, 2015 |
| 2. | Jared Kroff, "Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016 |
| 3. | Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005. |
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | |

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|---|---|---|---|
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE607L | Game Programming | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the processes, mechanics, issues in game design and game engine development
2. To understand modeling, techniques, handling situations and logic
3. To build and integrate technologies such as multimedia, artificial intelligence and physics-based modeling into a cohesive, interactive game application.

**Course Outcomes**

1. Design, develop, test, evaluate, debug, and modify code to meet design specifications for games.
2. Design unique gaming environments, levels and characters by choosing appropriate game strategies and patterns based on an analysis of past and present trends.
3. Design and develop a full-fledged computer game through animation principles and artificial intelligence.

| Module:1 | Introduction | 3 Hours |
|---|---|---|

Introducing the 10-Stage Workflow: Brainstorming, Initial Design: Game Overview, Game Details, Prototyping, Refining Design, and Project Management: Identify Resources - Compress Space - Schedule Work, Asset Creation, Importing Assets, Level Design, Scripting, Testing, Building, Recommendations for Working Practice.

| Module:2 | Gamming Environments | 5 Hours |
|---|---|---|

Configuring the Blender GUI: Dark Themes - Disable Python Tooltips - Exporting Blender Models to Unity: Blend Files - Exporting Manually to FBX, Exploring FBX Files, and Importing FBX Files into Unity: Light map UVs - Scale Factor.
Modular Environments and Static Meshes: Advantages of the Modular Method, Getting Started with Modular Environments in Blender - Extending from the Base Tile, Modular Environment Blender Workflow, UV Mapping and Texture Creation, Importing and Configuring Environments in Unity: Using Prefabs, Static Batching.

| Module:3 | Terrain | 4 Hours |
|---|---|---|

Creating Terrain in Unity: Terrain Settings - Sculpting Terrain -Texture-Painting Terrain, Evaluating Unity Terrains, Blender Terrain Modeling: The Proportional Editing Method - The Displacement-Texture Method - The Sculpting Method, Terrain Resolution, Texture-Painting Terrain: UV Mapping Terrains - Generating a Texture for Painting - Painting from the UV Image Editor - Painting from the 3D View - Painting with Textures , Working with Roads and Paths: Creating Roads.

| Module:4 | Physics based Game Modelling | 3 hours |
|---|---|---|

Basic Newtonian Mechanics- Forces: Gravitational Force, Friction, Centripetal Force, Basic Kinematics: The Relationship Between Force, Acceleration, Velocity and Location - Rigid Body Motion and Collision

| Module:5 | Animation workflows | 5 Hours |
|---|---|---|

Animation Units: The key frame, Preparing for Animation in Blender: Use a Dedicated Animation Layout - Beware of Auto-Key - Insert Single Key frames - Animation Length - Exporting Animations to FBX - Working with Multiple Animations,

| | | |
|---|---|---|
| Key frame Animations from Blender to Unity, Follow-Path Animations and Animation Baking, Blend Shapes and Shape Keys, Bones and Rigging: Always Name Bones - Use X-Axis Mirror for Character Rigs - Forward and Inverse Kinematics - Deform and Control Bones - Exporting Rigged Characters - Importing Rigged Meshes into Unity. | | |
| **Module:6** | **Game Programming and Retopologizing** | **5 Hours** |
| Objects, Dependencies, and Event-Driven Programming: Hard-Coded Dependencies - Solving DI: Component-Based Design and Messages, Taking Messages Further: Broadcast Message and Hierarchies, Sending Messages to Selected Objects, Sending Messages to Parents, Notification System, Notifications Manager In-Depth, Singletons, Messages and Active Objects, Traversing Game Object Hierarchies. Retopologizing: High-Poly Meshes and Subdivision Surfaces, High-Poly Meshes and Real-Time Games - Retopologizing in Practice, Using Decimate. | | |
| **Module: 7** | **AI for Games** | **3 Hours** |
| Model of Game AI: Decision Making, Strategy, Infrastructure and Agent-based AI; AI engine; Behavior authoring, Tree Search, Evolutionary Computation, Supervised Learning and Unsupervised Learning, Modeling Players. | | |
| **Module:8** | **Contemporary Issues** | **1 Hour** |
| | | |
| | | |
| | **Total Lecture hours:** | **30 Hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Alan Thorn, Practical Game Development with Unity and Blender, Cengage Learning, 2015. |
| 2. | Palmer G. Physics for game programmers. Berkeley: Apress; 2005 |
| 3 | Artificial Intelligence and Games, Georgios N. Yannakakis and Julian Togelius, January 26, 2018, Springer |
| **References Books:** | |
| 1 | Sherrod A. Game Graphic Programming. Cengage Learning; 2008. |
| 2 | Artificial Intelligence for Games, 2nd Edition, Ian Millington and John Funge,2009 |
| 3 | Akenine-Mo, T., Haines, E. and Hoffman, N., 2018. Real-time rendering |
| 4 | Fundamentals of Game Design, 3rd Edition, Ernest Adams, New Riders; 2013 |
| 5 | Game Design Foundations, Second Edition, Roger E. Pedersen, Jones & Bartlett Learning; 2009 |
| 6. | Game Engine Architecture, 3rd Edition, Jason Gregory, A K Peters, 2019 |
| Mode of Evaluation: CAT / Written Assignment / Quiz / FAT | |

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE607P | Game Programming Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the processes, mechanics, issues in game design, and game engine development
2. To understand modeling, techniques, handling situations, and logics
3. To build and integrate technologies such as multimedia, artificial intelligence, and physics modeling into a cohesive, interactive game application.

**Course Outcomes**

At the end of this course, student will be able to:

1. Classify different Sensors & Actuators based on various physical phenomena and learn various sensor calibration techniques
2. Select the relevant sensors and actuators to design real-time data acquisition from ambience via case studies

**Indicative Experiments**

| | | |
|---|---|---|
| 1. | Game Programming - UNITY Basics | **2 Hours** |
| 2. | Model Creation – 3D blender | **4 Hours** |
| 3. | 2D/ 3D Game environment | **4 Hours** |
| 4. | Game environment creation | **2 Hours** |
| 5. | Object motion simulation | **4 Hours** |
| 6. | Deploying lighting effects | **2 Hours** |
| 7. | Physics based game creation | **4 Hours** |
| 8. | Creation of a Tile map based game | **2 Hours** |
| 9. | Multiple Levels game development | **2 Hours** |
| 10. | Game automation using AI | **4 Hours** |
| | **Total Laboratory Hours** | **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Alan Thorn, Practical Game Development with Unity and Blender, Cengage Learning, 2015. |
| 2. | Game Engine Architecture, 3rd Edition, Jason Gregory, A K Peters, 2019 |
| 3. | Palmer G. Physics for game programmers. Berkeley: Apress; 2005 |
| 4. | Artificial Intelligence and Games, Georgios N. Yannakakis and Julian Togelius, January 26, 2018, Springer |

**Reference Books**

| | |
|---|---|
| 1. | Sherrod A. Game Graphic Programming. Cengage Learning; 2008. |
| 2. | McShaffry M. Game coding complete. Nelson Education; 2014 |
| 3. | Akenine-Mo, T., Haines, E. and Hoffman, N., 2018. Real-time rendering |
| 4. | Fundamentals of Game Design, 3rd Edition, Ernest Adams, New Riders; 2013 |
| 5. | Game Design Foundations, Second Edition, Roger E. Pedersen, Jones & Bartlett Learning; 2009 |

Mode of Evaluation: CAT / Mid-Term Lab/ FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE608L | Information Security and Risk Management | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To learn about security policies and their impacts.
2. To assess the framework, lifecycle and controls of security under a variety of scenarios.
3. To analyze the security risk calculations and mitigating them by using various policies.

**Course Outcome**

Upon completion of this course, the student will be able to:

1. Understand the principles and policies of information security.
2. Analyze and explore the information security controls.
3. Assess and evaluate the risk management practices of information security.
4. Identify the disasters and recovering from them with appropriate decisions.

| | | |
|---|---|---|
| **Module:1** | **Information Security Principles** | **6 hours** |
| Information Security- Assets and Types - Threat, Vulnerability, Risk and Impact - Information Security Policy Concepts - Need for Information Security. | | |
| **Module:2** | **Information Security Framework** | **7 hours** |
| Organization and Responsibilities: Organizational Policy, Standards and Procedures - Information Security Governance - Information Assurance Programme Implementation - Security Incident Management - Legal Framework: Security Standards and Procedures. | | |
| **Module:3** | **Security Life Cycle and Controls** | **8 hours** |
| Information Security Life Cycle - Testing, Audit, Review and Controls - Systems Development and Support - General Controls - People Security - User Access Controls - Technical Security - Protection from Malicious Software - Physical Security - Different Uses of Controls. | | |
| **Module:4** | **Security Management Models and Performance Measurement** | **6 hours** |
| Blueprints - Frameworks and Security Models - Security Architecture Models - Various Access Control Models - Information Security Performance Measurement. | | |
| **Module:5** | **Risk Assessment** | **6 hours** |
| Threats and its Categories - Vulnerabilities and its Categories - Risk - Calculation of Overall Risk - Risk Identification - Risk Analysis - Risk Evaluation - Risk Control - Risk Termination - Risk Reduction - Risk Transfer - Risk Tolerance - Overall Risk Assessment. | | |
| **Module:6** | **Risk Management** | **4 hours** |
| Risk Management Framework and Process - Managing Risk - Risk Treatment- Alternative Risk Management Methodologies. | | |
| **Module:7** | **Disaster Recovery and Business Continuity Management** | **6 hours** |
| Disaster Recovery Process and policy - Relationship between Disaster Recovery and Business Continuity Management - Resilience and Redundancy - Approaches to Writing and Implementing Plans - Need for Documentation - Maintenance and Testing. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Andy Taylor, David Alexander, Amanda Finch and David Sutton, “Information Security Principles”,2020, Third Edition, BCS, United Kingdom. |

| | | | |
|---|---|---|---|
| 2. | Michael E. Whitman and Herbert J. Mattord, “Management of Information Security”, 2018, Sixth Edition, Cengage Learning, United States of America. | | |
| **Reference Books** | | | |
| 1. | Calder, A., and Watkins, S. G., “Information security risk management for ISO27001/ISO27002”, 2018, Third Edition, IT Governance Ltd, United States of America. | | |
| 2. | Susanto, H., and Almunawar, M. N, “Information security management systems: A novel framework and software as a tool for compliance with information security standards”, 2018, First Edition, Apple Academic Press, New York. | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE609L | Cryptosystems | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To learn the concept of Cryptosystems.
2. To understand the design of cryptanalytics and security algorithms.
3. To explore various authentication and hashing algorithms.

**Course Outcome**

Upon completion of this course, the student will be able to:

1. Understand the fundamental of Cryptosystems requirements.
2. Identify and apply the concept of Cryptographic algorithms.
3. Analyze and explore the use of authentication and hashing.
4. Gain a deep insight into attacks and emerging security algorithms.
5. Explore and analyze of signature and key exchange algorithms.

| | | |
|---|---|---|
| **Module:1** | **Mathematical Foundations of Cryptosystems** | **4 hours** |

Cryptographic attacks – Modular arithmetic – Fermat's Theorem, Euler's Theorem, Extended Euclidean Algorithm, Chinese Remainder Theorem - Solovay Straseen Test - The Jacobi Symbol –Pollard's Rho Method, Pollard's p-1 Method, Pollard's Kangaroo Algorithm.

| | | |
|---|---|---|
| **Module:2** | **Classical Cryptography** | **4 hours** |

Cryptosystems: Affine Cipher, Vigenere Cipher, Hill Cipher, Linear Feedback Shift Register (LFSR) – Cryptanalysis on Affine Cipher, Vigenere Cipher, Hill Cipher and LFSR.

| | | |
|---|---|---|
| **Module:3** | **Block Ciphers and Stream Ciphers** | **4 hours** |

Shannon's Theory – Linear Cryptanalysis – Differential Cryptanalysis – Description and Analysis of DES – Description and Analysis of AES – Modes of Operation.

| | | |
|---|---|---|
| **Module:4** | **Hash Functions and Message Authentication** | **4 hours** |

Hash Functions and Data Integrity – Security of Hash Functions – MD5 – SHA512 – Nested MAC and HMAC – CBC MAC.

| | | |
|---|---|---|
| **Module:5** | **Public Key Cryptography and Discrete Logarithms** | **4 hours** |

RSA Cryptosystem – Shanks' Algorithm – Elliptic Curves Over the Reals – Elliptic Curves Modulo a Prime – Elliptic Curves Over Finite Fields – ElGamal Cryptosystems on Elliptic Curves - Elliptic Curve Diffie – Hellman.

| | | |
|---|---|---|
| **Module:6** | **Signature Schemes and Post-Quantum Cryptography** | **5 hours** |

Number Theory Research Unit (NTRU): Basics, Lattices and Security of NTRU – Code Based Cryptography – McEliece Cryptography – Lamport Signature Scheme – Winternitz Signature Scheme – Merkle Signature Scheme.

| | | |
|---|---|---|
| **Module:7** | **Key Distribution and Key Agreement Schemes** | **4 hours** |

Key Predistribution - Session Key Distribution Schemes: Needham Schroeder Scheme, Kerberos, Bellare Rogaway Scheme – Diffie-Hellman Key Agreement - MTI Key Agreement - Paillier Cryptosystem – Algebraic Structures – Group and Ring.

| | | |
|---|---|---|
| **Module:8** | **Contemporary Issues** | **1 hours** |
| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

1. Douglas R. Stinson, "Cryptography: Theory and Practice", 2018, 4th Edition, CRC Press, United states.

**Reference Books**

| | | | |
|---|---|---|---|
| 1. | Bruce Schneier, “Applied Cryptography: Protocols, Algorithms and Source code in C”, 2017, 20th edition, John Wiley & Sons, New York. | | |
| 2. | Behrouz A Forouzan, Debdeep Mukhopadhyay, “Cryptography and Network Security”, 2011, Tata Mcgraw Hill education private limited, India | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE609P | Cryptosystems Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To learn the concept of Cryptosystems.
2. To understand the design of cryptanalytics and security algorithms.
3. To explore various authentication and hashing algorithms.

**Course Outcome**

Upon completion of this course, the student will be able to:

1. Gain a deep insight into attacks and emerging security algorithms.
2. Explore and analyze of signature and key exchange algorithms.

**Indicative Experiments**

| | |
|---|---|
| 1. | Implement a client and a server on different computers. Perform the communication between these two entities by using RSA cryptosystem. |
| 2. | Implement a client and a server on different computers. Perform the authentication of sender between these two entities by using digital signature cryptosystem |
| 3. | Implement man-in-the middle attack in Diffie-Hellman key exchange algorithm |
| 4. | Implementing SHA-512 message digest algorithm |
| 5. | Demonstrate the classical cryptography algorithms |
| 6. | Implement Data Encryption Standard algorithm. |
| 7. | Implement a session key agreement algorithm. |
| 8. | Demonstrate the hash-based message authentication code (HMAC) algorithm. |
| 9. | Implement ElGamal cryptosystems on elliptic curves |
| 10. | Implement Advanced Encryption Standard algorithm |

| | | |
|---|---|---|
| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Douglas R. Stinson, “Cryptography: Theory and Practice”, 2018, 4th Edition, CRC Press, United states. |

**Reference Books(s)**

| | |
|---|---|
| 1. | Bruce Schneier, “Applied Cryptography: Protocols, Algorithms and Source code in C”, 2017, 20th edition, John Wiley & Sons, New York. |
| 2. | Behrouz A Forouzan, Debdeep Mukhopadhyay, “Cryptography and Network Security”, 2011, Tata Mcgraw Hill education private limited, India |

| | | | |
|---|---|---|---|
| Mode of Evaluation: Continuous Assessment / FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE610L | Penetration Testing and Vulnerability Assessment | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To comprehend the security framework related occurrences and knowledge on expected protections, and countermeasures against normal vulnerabilities.
2. To identify security weaknesses in a network, machine, and in software.
3. To make students familiarization with cyber kill-chains.

**Course Outcome**

Upon completion of this course, the student will be able to:

1. Identify flaws and vulnerabilities in applications, websites, networks, systems, protocols, and configurations using both manual techniques and assistive tools.
2. Deploy and test exploits over targeting operating systems and services
3. Rich knowledge on legal and ethical issues related to vulnerability and penetration testing.
4. Ability to perform pentest on target and generate a report based on the test and determine the security threats and vulnerabilities in computer networks.
5. Using the acquired knowledge into practice for testing the vulnerabilities and identifying threats.

| Module:1 | Pentesting and Information Security | 4 hours |
|---|---|---|

Pentester – Types of Hackers – Pentest Methodology – Pentest Types – Vulnerability Scanning – Vulnerability Assessments – Pentest Target and Specializations - Asset Management: CIA Triad – Security Controls – Access Controls – Incident Responses – Malware – Advanced Persistent Threats – Cyber Kill Chain – Air-gapped Machines – Dark Web.

| Module:2 | Recon and Hijacking | 4 hours |
|---|---|---|

Reconnaissance – External ¬- Dumpster Diving – Social Media – Social Engineering - Internal – Sniffing and Scanning – De-Authentication of Attacks – Detection Mechanism - Session Hijacking: Blind and Non-Blind Spoofing - Detection and Prevention Mechanisms.

| Module:3 | Network and Wireless Mayhem | 4 hours |
|---|---|---|

WEP Theory – SSID - WPA – WPS -.MAC Filtering – Port Security – IPsec - War Diving: Basic Web Cracking – Detecting Wireless Attacks - Fake Authentication – Handshake Theory - Bypassing Firewalls – Evading Intruder Detection System - Securing Network from Attacks.

| Module:4 | Web Server Attacks | 4 hours |
|---|---|---|

Understanding Web Languages - Web Architecture - Webpage Spoofing – Information Gathering from Target Websites – Finding Subdomains – Files Based Analysis - Cookies Handling - Web Page Attacks – Attack Detection – Protection Against Web Page Attacks – MITMF Code Injection.

| Module:5 | Injection Vulnerability | 4 hours |
|---|---|---|

Databases – Testing Database Vulnerability – Securing SQL Server – Detecting Database Attacks – Protection Against Database Attacks - File Upload Vulnerability – Inclusion Vulnerability - Code Execution – Local File – Remote File – Mitigation Strategies.

| Module:6 | Gaining Access | 5 hours |
|---|---|---|

Introduction to Gaining Access – Server Side – Client Side – Post – Exploitation Server Side Attacks – Metasploit and MSFS - Scripting Vulnerabilities - Automatic Vulnerability Compliances using OWASP ZAP.

| Module:7 | Escalation | 4 hours |
|---|---|---|

Trojan, Viruses and Backdoor Applications - Detection Mechanism - Unix Permission and Root Access – Buffer overflow – Memory Architecture – Examples – Escalation –

| | | |
|---|---|---|
| Linux – Window – Preventing Mechanism – DDOS – Detection and Prevention – Tools. | | |
| **Module:8** | **Contemporary Issues** | **1 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |
| **Text Book(s)** | | |
| 1. | Phillip L. Wylie, Kim Crawley, "The Pentester BluePrint: Starting a Career as an Ethical Hacker", 2020, Wiley, United States. | |
| 2. | Sabih, Zaid, "Learn Ethical Hacking from Scratch: Your stepping stone to penetration testing", 2018 Packt Publishing Ltd, United Kingdom. | |
| **Reference Books** | | |
| 1. | Diogenes, Yuri, and Erdal Ozkaya, "Cybersecurity??? Attack and Defense Strategies: Infrastructure security with Red Team and Blue Team tactics", 2018, Packt Publishing Ltd, United Kingdom. | |
| 2. | Andrew Whitaker, and Daniel P. Newman. "Penetration Testing and Network Defense", 2005, Cisco Press, New Jersey. | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | |
| Recommended by Board of Studies | 26-07-2022 | |
| Approved by Academic Council | No. 67 | Date 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE610P | Penetration Testing and Vulnerability Assessment Lab | 0 | 0 | 2 | 1 |

| Pre-requisite | NIL | Syllabus version |
|---|---|---|
| | | 1.0 |

**Course Objectives:**

1. To comprehend the security framework related occurrences and knowledge on expected protections, and countermeasures against normal vulnerabilities.
2. To identify security weaknesses in a network, machine, and in software.
3. To make students familiarization with cyber kill-chains.

**Course Outcome:**

Upon completion of this course, the student will be able to:

1. Ability to perform pentest on target and generate a report based on the test and determine the security threats and vulnerabilities in computer networks.
2. Using the acquired knowledge into practice for testing the vulnerabilities and identifying threats.

| List of Challenging Experiments (Indicative) | | |
|---|---|---|
| 1. | Set up of Kali Linux in a Virtual machine and setup with DNS info and collection of local networks | 3 hours |
| 2. | Scan the network for Windows XP and Windows 7 Target machines in local network and virtual network | 3 hours |
| 3. | Identify the open ports and firewall rules setup | 2 hours |
| 4. | Use password guessing tools to guess a password. Use password strengthening tools to strengthen the password. Try guessing the password and tabulate the enhanced difficulty due to length of password and addition of special characters. | 2 hours |
| 5. | Extract password hashes from Windows XP/NT machine. Use a password extraction tool, using word list, single crack or external mode to recover the password. Increase the complexity of the password and determine the point at which the cracking tool fails. | 2 hours |
| 6. | Cracking Linux passwords | 2 hours |
| 7. | Experiments on SQL injections | 2 hours |
| 8. | Analysis of WEP flaws | 2 hours |
| 9. | Experiments on Wireless DDoS Attacks | 2 hours |
| 10. | Prevention against Cross Site Scripting Attacks | 2 hours |
| 11. | Experiments on Metasploit Framework | 2 hours |
| 12. | Cross Site Scripting | 2 hours |
| 13. | Cross Site Request Forgery | 2 hours |
| 14. | File upload vulnerability on social engineering | 2 hours |
| **Total Laboratory Hours** | | **30 hours** |

**Text Book(s)**

1. Phillip L. Wylie, Kim Crawley, “The Pentester BluePrint: Starting a Career as an Ethical Hacker”, 2020, Wiley, United States.
2. Sabih, Zaid, “Learn Ethical Hacking from Scratch: Your stepping stone to penetration testing”, 2018 Packt Publishing Ltd, United Kingdom.

| **Reference Book(s)** | | | |
|---|---|---|---|
| 1. | Diogenes, Yuri, and Erdal Ozkaya, “Cybersecurity??? Attack and Defense Strategies: Infrastructure security with Red Team and Blue Team tactics”, 2018, Packt Publishing Ltd, United Kingdom. | | |
| 2. | Andrew Whitaker and Daniel P. Newman. “Penetration Testing and Network Defense”, 2005, Cisco Press, New Jersey. | | |
| Mode of Evaluation: Continuous Assessment / FAT | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE611L | Malware Analysis | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce malware taxonomy and life cycle.
2. To analyze malware samples using static, dynamic analysis, and reverse engineering techniques.
3. To detect and analyze obfuscation and anti-malware techniques.

**Course Outcomes**

After completion of this course, the student shall be able to:

1. Apply the static and dynamic malware analysis on emerging samples.
2. Analyze the executable file and malware classification.
3. Understand the disassemblers, debuggers, and decompilers in malware analysis.
4. Explore the anti-malware analysis techniques.
5. Apply the reverse-engineering of malware and Obfuscation using emerging tools.

| Module:1 | Introduction to Malware | 4 hours |
|---|---|---|

Malware Taxonomy - Malware Attack Life Cycle - The Combat Teams - Anti-malware Products- Reverse Engineering for Windows and Linux systems.

| Module:2 | Static Malware Analysis | 4 hours |
|---|---|---|

Fingerprinting the Malware - PE: File types, and header analysis, Extracting Strings - Classifying Malware using YARA - Tools: PEid and TrID, MASTIFF, PE executables.

| Module:3 | Dynamic Malware Analysis | 4 hours |
|---|---|---|

Behavior Events Analysis using ProcMon and Autoruns - Detecting Code Injection - Automated dynamic analysis - Sandboxing: Tools and Techniques - Virus Total.

| Module:4 | Prepare for Reverse Engineering | 4 hours |
|---|---|---|

Reverse engineering as a process - Binary analysis tools, Disassemblers – Debuggers – Decompilers - Identification and Extraction of Hidden Components - Typical malware behavior - Malware delivery.

| Module:5 | Build and Debug the Malware | 4 hours |
|---|---|---|

Low-Level Language: Registers, Memory addressing, Opcode bytes - Builder and debugger: IDA Pro, Ollydebug -Windows API libraries - Packing and Encryption.

| Module:6 | Obfuscation Techniques | 5 hours |
|---|---|---|

File Obfuscation - Binary Obfuscation Techniques - Assembly of data - Encrypted data identification - Decrypting with x86dbg - Control flow flattening obfuscation - Garbage code insertion - Dynamic library loading.

| Module:7 | Anti-Malware analysis | 4 hours |
|---|---|---|

Anti-debugging - Anti-VM - Anti-emulation - Anti-dumping - SysInternals Suite Tools – Deadlisting - Analysis of HTML scripts - MS Office macro analysis - PDF file analysis – SWFTools – FLASM – Flare.

| Module:8 | Contemporary Issues | 1 hours |
|---|---|---|
| | | |
| | Total Lecture hours: | 30 hours |

**Text Book(s)**

| | |
|---|---|
| 1. | Abhijit Mohanta, Anoop Saldanha, Malware Analysis and Detection Engineering a Comprehensive Approach to Detect and Analyze Modern Malware, 2020, 1st edition, Apress (ISBN 978-1-4842-6192-7), United States. |
| 2. | Reginald Wong, Mastering Reverse Engineering, 2018, 1st edition, Packt Publishing Ltd, Birmingham, ISBN 978-1-78883-884-9, UK. |
| **Reference Books** | |
| 1. | M. Sikorski and A. Honig, Practical Malware Analysis: The Hands-on Guide to Dissecting Malicious Software. 2012, 1st edition, No Starch Press San Francisco, CA. (ISBN No.: 9781593272906), United States. |

| | | | |
|---|---|---|---|
| Mode of Evaluation: CAT, assignment, Quiz and FAT | | | |
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No.68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE611P | Malware Analysis Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce malware taxonomy and life cycle.
2. To analyze malware samples using static, dynamic analysis, and reverse engineering techniques.
3. To detect and analyze obfuscation and anti-malware techniques.

**Course Outcomes**

After completion of this course, the student shall be able to:

1. Explore the anti-malware analysis techniques
2. Apply the reverse-engineering of malware and Obfuscation using emerging tools.

| **Indicative Experiments** | | |
|---|---|---|
| 1 | Disassemble Portable Executable (PE32) Files using PEid and TrID, to identify<br>• file compilation date<br>• imports/ exports, suspicious strings<br>• run-time effect, procmon filter<br>• hist -based signatures revealing files<br>• registry keys, processes, services<br>• network-based signatures | **3 hours** |
| 2 | Static and Dynamic Malware Analysis:<br>• Sandboxing the malware using SANDBOX tool: Cuckoo (open source)<br>• Sample Malware analysis Virus Total<br>• Registry analysis using Any run<br>• Malware analysis via hex code | **4 hours** |
| 3 | Reverse-engineering the malware using IDA Pro: strings analysis, local variables, graph mode to cross-references, Analyzing Functions | **4 hours** |
| 4 | Debug and Disassemble the malware using OllyDbg: Debug the malware, Viewing Threads and Stacks, OllyDbg Code-Execution Options, Breakpoints, Loading DLLs, Exception Handling | **4 hours** |
| 5 | MASTIFF is a static analyzer framework (Linux and Mac) with the following plugins:<br>• ssdeep: fuzzy hash, or context-triggered piecewise hashes (CTPH) to identify nearly identical files for identifying variants of a malware family<br>• pdftools: extracts information about PDF files.<br>• exiftool: This shows info, from image files.<br>• disitool: extract digital signatures from signed executables.<br>• pyOLEscanner: extract information from OLE file types, such as Word documents and Excel spreadsheets | **4 hours** |
| 6 | Packing and obfuscation:<br>• Pack and unpack the malware: UPX tool | **3 hours** |

| | | |
|---|---|---|
| | • obfuscation and de-obfuscation of the malware using CFF explorer | |
| 7 | Strings and API Analysis:<br>• SysInternals Suite's strings: This is a command-line tool for Windows that shows the list of text strings in any type of file.<br>• BinText: This is a GUI-based Windows tool that can display the ASCII and Unicode text strings for a given file.<br>• API Monitor: helps reverse engineering by monitoring API calls as the program runs. | **4 hours** |
| 8 | Anti Malware analysis using:<br>• WinDbg<br>• IDA Pro / OllyDBG<br>• SysInternals Suite Tools | **4 hours** |
| | **Total Laboratory Hours** | **30 hours** |
| **Text Book(s)** | | |
| 1. | Reginald Wong, Mastering Reverse Engineering, 2018, 1st edition, Packt Publishing Ltd, Birmingham, ISBN 978-1-78883-884-9, UK | |
| **Reference Books** | | |
| 1. | Abhijit Mohanta, Anoop Saldanha, Malware Analysis and Detection Engineering a Comprehensive Approach to Detect and Analyze Modern Malware, 2020, 1st edition, Apress (ISBN 978-1-4842-6192-7), United States. | |
| 2. | C. Eagle, The IDAPro Book: The Unofficial Guide to the worlds most popular Disassembler, 2nd Ed. San Francisco: No Starch Press San Francisco, CA, 2011. (ISBN No. :<br>978-1-59327-289-0). | |

| | | | |
|---|---|---|---|
| Mode of assessment: Continuous assessment and FAT | | | |
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE612L | Cyber Security | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand key terms and concepts in Cyber security, Policies, Governance and Compliance.
2. To exhibit knowledge to secure corrupted systems, protect personal data, and secure computer networks in an Organization.
3. To understand principles of cyber security and to guarantee a secure network by analyzing the nature of attacks through cyber forensics software or tools.

**Course Outcomes**

After completion of this course, the student shall be able to:

1. Analyze and evaluate the cyber security needs of an organization.
2. Analyze the security issues in networks and computer systems to secure an infrastructure.
3. Design operational cyber security strategies and policies.
4. Apply critical thinking and problem-solving skills to detect current and future attacks on an organization's computer systems and networks.

| Module:1 | Introduction to Cyber Security | 6 hours |
|---|---|---|

Cyber Security- Layers of security, Vulnerability, Assets and Threat, Challenges and Constraints - Computer Criminals - CIA Triad - Motive of attackers - Spectrum of attacks - Taxonomy of various attacks – Cryptography - Security Governance – Challenges and Constraints, Security Models and Risk Management, Legacy Cyber security systems – Transformations in Cyber security.

| Module:2 | Cyber Security Technologies | 6 hours |
|---|---|---|

Mobile Security – Advanced Data Security: Cloud Security, IoT Security - Incident detection response - Penetration testing – User Behavior Analytics (UBA) – Endpoint Detection and Response (EDR).

| Module:3 | Vulnerabilities and Safeguards | 6 hours |
|---|---|---|

Software Vulnerabilities - Complex Network Architectures, Open Access to Organizational Data, Weak Authentication, poor cyber security awareness - Cyber Security Safeguards – Overview, Access control, Audit, Authentication, Biometrics, Deception, Denial of Service Filters, Ethical Hacking, Firewalls, Scanning, Security policy, Threat Management, Defending malicious software, Applying software update and patches.

| Module:4 | Securing Infrastructure and Local Host | 7 hours |
|---|---|---|

Infrastructure security in the real world and challenges – Understanding access control and monitoring systems: Access control security policies, Physical security controls – Intrusion detection and Reporting systems – Securing host device and challenges – Protecting the inner perimeter – Protecting remote access: Local protection tools, local intrusion detection tools, configuring browser security, Hardening operating systems.

| Module:5 | Cyber Security Tools | 6 hours |
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Zenmap – Hydra –Kismet – John the Ripper – Airgeddon – Deauther Board – Aircrack-ng – EvilOSX.

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| **Module:6** | **Cyber Security Strategies** | **6 hours** |
| Need for building cyber strategy – Cyber-attack strategies (Red team) – Cyber defense strategies (blue team) – Introduction to Cyber security kill chain – Reconnaissance – Weaponization – Privilege Escalation - Exfiltration - Threat Life cycle management phases. | | |
| **Module:7** | **Cybercrime Challenges** | **6 hours** |
| Challenges of fighting cybercrime- Opportunities, general challenges, and legal challenges - Capacity building- Cyber security and cybercrime: Capacity building methodology, Strategy as a starting point, the relevance of policy, the role of regulators in fighting cybercrime, high standards in developing countries. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
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| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Yuri Diogenes, Erdal Ozkaya, Cyber security - Attack and Defense Strategies, Packt Publishers, 2018. |
| 2. | Charles J. Brooks, Christopher Grow, Philip A. Craig, Donald Short, Cybersecurity Essentials, Wiley Publisher, 2018. |
| **Reference Books** | |
| 1. | William Stallings, Effective Cybersecurity: A Guide to Using Best Practices and Standards, 1st edition, 2019. |
| 2. | Nina Godbole, Sunit Belapure, Cyber Security - Understanding cybercrimes, Computer Forensics and Legal Perspectives, Wiley, 2011. |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | |

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|---|---|---|---|
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE613L | Digital Forensics | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the basics of digital forensics technology, systems and services.
2. To learn about data recovery, data seizure, digital evidence controls and forensics analysis.
3. To learn and develop different tools for digital forensic acquisition and analysis.

**Course Outcomes**

After completion of this course, the student shall be able to:

1. Learn the fundamentals of digital forensics technology along with different systems and services.
2. Recover and seize data from a crime scene without damage, using legal procedures and standards.
3. Exhibit knowledge in forensic data acquisition and analysis and investigate artifacts in different operating systems.
4. Apply forensics tools and concepts on modern frameworks such as network, email, smart phones, cloud and social media.

| Module:1 | Introduction to Digital Forensics | 6 hours |
|---|---|---|

Digital forensics fundamentals: Use of Computer Forensics - Benefits of Professional Forensics Methodology - Steps Taken by Computer Forensics Specialists - Case Studies - Types of Computer Forensics Technology: Military, Law Enforcement, Business - Specialized Forensics Techniques - Hidden Data and How to Find It - Protecting Data from Being Compromised - Internet Tracing Methods.

| Module:2 | Digital Forensics Systems and Services | 6 hours |
|---|---|---|

Types of Computer Forensics Systems: Firewall and IDS Security Systems - Storage Area Network Security Systems - Instant Messaging (IM) Security Systems - Biometric Security Systems - Computer Forensics Services: Occurrence of Cyber Crime - Cyber Detectives - Fighting Cyber Crime with Risk Management Techniques - Computer Forensics Investigative Services - Forensic Process Improvement.

| Module:3 | Digital Forensics Evidence and Capture | 6 hours |
|---|---|---|

Data Recovery: Data Backup and Recovery, Data-Recovery Solution, Hiding and Recovering Hidden Data - Evidence Collection and Data Seizure: Collection of Evidence and Options, Obstacles - Types of Evidence - The Rules of Evidence - Volatile Evidence - Volatile Memory Forensics- Controlling Contamination: The Chain of Custody, Reconstructing the Attack.

| Module:4 | Data Preservation and Forensics Analysis | 7 hours |
|---|---|---|

Duplication and Preservation of Digital Evidence: Preserving the Digital Crime Scene - Computer Evidence Processing Steps - Legal Aspects of Collecting and Preserving Evidence - Computer Image Verification and Authentication - Computer Forensics Analysis: Discovery of Electronic Evidence - Identification of Data - Reconstructing Past Events - disk and file system analysis.

| Module:5 | Network and Operating System Forensics | 6 hours |
|---|---|---|

Network forensics: Investigation on virtual network and Email, Internet Artifacts - Damaging Computer Evidence - System Testing - Operating System Artifacts:

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|---|---|---|
| Windows System Artifacts, Linux System Artifacts. | | |
| **Module:6** | **Mobile and Cloud Forensics** | **6 hours** |
| Mobile Forensics: Acquisition Procedures for Mobile, Equipment, Tools, Internet of Anything - Cloud Forensics: Service Levels, cloud vendors, Legal Challenges and Technical Challenges, Acquisition, Investigation, Tools: Open-Stack, F-Response, AXIOM. | | |
| **Module:7** | **Forensics Tools** | **6 hours** |
| Open source tools: The Sleuth Kit (TSK) and Autopsy - SANS SIFT Investigative tool - Voltality - CAINE investigative environment - windows System internals- Commercial tools: Encase, FTK, PRO Discover Basic, Nirsoft. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | John R. Vacca, Computer Forensics: Computer Crime Scene Investigation, 2015, Second Edition, Charles River Media, Inc. (ISBN No. : 978-1-58450-389-7) |
| 2. | Cory Altheide, Harlan Carvey, Digital Forensics with Open Source Tools: Using Open Source Platform Tools, 2011, First Edition, British Library Cataloguing-in-Publication Data. (ISBN No. : 978-1-59749-586-8) |
| **Reference Books** | |
| 1. | B. Nelson, A. Phillips, F. Enfinger, and C. Steuart, Guide to Computer Forensics and Investigations, 2019, Sixth Edition. CENGAGE, INDIA (ISBN: 9789353506261) |
| Mode of Evaluation: CAT, assignment, Quiz and FAT | |

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|---|---|---|---|
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No.68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE614L | Big Data Frameworks and Technologies | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the need of a framework to store and process the big data.
2. To have knowledge on the Big Data Technologies for processing the Different types of Data.
3. To understand the advanced frame work for faster accessing and processing of Big Data.

**Course Outcomes**

Upon completion of the course the student will be able to

1. Understand the need of new frame work to deal with huge amounts of Data.
2. Demonstrate the Hadoop framework Hadoop Distributed File System and MapReduce.
3. Demonstrate the Pig architecture and evaluation of pig scripts.
4. Describe the Hive architecture and execute SQL queries on sample data sets.
5. Demonstrate spark programming with different programming languages and graph algorithms.

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| **Module:1** | **Big Data** | **3 hours** |
| Understanding Big Data: Concepts and terminology, Big Data Characteristics, Different types of Data, Identifying Data Characteristics - Big Data Architecture - Big Data Storage: File system and Distributed File System, NoSQL, Sharding, Replication, Sharding and Replication, ACID and BASE Properties. | | |
| **Module:2** | **Hadoop Framework** | **5 hours** |
| Hadoop Architecture - Hadoop Distributed File System (HDFS) –YARN – Hadoop I/O – Map Reduce: Developing a map-reduce application – Map-reduce working procedure – Types and Formats - Features of Map reduce: sorting and joins- Pipelining MapReduce jobs. | | |
| **Module:3** | **Hadoop Technologies-PIG** | **4 hours** |
| Introduction, Parallel processing using Pig, Pig Architecture, Grunt, Pig Data Model-scalar and complex types. Pig Latin- Input and output, Relational operators, User defined functions -Working with scripts. Hadoop Operations. | | |
| **Module:4** | **Hive** | **4 hours** |
| Introduction-Hive modules, Data types and file formats, Hive QL-Data Definition and Data Manipulation-Hive QL queries, Hive QL views- reduce query complexity. Hive scripts. Hive QL Indexes- Aggregate functions- Bucketing vs Partitioning. | | |
| **Module:5** | **Spark** | **5 hours** |
| Overview of Spark – Hadoop Overview of Spark – Hadoop vs. Spark – Cluster Design – Cluster Management – performance, Application Programming interface (API): Spark Context, Resilient Distributed Datasets, Creating RDD, RDD Operations, and Saving RDD - Lazy Operation – Spark Jobs. | | |
| **Module:6** | **Data Analysis with Spark Shell** | **4 hours** |
| Writing Spark Application - Spark Programming in Scala, Python, R, Java - Application Execution | | |
| **Module:7** | **Spark SQL and GraphX** | **4 hours** |
| SQL Context – Importing and Saving data – Data frames – using SQL – GraphX overview – Creating Graph – Graph Algorithms. | | |
| **Module:8** | **Contemporary Issues** | **1 hour** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| **Text Book(s)** | | | |
|---|---|---|---|
| 1. | Thomas Erl, Wajid Khattak, and Paul Buhler, Big Data Fundamentals: Concepts, Drivers &Techniques, Pearson India Education Service Pvt. Ltd., First Edition, 2016. | | |
| 2. | Tom White, Hadoop: The Definitive Guide, O'Reilly Media, Inc., Fourth Edition, 2015. | | |
| **Reference Books** | | | |
| 1. | Alan Gates, Programming Pig Dataflow Scripting with Hadoop, O'Reilly Media, Inc, 2011. | | |
| 2. | Jason Rutherglen, Dean Wampler, Edward Caprialo, Programming Hive, O'ReillyMedia Inc,2012 | | |
| 3. | Mike Frampton, "Mastering Apache Spark", Packt Publishing, 2015. | | |
| Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE614P | Big Data Frameworks and Technologies Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the need of a framework to store and process the big data.
2. To have knowledge on the Big Data Technologies for processing the Different types of Data.
3. To understand the advanced frame work for faster accessing and processing of Big Data.

**Course Outcome**

1. Implement and evaluate the data manipulation procedures using pig, hive and spark on Hadoop frame work.

| **Indicative Experiments** | |
|---|---|
| 1. | Installing and configuring the Hadoop frame work. HDFS Commands, |
| 2. | Map Reduce Program to show the need of combiner |
| 3. | Map Reduce I/O Formats – Text, Key – Value |
| 4. | Map Reduce I/O Formats – NLine – Multiline |
| 5. | Installing and Configuring Apache PIG and HIVE |
| 6 | Sequence File Input / Output Formats |
| 7. | Distributed Cache & Map side Join, Reduce Side Join |
| 8. | Building and Running Spark Application |
| 9. | Word count in Hadoop and Spark |
| 10. | Manipulation RDD |
| 11. | Spark Implementation of Matrix algorithms in Spark Spark Sql programming, Building Spark Streaming application |
| | **Total Laboratory Hours** **30 hours** |

**Reference Books**


1. Mike Frampton “Mastering Apache Spark” – Pract Publishing 2015
2. Tom White, “Hadoop – The Definitive Guide”, O’Relly 4th Edition 2015
3. Nick Pentreath, “Machine Learning with Spark” Pract Publishing 2015
4. Mohammed Gulle , “Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large Scale Data Analysis” – Apress 2015
5. Adam Shook and Donald Mine,“MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems” - O’Relly 2012


Mode of Assessment: Continuous Assessment / FAT / Oral examination and others

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|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE615L | Data Analytics | 2 | 0 | 0 | 2 |
| Pre-requisite | Nil | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Explicate how to design, construct, and quality check a dataset before using it to a build prediction model.
2. Understanding the importance about feature selection in data models.
3. Understanding how information theory, similarity score and Probability theory can be used to build prediction models.

**Course Outcomes**

Upon completion of the course the student will be able to

1. Students will understand the basic concept of data mining and life cycles of data analytics.
2. Analyze and Apply the different data preprocessing techniques.
3. Analyze the characteristics of the data and its important feature.
4. Apply the prediction model for decision making for a given set of problems.
5. Students will understand the concept of distributed machine learning.

| | | |
|---|---|---|
| **Module:1** | **Introduction to Data Mining** | **4 hours** |
| Introduction to Data Mining, Challenges in Data Mining, Data Mining Tasks, Machine Learning, Predictive Data Analytics Lifecycle, Predictive Data Analytics Tools | | |
| **Module:2** | **Exploring Data** | **5 hours** |
| Different types of data, Normal Distribution, Identifying Data Quality Issues, Missing Values, Irregular Cardinality, Outlier, Advanced Data Exploration, Visualizing Relationships Between Features, Measuring Covariance and Correlation, Data Preparation, Normalization, Binning, Sampling | | |
| **Module:3** | **Feature Selection** | **3 hours** |
| Feature Reduction- Feature Selection, Statistics for Feature Selection, Chi-Squared Test for Feature Selection, ANOVA F-test for Feature Selection, RFE feature selection, Dimensionality Reduction and PCA | | |
| **Module:4** | **Decision Tree and Similarity-based Learning** | **5 hours** |
| Decision Trees, Shannon's Entropy Model, Information Gain, Standard Approach: The ID3 Algorithm, Feature Space, Measuring Similarity Using Distance Metrics, Standard Approach: The Nearest Neighbor Algorithm, Extensions and Variations, Handling Noisy Data, Efficient Memory Search, Data Normalization, Predicting Continuous Targets | | |
| **Module:5** | **Probability-based Learning** | **3 hours** |
| Fundamentals, Bayes' Theorem, Bayesian Prediction, Conditional Independence and Factorization, Standard Approach: The Naive Bayes Model | | |
| **Module:6** | **Error-based Learning** | **4 hours** |
| Simple Linear Regression, Measuring Error, Error Surfaces, Standard Approach: Multivariable Linear Regression with Gradient Descent, Multivariable Linear Regression, Gradient Descent, Choosing Learning Rates and Initial Weights. | | |
| **Module:7** | **Distributed Machine Learning** | **5 hours** |
| Data Parallelism - Splitting Input Data, Parameter Server and All-Reduce - Building a Data Parallel Training and Serving Pipeline-Model Parallelism - Splitting the Model-Pipeline Input and Layer Split- Implementing Model Parallel Training and Serving Workflows - Federated Learning and Edge Devices | | |
| **Module:8** | **Contemporary Issues** | **1 hour** |
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| | **Total Lecture hours** | **30 hours** |

**Text Book(s)**

1. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy -Fundamentals of Machine Learning

| | |
|---|---|
| | for Predictive Data Analytics: Algorithms, Worked Examples, MIT Press 2020 , 2nd Edition. |
| 2. | Jason Brownlee -Data Preparation for Machine Learning: Data Cleaning, Feature Selection, and Data Transforms in Python, First Edition, 2020. |
| **Reference Books** | |
| 1. | Pang-Ning Tan; Michael Steinbach; Anuj Karpatne; Vipin Kumar -Introduction to Data Mining. By: Publisher: Pearson, Edition: 2nd, 2019. |
| 2. | Guanhua Wang-Distributed Machine Learning with Python, Packt Publishing, 2022. |
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|---|---|---|---|
| Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE615P | Data Analytics Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Understand and analyze how information theory, similarity score and Probability theory can be used to build prediction models.

**Course Outcome**

Upon completion of the course the student will be able to

1. Analyze the different data preprocessing techniques.
2. Apply the prediction model for decision making for a given set of problems.
3. Apply regression algorithms for finding relationships between data variables

| **Indicative Experiments** | |
|---|---|
| 1. | Find the statistical measures of central tendency and dispersion such as min(), max(), mean(), meadian(), quantile(), sd() ,var() and summary() for real world datasets. |
| 2. | Demonstrate the different data visualization techniques. (Scatter Plot, Horizontal Bar Chart, Histogram, Visualization of Time Series data (Line Graphs) for applications such as weather analysis. |
| 3. | Perform the chi-square test and ANOVA F-test on datasets. |
| 4. | Implement the PCA method for dimensionality reduction on datasets. |
| 5. | Implement the RFE method and show the importance of features |
| 6. | Implement the Decision Tree for given datasets and compute the accuracy of model. |
| 7. | Implement the K-Nearest Neighbor Algorithm for given datasets and analyze the results. |
| 8. | Implement the Naïve Bayes method. |
| 9. | Implement simple linear regression program to predict the future values and analyze the goodness of fit. |
| 10. | Implement multivariate linear regression program to predict the future values analyze the goodness of fit. |
| 11. | Implementation of Distributed Decision Trees |
| | **Total Laboratory Hours** **30 hours** |

**Text Book(s)**

1. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy -Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, MIT Press 2020, 2nd Edition.

**Reference Books**

1. Jason Brownlee -Data Preparation for Machine Learning: Data Cleaning, Feature Selection, and Data Transforms in Python, First Edition, 2020.
2. Guanhua Wang-Distributed Machine Learning with Python, Packt Publishing, 2022.

Mode of Assessment: Continuous Assessment / FAT / Oral examination and others

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE616L | Data Visualization | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the various types of data, apply and evaluate the principles of data visualization.
2. Acquire skills to apply visualization techniques to a problem and its associated dataset.
3. To apply structured approach to create effective visualizations from the massive dataset using various visualization tools.

**Course Outcomes**

Upon completion of the course the student will be able to

1. Analyze the different data types, visualization types to bring out the insight.
2. Relate the visualization towards the problem based on the dataset to analyze and bring out valuable insight on large dataset.
3. Design visualization dashboard to support the decision making on large scale data.
4. Demonstrate the analysis of large dataset using various visualization techniques and tools.

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|---|---|---|
| **Module:1** | **Introduction to Data Visualization** | **4 hours** |

Overview of data visualization - Data Abstraction - Task Abstraction - Dimensions and Measures - Analysis: Four Levels for Validation. Statistical charts (Bar Chart - stacked bar chart – Line Chart - Histogram - Pie chart - Frequency Polygon - Box plot - Scatter plot - Regression curves.)

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| **Module:2** | **Visualization Techniques** | **4 hours** |

Introduction to various data visualization tools - Scalar and point techniques - vector visualization techniques - multidimensional techniques - visualizing cluster analysis – K-means and Hierarchical Cluster techniques.

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| **Module:3** | **Spatio-temporal Data Visualization** | **4 hours** |

Time Series data visualization – Text data visualization – Spatial Data Visualization

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| **Module:4** | **Visual Analytics** | **3 hours** |

Networks and Trees - Heat Map – Tree Map - Map Color and Other Channels Manipulate View - Visual Attributes

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| **Module:5** | **Multivariate Data Visualization** | **5 hours** |

Multivariate data visualization – Geometric projection techniques - Icon-based techniques - Pixel-oriented techniques - Hierarchical techniques - Scatterplot matrix - Hyper box - Trellis display - Parallel coordinates

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|---|---|---|
| **Module:6** | **Data Visualization Tools** | **5 hours** |

Tableau functions and logics: Marks and Channels-Arrange Tables- Arrange Spatial Data-Facets into multiple views

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|---|---|---|
| **Module:7** | **Visualization Dashboard Creations** | **4 hours** |

Data Dashboard- Taxonomies- User Interaction- Organizational Functions-Dashboard Design – Worksheets - Workbooks – Workbook Optimization - Protection and common mistakes. Dashboard creation using visualization tool use cases: Finance-marketing-insurance-healthcare.

| | | |
|---|---|---|
| **Module:8** | **Contemporary Issues** | **1 hour** |
| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

1. Tamara Munzer, Visualization Analysis and Design, 1st edition, CRC Press, United

| | | | |
|---|---|---|---|
| | States, 2015. | | |
| 2 | Michael Fry, Jeffrey Ohlmann, Jeffrey Camm, James Cochran, Data Visualization: Exploring and Explaining with Data, South-Western College Publishing, 2021 | | |
| **Reference Books** | | | |
| 1. | Dr. Chun-hauh Chen, W. K. Hardle, A. Unwin, Handbook of Data Visualization, 1st edition, Springer publication, Germany, 2008. | | |
| 2. | Ben Fry, Visualizing Data, 1st edition, O'Reilly Media, United States, 2008. | | |
| 3. | Avril Coghlan, A little book of R for multivariate analysis, 1st edition, Welcome Trust Sanger Institute, United Kingdom, 2013. | | |
| Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar | | | |
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE616P | Data Visualization Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus Version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Analyze and solve real time data visualization scenarios using Python/R integrating with Tableau.

**Course Outcome**

Upon completion of the course the student will be able to

1. Integrate with Tableau for various data visualization scenarios.
2. Design visualization dashboard to support the decision making on large scale data.
3. Demonstrate the analysis of large dataset using various visualization techniques and tools.

| Indicative Experiments | |
|---|---|
| 1. | Acquiring and plotting data |
| 2. | Statistical Analysis |
| 3. | K-means and Hierarchical Cluster techniques |
| 4. | Multivariate Analysis, Correlation, regression and analysis of variance. |
| 5. | Financial analysis Clustering, Histogram and Heat Map. |
| 6. | Time-series analysis Stock Market. |
| 7. | Visualization of various massive dataset Healthcare, Census, Geospatial. |
| 8. | Visualization on Streaming dataset Stock market, weather forecasting. |
| 9. | Market-Basket Data analysis-visualization |
| 10. | Text visualization using web analytics |
| | **Total Laboratory Hours** **30 hours** |

**Text Book(s)**

1. Tamara Munzer, Visualization Analysis and Design, 1st edition, CRC Press, United States, 2015.
2. Michael Fry, Jeffrey Ohlmann, Jeffrey Camm, James Cochran, Data Visualization: Exploring and Explaining with Data, South-Western College Publishing, 2021

**Reference Books**

1. Dr. Chun-hauh Chen, W. K. Hardle, A. Unwin, Handbook of Data Visualization, 1st edition, Springer publication, Germany, 2008.
2. Ben Fry, Visualizing Data, 1st edition, O'Reilly Media, United States, 2008.
3. Avril, A little book of R for multivariate analysis, 1st edition, Welcome Trust Sanger Institute, United Kingdom, 2013.

Mode of Assessment: Continuous Assessment / FAT / Oral examination and others

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|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE617L | Domain Specific Predictive Analytics | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus vision | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the fundamental concepts of predictive analytics.
2. To impart the knowledge on various steps that are necessary before constructing the predictive model.
3. To gain knowledge on the assessment of predictive models for decision making.

**Course Outcomes**

Upon completion of the course the student will be able to

1. Understand the fundamental concepts of predictive analytics.
2. Define the problem and prepare the data for analysis.
3. Construct different predictive models for decision making.
4. Apply descriptive modeling techniques for the given data.
5. Assess and interpret different predictive models.
6. Understand and apply appropriate algorithms for analyzing the data in healthcare domain.

| Module:1 | Overview of Predictive Analytics | 4 hours |
|---|---|---|

Introduction to Analytics – Predictive Analytics – Parametric vs. Non-Parametric Models -Business Intelligence – Predictive Analytics vs. Business Intelligence – Predictive Analytics vs. Statistics – Predictive Analytics vs. Data Mining – Challenges in using Predictive Analytics - Obstacles with Data - Obstacles with Modeling

| Module:2 | Problem Setting, Data understanding and Preparation | 4 hours |
|---|---|---|

Defining Data for Predictive Modeling – Defining Target Variable – Defining Measures of Success for Predictive Models - Single Variable and Multiple Variable Summaries – Data Visualization – Variable Cleaning – Feature Creation - Case study: Fraud Detection

| Module:3 | Predictive Modeling | 4 hours |
|---|---|---|

Parameter Settings – Measures of Interesting Rules – Deploying Association Rules – Building Classification Rules from Association Rules – Neural Networks - Decision Trees – Linear Regression - Logistic Regression – K-Nearest Neighbor Classifier

| Module:4 | Descriptive Modeling | 4 hours |
|---|---|---|

Data Preparation Issues with Descriptive Modeling - Principal Component Analysis (PCA) Algorithm - Applying PCA to New Data - PCA for Data Interpretation - Clustering Algorithms - The K-Means Algorithm - The Kohonen SOM Algorithm - Visualizing Kohonen Maps

| Module:5 | Model Ensembles and Assessing Predictive Models | 4 hours |
|---|---|---|

Model Ensembles - The Wisdom of Crowds - Bias Variance Tradeoff - Bagging - Boosting - Random Forests - Stochastic Gradient Boosting - Heterogeneous Ensembles - Interpreting Model Ensembles - Batch Approach to Model Assessment - Percent Correct Classification - Rank-Ordered Approach to Model Assessment - Assessing Regression Models.

| Module:6 | Healthcare Analytics(T2:Ch1&11) | |
|---|---|---|

Introduction - Healthcare Data Sources and Basic Analytics - Electronic Health

| | | |
|---|---|---|
| Records - Clinical Prediction Models - Privacy-Preserving Data Publishing - Temporal Data Mining for Healthcare Data - Association Analysis - Classical Methods - Temporal Methods - Temporal Pattern Mining - Sequential Pattern Mining - Time-Interval Pattern Mining - Medical Applications - Sensor Data Analysis - Convolutional Event Pattern Discovery - Patient Prognostic via Case-Based Reasoning - Disease Progression Modeling | | |
| **Module:7** | **Visual Analytics for Healthcare Data** | **5 hours** |
| Visual Analytics and Medical Data Visualization - Clinical Data Types - Standard Techniques to Visualize Medical Data - High-Dimensional Data Visualization - Visualization of Imaging Data - Visual Analytics in Healthcare - Visual Analytics in Public Health and Population Research - Geospatial Analysis- Visual Analytics for Clinical Workflow - Visual Analytics for Clinicians - Patient Progress and Guidelines - Visual Analytics for Patients - Assisting Comprehension | | |
| **Module:8** | **Contemporary Issues** | **1 hour** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Dean Abbott, Applied Predictive Analytics: Principles and Techniques for the professional Data Analyst, John Wiley & Sons Inc. Publishers, First edition, 2014. |
| 2. | Chandan K. Reddy, Charu C. Aggarwal, Healthcare Data Analytics, Chapman & Hall/CRC, Data Mining and Knowledge Discovery Series, 2015. |
| **Reference Books** | |
| 1. | Klimberg, Ron and B.D. McCullough, Fundamentals of Predictive Analytics with JMP®, Cary, NC: SAS Institute Inc., Second Edition, 2016. |
| 2. | Eric Siegel, Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, John Wiley & Sons Inc. Publishers, Second edition, 2016. |
| 3. | Hui Yang, Eva K. Lee, Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, John Wiley & Sons Inc. Publishers, 2016. |

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|---|---|---|---|
| Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar | | | |
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE617P | Domain Specific Predictive Analytics Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the fundamental concepts of predictive analytics.
2. To impart the knowledge on various steps that are necessary for constructing the predictive model.
3. To gain knowledge on the assessment of predictive models for decision making.

**Course Outcome**

Upon completion of the course the student will be able to

1. Understand the fundamental concepts of predictive analytics.
2. Define the problem and prepare the data for analysis.
3. Construct different predictive models for decision making.
4. Apply descriptive modeling techniques for the given data.
5. Assess and interpret different predictive models.
6. Understand and apply appropriate algorithms for analyzing the data in healthcare domain.

**Indicative Experiments**

Experiments can be implemented using R/Python.

| | |
|---|---|
| 1. | Clustering based data analytics using R/Python. (K-Means, SOM algorithms) |
| 2. | Demonstrate the statistics for a sample data like mean, standard deviation, normal/uniform distribution, variance and correlation. |
| 3. | Demonstrate missing value analysis, fixing missing values and outlier analysis using Healthcare domain datasets. |
| 4. | Demonstrate data visualization, histograms and multiple variable summaries. |
| 5. | Demonstrate transformation, scaling, binning, fixing skewed values and sampling. |
| 6 | Demonstration of Apriori algorithm on transaction dataset to find association rules. |
| 7. | Demonstration of Linear and Logistic regression using various domain datasets. |
| 8. | Demonstration of predictive models such as Decision Tree, Neural network and K-Nearest Neighbor using various domain datasets. |
| 9. | Demonstration of Temporal Mining Techniques |
| 10. | Demonstration of predictive analytics using healthcare data and microarray data. |
| | **Total Laboratory Hours** \| **30 hours** |

**Text Book(s)**

1. Dean Abbott, Applied Predictive Analytics: Principles and Techniques for the professional Data Analyst, John Wiley & Sons Inc. Publishers, First edition, 2014.

| | | | |
|---|---|---|---|
| 2. Chandan K. Reddy, Charu C. Aggarwal, Healthcare Data Analytics, Chapman & Hall/CRC, Data Mining and Knowledge Discovery Series, 2015. | | | |
| **Reference Books** | | | |
| 1. Manohar Swamynathan, Mastering Machine Learning with Python in Six Steps, Apress Publishers, First edition, 2017. | | | |
| | | | |
| Mode of Assessment: Continuous Assessment / FAT | | | |
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE618L | Social Network Analytics | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Understand the components and entities of the social network
2. Analyze social media data to comprehend user sentiments and recommend the essential information appropriately.
3. Model and visualize the social network

**Course Outcomes**

1. Illustrate the basic concepts of social network.
2. Analyse the networks to find prominent actors and relate social network models.
3. Develop social network applications using tools and techniques.
4. Detect and analyze the communities in social networks.
5. Design a system to assimilate information available on the web to model and build Social Network Application.

| Module:1 | Fundamentals of Social Network Analysis | 4 hours |
|---|---|---|

Social Network Perspective, Fundamentals concepts in Network Analysis: Sociogram, Sociometry. Social Network Data: Types of Networks: One-Mode, Two-Mode, Affiliation, Ego-centered and Special Dyadic Networks, Network Data, Measurement and Collection, Notations for Social Network Data: Graphs, Directed, Singed, Valued graphs, Multigraph, Relations and Matrices.

| Module:2 | Centrality and Prestige | 4 hours |
|---|---|---|

Prominence: Actor-Centrality, Prestige, Group-Centrality, Prestige, Non directional Relations-Degree, Closeness, Betweenness, Eigen Vector Centrality, Directional Relations-Centrality, Prestige.

| Module:3 | Structural Balance and Transitivity | 3 hours |
|---|---|---|

Structural Balance: Signed Non directional, Signed Directional Relations, Checking for Balance, Index for Balance, Clusterability-Theorems, Clustering Coefficient and Transitivity.

| Module:4 | Cohesive Subgroups | 5 hours |
|---|---|---|

Social Group and Subgroup-Notation, Subgroups Based on Complete Mutuality: Clique, Reachability and Diameter: n-cliques, n-clans and n-clubs, Subgroups Based on Nodal Degree: k-plexes, k-cores, Measures of Subgroup Cohesion, Community detection using Subgroups and Betweenness.

| Module:5 | Structural Equivalence | 4 hours |
|---|---|---|

Definition, Social Roles and , Positional Analysis, Measuring Structural Equivalence, Representation of Network Positions, Block Models: Introduction, Network Positions and roles-Introduction

| Module:6 | Dyadic and Triadic Methods | 4 hours |
|---|---|---|

Dyads: Definitions, Dyad Census, Index, Simple Distributions, Triads: Random Models and Substantive Hypotheses, Triad Census, Distribution of a Triad Census-Mean and Variance, Testing Structural Hypotheses.

| Module:7 | Models in Social Network | 5 hours |
|---|---|---|

| | | |
|---|---|---|
| Small world network- Watt Strogatz networks - statistical models for social networks - network evaluation model - Preferential attachment - power law - Random Model : Erdos -Renyi model - Barabasi Albert model - Epidemic model - Case study: Text and opinion Analysis | | |
| **Module:8** | **Contemporary Issues** | **1 hour** |
| | | |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Wasserman Stanley, and Katherine Faust, Social Network Analysis: Methods and Applications, Structural Analysis in the Social Sciences. Cambridge University Press, 2012 Online Edition. |
| 2. | Albert-László Barabási, Network Science, Cambridge University Press, 1st edition, 2016. |
| **Reference Books** | |
| 1. | John Scott, "Social Network Analysis", Sage Publications Ltd., Fourth Edition, 2017. |
| 2. | David Knoke & Song Yang, "Social Network Analysis", Sage Publishing, Third Edition, 2020. |

| | | | |
|---|---|---|---|
| Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar | | | |
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE618P | Social Network Analytics Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Understand the components of the social network
2. Analyze social media data to understand user sentiment and recommend the requisite information accordingly.
3. Model and visualize the social network

**Course Outcome**

Upon completion of the course the student will be able to

1. Demonstrate the basic properties of social network
2. Demonstrate of analysis of social networks to find prominent actors and apply social network models.
3. Develop social network applications using visualization tools.
4. Detect and analyze the communities in social networks.
5. Design a system to harvest information available on the web to model and build Social Network Application.

| Indicative Experiments | |
|---|---|
| 1. | Study and demonstrate to find the basic properties of a Graph/Social Network. |
| 2. | Demonstrate the calculation of Centrality measures. |
| 3. | Demonstrate the ranking of web pages in a web graph. |
| 4. | Find divisions in a Social Network. |
| 5. | Implement Community Detection algorithms on a Social Network. |
| 6. | Demonstrate modelling of Social Networks. |
| 7. | Visualize multidimensional Social Network. |
| 8. | Applications of Classification and Clustering on a Social Network. |
| 9. | Design and implement a Sentiment Analyzer. |
| 10. | Design and implement a Social Network. |
| | **Total Laboratory Hours** **30 hours** |

**Text Book(s)**

1. Wasserman Stanley, and Katherine Faust, Social Network Analysis: Methods and Applications, Structural Analysis in the Social Sciences. Cambridge University Press, 2012 Online Edition.
2. Albert-László Barabási, Network Science, Cambridge University Press, 1st edition, 2016.

**Reference Books**

1. John Scott, "Social Network Analysis", Sage Publications Ltd., Fourth Edition, 2017.
2. David Knoke & Song Yang, "Social Network Analysis", Sage Publishing, Third Edition, 2020.

Mode of Assessment: Continuous Assessment / FAT

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE619L | Text and Speech Analytics | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the tools and techniques for performing text and speech analytics in diverse contexts.
2. To understand the tools and technologies involved in developing text and speech applications.
3. To demonstrate the use of computing for building applications in text and speech processing.

**Course Outcomes**

Upon completion of the course the student will be able to

1. Develop tools to analyse the syntax and semantics of a statement written in a natural language.
2. Apply machine learning and deep learning techniques to natural language processing.
3. Use signal processing techniques to analyze/represent speech.
4. Execute trials of speech systems.
5. Evaluate the performance of NLP & Speech systems.

| Module:1 | Introduction to Text Processing and Language Modeling | 5 hours |
|---|---|---|

Introduction to Natural Language Processing (NLP) and Levels of NLP - Regular Expression - Basic Text processing- Text normalization - Vector Semantics and embedding : Lexical Semantics , Vector Semantics , Words and Vectors - Pointwise Mutual Information, N-gram Language Models : N-grams, Smoothing.

| Module:2 | Parts of speech and Named entities | 4 hours |
|---|---|---|

Parts of Speech Tagging - Hidden Markov Model - Conditional Random Fields. Constituency Grammars: Constituency, Context Free Grammars, Dependency Parsing: Dependency Relations, Dependency Formalism, Neural Dependency Parser.

| Module:3 | Logical Representations of Sentence Meaning | 4 hours |
|---|---|---|

Logical Representations of Sentence Meaning, Word Sense and Word Net, Word Sense Disambiguation, Word Sense Induction.

| Module:4 | Applications of Text and NLP | 4 hours |
|---|---|---|

Naive Bayes and Sentiment Analysis: Naive Bayes for text classification, Information Extraction - Relation extraction. Learning Architectures for Sequence Processing: Recurrent Neural Networks for text classification- Long Short-Term Memory (LSTM).

| | | |
|---|---|---|
| **Module:5** | **Phonetics** | **3 hours** |
| Speech Sounds and Phonetic Transcription, Articulatory Phonetics – Prosody - Acoustic Phonetics and Signals - Phonetic Resources. | | |
| **Module:6** | **Automatic Speech Recognition** | **4 hours** |
| Automatic Speech Recognition (ASR) Task - Feature Extraction: Log Mel Spectrum - Speech Recognition Architecture – Introduction: Gaussian Mixture Model - Connectionist Temporal Classification (CTC) - ASR Evaluation: Word Error Rate. | | |
| **Module:7** | **Text-To-Speech** | **5 hours** |
| Text-To-Speech (TTS) Preprocessing: Text normalization – TTS: Spectrogram Prediction – TTS: Vocoding - TTS Evaluation. | | |
| **Module:8** | **Contemporary Issues** | **1 hour** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Jurafsky, D. and J. H. Martin, Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition (3rd Draft), 2021. |
| **Reference Books** | |
| 1. | John Atkinson-Abutridy, Text Analytics: An Introduction to the Science and Applications of Unstructured Information Analysis, CRC Press, 2022. |
| 2. | Introduction to Voice Computing in Python, Jim Schwoebel, NeuroLex, 2018 |
| 3. | Theory and Applications of Digital Speech Processing, Lawrence R. Rabiner, Ronald W. Schafe, 1st Edn. Pearson, 2010. |
| 4. | Srinivasa-Desikan, Bhargav. Natural Language Processing and Computational Linguistics: A practical guide to text analysis with Python, Gensim, spaCy, and Keras. Packt Publishing Ltd, 2018. |
| | |

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|---|---|---|---|
| Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar | | | |
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE619P | Text and Speech Analytics Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the tools and techniques for performing text and speech analytics in diverse contexts.
2. To understand the tools and technologies involved in developing text and speech applications.
3. To demonstrate the use of computing for building applications in text and speech processing.

**Course Outcomes**

Upon completion of the course the student will be able to

1. Develop tools to analyse the syntax and semantics of a statement written in a natural language.
2. Apply machine learning and deep learning techniques to natural language processing.
3. Use signal processing techniques to analyze/represent speech.
4. Execute trials of speech systems.
5. Evaluate the performance of NLP & Speech systems.

| Indicative Experiments | |
|---|---|
| 1. | Introduction to text processing packages in Python. |
| 2. | Demonstration of Genism for Vectorizing Text, Transformations and n-grams. |
| 3. | Demonstration of Part-of-Speech tagging using spaCy. |
| 4. | Demonstration of text parsing, topic modeling, text clustering and text classification. |
| 5. | Demonstration of Deep learning techniques for text classification and for designing a chatbot. |
| 6 | Analyze Speech signal - Fast Fourier Transform (FFT), spectrogram, Linear predictive coding, Mel-frequency Cepstral Coefficients (MFCC) features. |
| 7. | Demonstration of Hidden Markov Model based Isolated word recognition. |
| 8. | Demonstration of Continuous speech recognition using CTC. |
| 9. | Demonstration of Alexa speech enabled application development system. |
| 10 | Demonstration of Google voice API based speech transcription system. |
| | **Total Laboratory Hours** **30 hours** |

**Text Book(s)**

1. Jurafsky, D. and J. H. Martin, Speech and language processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition (3rd Draft), 2021.

| |
|---|
| 2. Srinivasa-Desikan, Bhargav. Natural Language Processing and Computational Linguistics: A practical guide to text analysis with Python, Gensim, spaCy, and Keras. Packt Publishing Ltd, 2018. |
| **Reference Books** |
| 1. John Atkinson-Abutridy, Text Analytics: An Introduction to the Science and Applications of Unstructured Information Analysis, CRC Press, 2022.<br><br>2. Introduction to Voice Computing in Python, Jim Schwoebel, NeuroLex, 2018<br><br>3. Theory and Applications of Digital Speech Processing, Lawrence R. Rabiner, Ronald W. Schafe, 1st Edn. Pearson, 2010. |
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|---|---|---|---|
| Mode of Assessment: Continuous Assessment / FAT | | | |
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE620L | Analytics for Internet of Things | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the fundamentals of IoT data analytics and major challenges in IoT data analytics.
2. To provide knowledge on IoT network architecture and design.
3. To understand smart objects and IoT networking protocols.

**Course Outcomes**

Upon completion of the course the student will be able to

1. Understand the specific challenges in applying data analytics techniques over IoT data.
2. Will know IoT network architecture and design.
3. Smart objects and connecting smart objects
4. Analyze various IoT networking protocols.
5. Apply IoT analytics for cloud and data science for IoT analytics.

| Module:1 | IoT Analytics and Challenges | 3 hours |
|---|---|---|

Defining IoT analytics: Defining Analytics, Defining Internet of Things, The concepts of constrained - IoT analytics challenges: the Data volume, Problem with time and space, Data quality, Analytics Challenges - Business value concerns.

| Module:2 | IoT Network Architecture and Design | 5 hours |
|---|---|---|

Drivers behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

| Module:3 | Smart Objects: The Things in IoT | 3 hours |
|---|---|---|

Sensors, Actuators, and Smart Objects, Sensor Networks

| Module:4 | Connecting Smart Objects | 6 hours |
|---|---|---|

Communications Criteria, Range, Frequency Bands, Power Consumption, Topology, Constrained Devices, Constrained-Node Networks, IoT Access Technologies, IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, LoRaWAN.

| Module:5 | IoT Networking Protocols | 3 hours |
|---|---|---|

IoT networking data messaging protocols, Message Queue Telemetry Transport (MQTT), Hyper-Text Transport Protocol (HTTP), Constrained Application Protocol (CoAP), Data Distribution Service (DDS).

| Module:6 | IoT Analytics for the Cloud | 4 hours |
|---|---|---|

Building elastic analytics, Elastic analytics concepts, designing for scale, Cloud security and analytics, The AWS overview, Microsoft Azure overview.

| Module:7 | Data Science for IoT Analytics | 5 hours |
|---|---|---|

| | | |
|---|---|---|
| Machine learning (ML), Feature engineering with IoT data, Validation methods, Understanding the bias–variance tradeoff, Comparing different models to find the best fit using R, Random forest models using R, Anomaly detection using R. | | |
| **Module:8** | **Contemporary Issues** | **1 hour** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Andrew Minteer , Analytics for the Internet of things, Packt publishing 2017. |
| 2. | David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals:Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017. |

**Reference Books**

| | |
|---|---|
| 1. | Pethuru Raj, Anupama C. Raman, The Internet of Things, Enabling Technologies, Platforms, and Use Cases, CRC Press, 2017. |
| 2. | Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things Principles and Paradigms, Morgan Kaufmann, 1st edition, 2016. |
| 3. | Marco Schwartz, Internet of Things with Arduino Cookbook, Packt Publishing,2016 |
| 4. | Adeel Javed, "Building Arduino Projects for the Internet of Things: Experiments with Real-World Applications", 1st Edition, Apress, 2016. |

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Project / Seminar

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE620P | Analytics for Internet of Things Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the fundamentals of IoT data analytics and major challenges in IoT data analytics.
2. To provide knowledge on IoT network architecture and design.
3. To understand smart objects and IoT networking protocols.

**Course Outcome**

Upon completion of the course the student will be able to

1. Understand the specific challenges in applying data analytics techniques over IoT data.
2. Will know IoT network architecture and design.
3. Smart objects and connecting smart objects
4. Analyze various IoT networking protocols.
5. Apply IoT analytics for cloud and data science for IoT analytics.

| Indicative Experiments | |
|---|---|
| 1. | Study different sensors, actuators, and their applications. |
| 2. | Write a program using Arduino IDE for Blink LED. |
| 3. | Write a program to interface the DHT11 sensor with Arduino/Raspberry to print temperature and humidity readings. |
| 4. | Write an application to read temperature from the environment. If the temperature crosses the threshold value then it notifies with a buzzer. |
| 5. | Study and implement MQTT protocol using Arduino. |
| 6 | Study and implement COAP protocol using Arduino. |
| 7. | Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to the ThingSpeak cloud. |
| 8. | Write an application to send Light Sensor Values to the ThingSpeak cloud |
| 9. | Write an application to send Temperature and Humidity Values to the ThingSpeak cloud |
| 10. | Implementation of Machine learning approaches over IoT data. |
| | **Total Laboratory Hours** **30 hours** |

**Text Book(s)**

1. Andrew Minteer , Analytics for the Internet of things, Packt publishing 2017.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.

**Reference Books**

1. Pethuru Raj, Anupama C. Raman, The Internet of Things, Enabling Technologies, Platforms, and Use Cases, CRC Press, 2017.
2. Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things Principles and Paradigms, Morgan Kaufmann, 1st edition, 2016.

| | | | |
|---|---|---|---|
| 3. | Marco Schwartz, Internet of Things with Arduino Cookbook, Packt Publishing,2016 | | |
| 4. | Adeel Javed, "Building Arduino Projects for the Internet of Things: Experiments with Real-World Applications", 1st Edition, Apress, 2016. | | |
| Mode of Assessment: Continuous Assessment / FAT | | | |
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. 68 | Date | 19-12-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE621L | Control Engineering | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To present a clear exposition of the classical methods of control engineering, physical system modeling, and basic principles of frequency and time domain design techniques.
2. To teach the practical control system design with realistic system specifications.
3. To provide knowledge of state variable models and fundamental notions of state feedback design in discrete time.

**Course Outcome**

1. Formulate a mathematical model of physical systems.
2. Use different tools for control system design and analysis.
3. To understand the concept of time domain response, frequency domain response and solution of the discrete system.
4. Employ or Design compensators/controllers for design specifications.
5. Understand the fundamental limitations and challenges associated with the control of real-time physical systems.

| Module 1 | Systems and their Representations | 5 hours |
|---|---|---|
| Review of Basic Elements in Control Systems – Mathematical Modeling of Systems- Open Loop & Closed Loop Systems – Transfer Function and State Space Representation – State Space to Transfer Function Conversion. | | |
| **Module 2** | **Time Response and Stability Analysis** | **5 hours** |
| Introduction - Review of Time Response of First and Second Order System - Time Response Analysis- Concepts of Stability – Routh Hurwitz Criterion- Steady State Error. | | |
| **Module 3** | **Design of Feedback Control System** | **7 hours** |
| Introduction of Feedback Controllers-P, PI, PID and Compensator-Lag, Lead, Transient Response Design using Root Locus and Bode Plot. | | |
| **Module 4** | **State Variable Analysis** | **7 hours** |
| State Equations- Solution, State Transition Equations, Relationship between State Equation and Transfer Functions, Characteristic Equations- Eigen Value -Eigen Vector. | | |
| **Module 5** | **State Space Model Transformation** | **7 hours** |
| Diagonalization of Matrix – Canonical Forms, Methods of Computing State Transition Matrix, Controllability and Observability of Linear Time Invariant Systems, Pole Placement Techniques. | | |
| **Module 6** | **Discrete Time Systems** | **6 hours** |
| Overview of Design Approaches, Continuous Versus Digital Control, Sampling Process, Sample and Hold Device, A/D, D/A Conversion, Calculus of Difference Equations, Z-Transform, Pulse Transfer Function | | |
| **Module 7** | **Introduction to digital control system** | **6 hours** |
| Mapping of S-Plane to Z-Plane, Stability Analysis of Closed Loop Systems in Z-Plane, Jury Stability Test, State Diagram- Decomposition of Discrete Data Transfer Function. | | |
| **Module 8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture Hours** | **45 hours** |

**Text Book(s)**

1. Norman S. Nise, "Control System Engineering", John Wiley & Sons, 8th Edition, 2019.
2. K.Ogata, "Discrete-Time Control Systems", Pearson, 2015.

**Reference Books**

| | |
|---|---|
| 1. | K. Ogata," Modern Control Engineering", Pearson,5th Edition,2010. |
| 2. | R.C. Dorf & R.H. Bishop, "Modern Control Systems", Pearson Education 13th Edition, 2017. |
| 3. | Benjamin C Kuo, Farid Golnaraghi, "Automatic control systems" John Wiley & Sons. 8th Edition, 2007. |
| 4. | Graham C. Goodwin, Stefan F. Graebe, Mario E.Sagado, "Control system design", Prentice hall, 2003. |
| 5. | J.Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 6th Edition, 2018. |
| 6. | M. Gopal, "Digital Control and State Variable Methods", Tata McGraw-Hill Publications, 4th Edition, 2012. |


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|---|---|---|---|
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 29-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE621P | Control Engineering Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To present a clear exposition of the classical methods of control engineering, physical system modeling, and basic principles of frequency and time domain design techniques.
2. To teach the practical control system design with realistic system specifications.
3. To provide knowledge of state variable models and fundamental notions of state feedback design in discrete time.

**Course Outcome**

1. Formulate a mathematical model of Physical systems.
2. Use different tools for control system design and analysis.
3. To understand the concept of time domain response, frequency domain response and solution of discrete system
4. Employ or Design compensators/controllers for design specifications.
5. Understand the fundamental limitations and challenges associated with control of real-time physical systems.

**Indicative Experiments**

| | |
|---|---|
| 1. | Block Diagram Reduction |
| 2. | Determination of Time Domain Specifications |
| 3. | Stability Analysis of Linear Systems |
| 4. | PID Controller Design using Bode Plot |
| 5. | PID Controller Design using Root Locus |
| 6. | Transfer Function to State Space Conversion with Controllability and Observability Tests |
| 7. | Lag Compensator Design for Linear Servo Motor for Speed Control Application |
| 8. | Pole Placement Controller Design for Inverted Pendulum |
| 9. | PD Controller Design for Position Control of Servo Plant |
| 10. | Cascade Control Design for Ball and Beam System |
| 11. | PID Controller Design for Magnetic Levitation System |
| 12. | Determine the Response of First and Second Order System |
| 13. | Industrial Controller Design Using NI Systems for Vision Applications |
| 14. | Controller Design Using NI PITSCO Robotics Kit |
| 15. | Data Acquisition and Controller Design Using NI Educational Controller |
| | **Total Laboratory Hours** \| **30 hours** |

| | | | |
|---|---|---|---|
| Mode of assessment: Continuous Assessment / FAT | | | |
| Recommended by Board of Studies | 29-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE622L | Framework of Cyber Physical Systems | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To lay out the foundational structure for Cyber-Physical Systems (CPS) integrating hardware components with evolving technologies for sensing, computation, and actuation.
2. To explore essential new capabilities and technologies to ensure interoperability through interfacing methodology.
3. To provide better insight into overall processes involved in the CPS framework through Machine to Machine (M2M) integration.

**Course Outcome**

1. Comprehend the essential hardware devices required for the sensing and actuating process.
2. Analyze the signal processing and interfacing through appropriate techniques.
3. Build smart CPS framework for industrial applications through Machine to Machine (M2M) technologies.
4. Understand the various M2M communication technologies and protocols to deploy the CPS framework.
5. Realize the impact of M2M communication in constrained devices through its architectures and networks.

| Module 1 | Introduction | 7 hours |
|---|---|---|

Definitions - Classification of Sensors and Actuators - Units - Different Types of Sensors: Temperature Sensors and Thermal Actuators, Optical Sensors and Actuators, Electric and Magnetic Sensors and Actuators, Mechanical Sensors and Actuators, Acoustic Sensors and Actuators, Chemical Sensors and Actuators, Radiation Sensors and Actuators, MEMS and Smart Sensors.

| Module 2 | Signal Processing | 7 hours |
|---|---|---|

Modulation: Amplitude Modulation - Frequency Modulation - Phase Modulation - Amplitude Shift Keying - Frequency Shift Keying - Phase Shift Keying - CPS Essentials - Demodulation: Amplitude Demodulation - Frequency and Phase Demodulation - Encoding and Decoding: Unipolar and Bipolar Encoding - Biphase Encoding - Manchester Code.

| Module 3 | Interface Methods and Circuits | 6 hours |
|---|---|---|

Amplifiers - Power Amplifiers - Digital Circuits - Bridge Circuits - Data Transmission - Excitation Methods and Circuits - Noise and Interference - General Requirements for Interfacing Sensors and Actuators.

| Module 4 | Industrial IoT (IIoT) Design Methodology | 6 hours |
|---|---|---|

Introduction to M2M, M2M Communication Technologies - Challenges of Industrial IoT - Automation Framework Using IIoT System - Technologies in IIoT Solution - IIoT Development Platform.

| Module 5 | M2M Communication Technologies | 6 hours |
|---|---|---|

M2M Communication - Standards and Protocols - Application using M2M Communication.

| Module 6 | M2M Communication Protocols | 4 hours |
|---|---|---|

Internet Protocol Stack and M2M Communication - IPv6 and IoT Application Protocols - Constrained Application Protocols (CoAP)- MQTT Application Protocols - Standard Defining Bodies.

| Module 7 | M2M Communication in Constrained Devices | 7 hours |
|---|---|---|

Constrained Network and Constrained Devices - Internet Access - M2M Gateway Devices - Network Domain - Personal Area Network - Constrained Devices and its Architecture - Wireless Sensor Network - Multi-PHY Management and SUN WPAN - Network Architecture for WPAN - Routing Protocols for Sensor Networks - Constrained Application Protocol

| | | | |
|---|---|---|---|
| (CoRE). | | | |
| **Module:8** | **Contemporary Issues** | | **2 hours** |
| | | | |
| | **Total Lecture Hours** | | **45 hours** |
| **Text Book(s)** | | | |
| 1. | Nathan Ida, "Sensors, Actuators, and Their Interfaces: A Multidisciplinary Introduction", IET, 2nd Edition, 2020 | | |
| 2. | Veena S. Chakravarthi, "Internet of Things and M2M Communication Technologies: Architecture and Practical Design Approach to IoT in Industry 4.0", Springer International Publishing, 2021. | | |
| **Reference Books** | | | |
| 1. | Griffor ER, Greer C, Wollman DA, Burns MJ. Framework for Cyber-Physical Systems: Volume 1, overview. 2017 Jun 26. | | |
| 2. | Andre Platzer. Foundations of Cyber-Physical Systems. Lecture Notes, Computer Science Department, Carnegie Mellon University.2013. | | |
| 3. | P.Venkata Krishna, V.Saritha and H.P.Sultana. Challenges, Opportunities, and Dimensions of Cyber-Physical Systems. IGI Global, ISBN – 978-1466673120, 2014. | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 29-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE623L | Cyber Physical Systems Design | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the fundamentals of designing Cyber-Physical Systems (CPS) consisting of both discrete and continuous events.
2. To provide an overview of design automation and verification systems.
3. To provide exposure to practical applications of modeling and verification.

**Course Outcome**

1. Understand Cyber Physical System Framework.
2. Model its dynamic behavior through state machines and concurrent models.
3. Design a Cyber Physical System using various hardware components namely sensors, embedded processors, memory and input/output devices.
4. Perform multitasking and scheduling with a multiprocessor.
5. Analyze, verify and validate the working of the Cyber Physical System design.

| | | |
|---|---|---|
| **Module 1** | **Introduction to CPS** | **3 hours** |
| Introduction – National Institute of Standards and Technology (NIST) CPS Framework – Derivation of the CPS Framework - Description of the CPS Framework | | |
| **Module 2** | **Modeling Dynamic Behaviors – I** | **4 hours** |
| Continuous Dynamic – Newtonian Mechanics- Actor Models, Properties of Systems, Feedback Control, Discrete Dynamics- Discrete Systems- The Notion of State, Finite-State Machines- Extended State Machines- Nondeterminism, Behaviors and Traces. | | |
| **Module 3** | **Modeling Dynamic Behaviors -II** | **5 hours** |
| Hybrid Systems - Modal Models - Classes of Hybrid Systems – State Machines – Concurrent Composition- Hierarchical State Machines- Concurrent Models of Computation- Structure of Models- Synchronous - Reactive Models - Dataflow Models of Computation - Timed Models of Computation. | | |
| **Module 4** | **CPS Design and Implementation** | **4 hours** |
| Sensors and Actuators – Models of Sensors and Actuators - Common Sensors - Actuators - Embedded Processors – Types of Processors - Parallelism - Memory Architecture – Memory Technologies - Memory Hierarchy - Memory Models- Input and Output - I/O Hardware- Sequential Software in a Concurrent World. | | |
| **Module 5** | **Scheduling** | **4 hours** |
| Multitasking - Imperative Programs- Threads- Processes and Message Passing- Basics of Scheduling- Rate Monotonic Scheduling- Earliest Deadline First Scheduling and Mutual Exclusion- Multiprocessor Scheduling. | | |
| **Module 6** | **Analysis and Verification-I** | **4 hours** |
| Invariants- Linear Temporal Logic – Equivalence and Refinement- Models as Specifications- Type Equivalence and Refinement- Language Equivalence and Containment- Bisimulation. | | |
| **Module 7** | **Analysis and Verification-II** | **4 hours** |
| Reachability Analysis and Model Checking – Open and Closed Systems - Reachability Analysis - Abstraction of Model Checking – Model Checking Liveness Properties – Quantitative Analysis- Problems of Interest - Programs as Graphs - Factors Determining Execution Time- Basics of Execution Time Analysis. | | |
| **Module 8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture Hours** | **30 hours** |

**Text Book(s)**

1. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, http://Leeseshia.org, ISBN 978-1-312-42740-2, 2015.

| | | | |
|---|---|---|---|
| 2. | Rajeev Alur, Principles of Cyber-Physical systems. MIT Press. 2015. Charu C. Aggarwal," Recommender systems: The Textbook", First Ed., Springer, 2016. | | |
| **Reference Books** | | | |
| 1. | Griffor ER, Greer C, Wollman DA, Burns MJ. Framework for cyber-physical systems: Volume 1, overview. 2017 Jun 26. | | |
| 2. | Andre Platzer. Foundations of Cyber-Physical Systems. Lecture Notes, Computer Science Department, Carnegie Mellon University.2013. | | |
| 3. | P.Venkata Krishna,V.Saritha and H.P.Sultana (VIT University, India). Challenges, Opportunities, and Dimensions of Cyber-Physical Systems. IGI Global, ISBN – 978-1466673120, 2014. | | |
| 4. | Griffor ER, Greer C, Wollman DA, Burns MJ. Framework for cyber-physical systems: Volume 1, Overview. 2017 Jun 26. | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 29-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE623P | Cyber Physical Systems Design Lab | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To design a Cyber Physical System for a given application.
2. To logically develop and implement a Cyber Physical System.
3. To test and validate the developed Cyber Physical System.

**Course Outcome**

1. Design and develop the Cyber Physical System.
2. Verify and validate the developed Cyber Physical System.
3. Deploy Cyber Physical Systems in various practical applications.

| | **Indicative Experiments** |
|---|---|
| 1. | Embedded C/C++ Programming for CPS<br>• Port Handling, Timer Initialization<br>• Waveform Generation<br>• Serial Port Controller<br>• Interrupt Generation<br>• Motor Control using Embedded C<br>• PLC Emulation using Embedded C<br>• Pulse Width Modulation |
| 2. | Benchmark IoT for CPS<br>• Deployment of Sensors and IoT devices<br>• Control of Sensors using Open APIs like MQTT, COAP<br>• Addition of new sensors to CPS-IoT<br>• Control of Servo Motors using Embedded Software. |
| 3. | Modelling and Simulation of CPS using Ptolemy<br>• Computation Models<br>• Process Networks<br>• Discrete Events<br>• Data Flow<br>• Rendezvous Based models<br>• Synchronous/Reactive<br>• 3D Visualization<br>• Continuous Time Model<br>• Hybrid Systems Modeling using Hy Visual<br>• Scientific Workflows using Kepler |
| 4. | Additional Exercises<br>• Matlab and Simulink<br>• Robotic Control and Simulation<br>• Drone Control<br>• Automotive |
| | **Total Laboratory Hours** **30 hours** |

| | | | |
|---|---|---|---|
| Mode of assessment: Continuous assessment / FAT | | | |
| Recommended by Board of Studies | 29-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE624L | Real Time Systems | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To introduce the fundamental problems, concepts, and approaches in the design and analysis of real-time systems.
2. To formally state, design and evaluate real-time systems.

**Course Outcome**

1. Understand the fundamentals of real-time systems and apply appropriate real-time task scheduling techniques.
2. Handle resource sharing and dependencies among real-time tasks.
3. Design basic operating system functions needed for real-time computing.
4. Explore real-time databases and apply various network protocols for establishing real-time communication.
5. Detect and contain faults occurring in real-time systems.

| Module 1 | Basic Real-Time Systems and Concepts | 2 hours |
|---|---|---|

Concepts – Definitions - Events and Determinism – Applications - Basic Model Characteristics - Design Issues - Modelling Timing Constraints - Examples.

| Module 2 | Real-Time Task Scheduling | 4 hours |
|---|---|---|

Types of Real-Time Tasks and their Characteristics - Task Scheduling Basic Concepts – Process Scheduling - Round-Robin Scheduling - Cyclic Executives - Fixed-Priority Scheduling: Rate-Monotonic Approach - Dynamic- Priority Scheduling: Earliest Deadline First Approach.

| Module 3 | Resource Sharing among Real-Time Tasks | 5 hours |
|---|---|---|

Priority Inversion - Priority Inheritance Protocol (PIP) - Highest Locker Protocol (HLP) - Priority Ceiling Protocol (PCP) - Priority Inversion under PCP - Issues in using Resource Sharing Protocols – Comparison - Handling Task Dependencies.

| Module 4 | Real-Time Operating Systems | 5 hours |
|---|---|---|

Real-Time Kernels – Inter Task Communication and Synchronization- Thread Management - Memory Management - Input/Output Management - Case Study: POSIX, FreerRTOS, - VxWorks, Real-Time Linux.

| Module 5 | Real-Time Databases | 4 hours |
|---|---|---|

Basic Definition - Real-Time Vs General Purpose Databases -Main Memory Databases – Transaction –Priorities -Transaction Aborts - Concurrency Control Issues - Disk Scheduling Algorithms – Two-Phase Approach to Improve Predictability -Maintaining Serialization – Consistency - Databases for Hard Real-Time Systems - Example Applications.

| Module 6 | Real-Time Communication | 4 hours |
|---|---|---|

Basic Concepts - Real-Time Communication in a LAN (Soft and Hard) Bounded Access Protocols for LAN - Performance Comparison - Real-Time Communication Over Packet Switched Networks - QoS Framework – Routing - Resource Reservation - Rate Control - QoS Models.

| Module 7 | Fault Tolerance in Real-Time Systems | 4 hours |
|---|---|---|

Cause for Faults - Fault Types - Fault Detection- Fault and Error Containment – Redundancy Data – Diversity Reversal Checks - Malicious or Byzantine Failures - Integrated Failure – Handling - Clock Synchronization – Non Fault-Tolerant Synchronization Algorithm - Fault-Tolerant Synchronization in Hardware and Software.

| Module 8 | Contemporary Issues | 2 hours |
|---|---|---|
| | | |
| | Total Lecture Hours | 30 hours |

**Text Book(s)**

1. Phillip A. Laplante, Real-Time Systems Design and Analysis, 2013, 4th Edition, Prentice

| | | | | |
|---|---|---|---|---|
| | Hall of India. | | | |
| 2. | Rajib Mall, “Real-time Systems: Theory and Practice”, 2009, Pearson Education. | | | |
| **Reference Books** | | | | |
| 1. | Kayhan Erciyes,” Distributed Real Time Systems: Theory and Practice”, 2019. Springer. | | | |
| 2. | Allen Buruns and Andy Wellings, “Real Time systems and Programming Languages”, 2003, Pearson Education. | | | |
| 3. | R.J.A Buhr and D.L Bailey, “An Introduction to Real-Time Systems”, 1999, Prentice Hall International. | | | |
| 4. | Stuart Bennett, “Real Time Computer Control-An Introduction”, 1998, Prentice Hall of India. | | | |
| 5. | C.M Krishna and Kang G. Shin, “Real-Time Systems”, 1997, McGraw-Hill International Editions. | | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | | |
| Recommended by Board of Studies | | 29-07-2022 | | |
| Approved by Academic Council | | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE625L | Fault Tolerant Systems | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To create an understanding of the fundamental concepts of fault-tolerance.
2. To gain knowledge of sources of faults and means for their prevention and forecasting.
3. To learn basic techniques for achieving fault-tolerance in hardware, information and software systems.
4. To develop skills in modeling and evaluating fault-tolerant architectures in terms of reliability, availability and safety.
5. To understand the merits and limitations of fault-tolerant design.

**Course Outcome**

1. Understand the risk of failures and their peculiarities with different system failures.
2. Be aware of the threat of software defects and human operator error as well as hardware failures.
3. Know the different forms of redundancy and their applicability to different classes of dependability requirements.
4. Be able to specify the use of fault tolerance in the design of application software.
5. Understand the relevant factors in evaluating alternative system designs for a specific set of requirements towards Industry perceptions.

| | | |
|---|---|---|
| **Module 1** | **Dependability Concepts** | **5 hours** |
| Dependable System - Techniques for Achieving Dependability- Dependability Measures – Fault – Error - Failure - Faults and their Manifestation - Classification of Faults and Failures. | | |
| **Module 2** | **Fault Tolerant Strategies** | **5 hours** |
| Fault Detection - Masking - Containment- Location - Reconfiguration and Recovery. | | |
| **Module 3** | **Fault Tolerant Design Techniques** | **5 hours** |
| Hardware Redundancy - Software Redundancy - Time Redundancy and Information Redundancy. | | |
| **Module 4** | **Hardware Fault-Tolerance** | **6 hours** |
| Canonical and Resilient Structures - Reliability Evaluation Techniques and Models - Processor level Fault Tolerance - Byzantine Failures and Agreements. | | |
| **Module 5** | **Information Redundancy** | **8 hours** |
| Error Detection/Correction Codes (Hamming, Parity, Checksum, Berger, Cyclic, Arithmetic) - Encoding/Decoding circuits - Resilient Disk Systems (RAID). | | |
| **Module 6** | **Software Fault-Tolerance** | **8 hours** |
| Single-Version Fault Tolerance - N-Version Programming; Recovery Approach - Exception and Conditional (Assert) Handling - Reliability Metrics and Models. | | |
| **Module 7** | **Fault Handling: Industry 4.0 and Cyber Physical Production Systems (CPPS)** | **6 hours** |
| Fault Handling in Industrial Automated Production Systems (aPS) - Development of Runtime Environments and their Domain Specific Challenges of Programming Languages for aPS. | | |
| **Module 8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture Hours** | **45 hours** |

**Text Book(s)**


1. Elena Dubrova; Fault-Tolerant Design; Springer, 2013
2. Israel Koren and C. Mani Krishna; Fault-Tolerant Systems; Morgan-Kaufman Publishers, 2007.

| **Reference Books** | | | |
|---|---|---|---|
| 1. | Michael R. Lyu; Handbook of Software Reliability Engineering; IEEE Computer Society Press (and McGraw-Hill), 1996. | | |
| 2. | Martin L. Shooman; Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design; John Wiley & Sons Inc., 2002. | | |
| 3. | Fault Tolerant Computer System design by D. K. Pradhan, Prentice Hall.(1996) | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | |
| Recommended by Board of Studies | 29-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE626L | Industry 4.0 | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the rudiments and overview of Industry 4.0.
2. To gain knowledge of Industry 4.0 architecture, Cyber-Physical Systems, and IoT framework.
3. To explore the transformation of industrial processes through modern technologies.
4. To understand the necessity of the human factor towards Industry 4.0 and its scope in various sectors.

**Course Outcome**

1. Understand the fundamentals and framework of Industrial 4.0.
2. Comprehend various architectures of Cyber-Physical Systems connecting Industrial 4.0.
3. Study the IoT technologies and framework to value Industry 4.0 and Operator 4.0.
4. Evaluate and design Cobot for automating industrial operations.
5. Make interface of human factors and realize the impact of Industry 4.0 across the sectors.

| Module 1 | Fundamentals of Industry 4.0 | 5 hours |
|---|---|---|
| Introduction - Definition - Key Paradigm – Evolution of Industry 4.0, Framework of Industry 4.0 - Nine Pillars - Macro and Micro Perspective of Industry 4.0 - Components - Design Principles - Reference Architecture Model Industry 4.0 (RAMI 4.0) | | |
| **Module 2** | **Industry 4.0 Architecture and Cyber-Physical Systems** | **5 hours** |
| Cyber-Physical Systems - CPS 5C Level Architecture - Implementation of 5C CPS Architecture in Factories - Classification of CPS in Context of Industry 4.0 - Operational Technology and Information Technology | | |
| **Module 3** | **Internet of Things** | **5 hours** |
| Internet of Things - IoT Technologies - IoT Framework - Architecture of IoT - Key Technologies involved in 5G for IoT - IoT Cloud Platforms – Ethics in IoT Technologies. | | |
| **Module 4** | **Operator 4.0** | **6 hours** |
| Augmented Reality - Wearable Devices - Wearable and Localization Devices - Sensors used in Wearable Devices. | | |
| **Module 5** | **Collaborative Robots (Cobot)** | **8 hours** |
| Introduction - Characteristics of Cobots - Cobots in Complex Environments - Working Alongside Humans - Level of Automation and Collaboration - Conflicts and Trust - Guidelines for Designing a Cobot - Cobots in Industry Operations - Cobots as Workforce - Applications of Cobots. | | |
| **Module 6** | **Human Factors in Industry 4.0** | **8 hours** |
| Interfaces of Industry 4.0 and Humans - Inclusion of Human Factor - Human Factor Specialist. | | |
| **Module 7** | **Industry 4.0 across the Sectors** | **6 hours** |
| Introduction - Transportation 4.0 - Logistics 4.0- Manufacturing 4.0 – Digital Twin- Case Studies: Smart Factories - Smart Cities - Smart Products. | | |
| **Module 8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture Hours** | **45 hours** |

**Text Book(s)**


1. Diego Galar Pascual, Pasquale Daponte, Uday Kumar, "Handbook Of Industry 4.0 and Smart Systems", CRC Press, 2020.
2. Peter Matthews, Steven Greenspan, "Automation and Collaborative Robotics: A Guide

| | | | | |
|---|---|---|---|---|
| | to the Future of Work", Apress Publisher, 2020 | | | |
| **Reference Books** | | | | |
| 1. | Jesús Hamilton Ortiz, Industry 4.0 Current Status and Future Trends, Intech open publisher, 2020. | | | |
| Mode of Evaluation: CAT / Assignment / Quiz / FAT | | | | |
| Recommended by Board of Studies | | 29-07-2022 | | |
| Approved by Academic Council | | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE698J | Internship I/ Dissertation I | | | | 10 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives:**

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation.

**Course Outcome:**

1. Considerably more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work.
2. The capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.
3. A consciousness of the ethical aspects of research and development work.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

**Module Content** **(Project duration: one semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Dissertation should be individual work.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

**Mode of Evaluation:** Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE699J | Internship II/ Dissertation II | | | | 12 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives:**

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

**Course Outcome:**

Upon successful completion of this course students will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing.
5. Synthesize the results and arrive at scientific conclusions / products / solution.
6. Document the results in the form of technical report / presentation.

**Module Content** **(Project duration: one semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Dissertation should be individual work.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

**Mode of Evaluation:** Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | 26-07-2022 | | |
| Approved by Academic Council | No. 67 | Date | 08-08-2022 |

| Course code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MFRE501L | Français Fonctionnel | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Demonstrate competence in reading, writing, and speaking basic French, including knowledge of vocabulary (related to profession, emotions, food, workplace, sports/hobbies, classroom and family).
2. Achieve proficiency in French culture oriented view point.

**Course Outcome**

At the end of the course, the student will be able to

1. Remember the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc.
2. Create communicative skill effectively in French language via regular / irregular verbs.
3. Demonstrate comprehension of the spoken / written language in translating simple sentences.
4. Understand and demonstrate the comprehension of some particular new range of unseen written materials.
5. Demonstrate a clear understanding of the French culture through the language studied.

| | | |
|---|---|---|
| **Module:1** | **Saluer, Se présenter, Etablir des contacts. Compétences en lecture - consulter un dictionnaire, appliquer des stratégies de lecture, lire pour comprendre.** | **9 hours** |

Les nombres cardinaux- Les 7 jours de la semaine-Les 12 mois de l'année- La date-Les saisons-Les Pronoms personnels sujets-Les Pronoms Toniques- La conjugaison des verbes réguliers- er / - ir /-re verbes (Le présent)- La conjugaison des verbes irréguliers- avoir /être / aller / venir / faire /vouloir /pouvoir etc.

*Savoir-faire pour:* saluer, et se présenter – épeler en français – communiquer en classe – utiliser des stratégies pour comprendre un texte en français.

| | | |
|---|---|---|
| **Module:2** | **Présenter quelqu'un, Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.** | **7 hours** |

La conjugaison des verbes Pronominaux (s'appeler/ s'amuser/ se promener)- La Négation- L'interrogation avec 'Est-ce que ou sans Est-ce que'- Répondez négativement.

| | | |
|---|---|---|
| **Module:3** | **Situer un objet ou un lieu, Poser des questions** | **6 hours** |

Les articles (défini/ indéfini)- Les prépositions (à/en/au/aux/sur/dans/avec etc.)- L'article contracté- L'heure- La Nationalité du Pays- Les professions- L'adjectif (La Couleur, l'adjectif possessif, l'adjectif démonstratif, l'adjectif interrogatif (quel/quelle/quels/quelles)- L'interrogation avec Comment/ Combien / Où etc., Pronoms relatifs simples (qui/que/dont/où).

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| **Module:4** | **Comprendre et traduire un texte court, Demander et indiquer le chemin.** | **5 hours** |

La traduction simple d'un texte/ dialogue :(français-anglais / anglais –français)

| | | |
|---|---|---|
| **Module:5** | **Trouver les questions, Répondre aux questions générales en français, Écouter des vidéos (site internet, YouTube) qui aident à améliorer leur prononciation/ vocabulaire et leurs compétences orales** | **6 hours** |

L'article Partitif (du/ de la / de l'/ des) -Faites une phrase avec les mots donnés- Mettez les phrases en ordre, masculin/féminin ; singulier/pluriel- Associez les phrases- les adverbes de temps (ensuite/hier/puis….)

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| **Module:6** | **Comment écrire un passage - développer des ompétences rédactionnelles. Discussion de groupe (donnez un sujet et demandez aux élèves de partager** | **5 hours** |

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|---|---|---|
| | **leurs idées)** | |
| Décrivez La Famille -La Maison -L'université -Les Loisirs-La Vie quotidienne- La ville natale- Un personnage célèbre | | |
| **Module:7** | **Comment écrire un dialogue** | **5 hours** |
| Dialogue<br>a) Réserver un billet de train<br>b) Entre deux amis qui se rencontrent au café<br>c) Parmi les membres de la famille<br>d) Entre le patient et le médecin<br>e) Entre le professeur et l'étudiant(e) | | |
| **Module:8** | **Contemporary Topics** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book(s)** | |
| 1. | Adomania 1, Méthode de français, CelineHimber, Corina Brillant, Sophie Erlich. Publisher HACHETTE, February 2016. |
| 2. | Enchanté 1 !, Méthode de français, Rachana Sagar Private Limited, Jan 2017. |
| **Reference Books** | |
| 1. | Le français pour vous 1, Méthode de français, VinodSikri, Anna Gabriel Koshy, Prozopublishing, Jan 2019. |
| 2. | Accueil 1, Méthode de français, Rachana Sagar Private Limited, January 2016 |
| 3. | Apprenons le français 1 Méthode de français, Mahitha Ranjit & Monica Singh, Jan 2019 |
| Modeof Evaluation **:** Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test | |

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| Recommended by Board of Studies | 19-05-2022 | | |
| Approved by Academic Council | No. 66 | Date | 16-06-2022 |

| Course code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MGER501L | Deutsch für Anfänger | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. Demonstrate competency in reading, writing and speaking in Basic German.
2. Achieve proficiency in German culture oriented view point.
3. Develop basic vocabulary in the technical field.

**Course Outcome**

At the end of the course, the student will be able to

1. Communicate in German language in their daily life communicative situations.
2. Apply the German language skill in writing corresponding letters, E-Mailsetc.
3. Create the talent of translating passages from English-German and vice versa and to
   frame simple **dialogues** based on given situations.
4. Understand and demonstrate the comprehension of some particular new range of unseen
   written materials.
5. Develop a general understanding of German culture and society.

| Module:1 | Die erste Begegnung | 6 hours |
|---|---|---|

Einleitung, Begrüssungs formen, Länder und Sprachen, Alphabet, Buchstabieren, Personalpronomen, Zahlen (1-100), Telefonnummer und E-Mail Addressenennen W-fragen, Aussagesätze, Nomen – Singular und Plural und Artikel

**Lernziel:**

Verständnisvon Deutsch, Genus- Artikelwörter

| Module:2 | Hobbys und Berufe | 6 hours |
|---|---|---|

Über Hobbyssprechen, Wochentage, Jahreszeiten, und Monatenennen, Uhrzeitensagen, über Arbeit, Berufe und Arbeitszeitensprechen, Zahlen (Hundertbiseine Million) Aritel (bestimmter, unbestimmter), Plural der Substantive, Konjugation der Verben (regelmässig /unregelmässig), Ja-/Nein- Frage, Imperativmit Sie.

**Lernziel :**

Sätzeschreiben, überHobbyserzählen, über Berufesprechenusw.

| Module:3 | Alltag und Familie | 7 hours |
|---|---|---|

Über die Familiesprechen, eineWohnungbeschreiben, Tagesablaufschreiben, Mahlzeiten, Lebensmittel, Getränke Possessivpronomen, Negation, Kasus- Akkusativ und Dativ (bestimmter, unbestimmterArtikel), trennnbareverben, Modalverben, Adjektive, Präpositionen

**Lernziel :**

Sätzemit Modalverben, Verwendung von Artikel, über Familiesprechen, eine Wohnungbeschreiben.

| Module:4 | Situations gespräche | 6 hours |
|---|---|---|

**Dialoge:**

a) Gespräche mit Familienmitgliedern, am Bahnhof,
b) Gespräche beim Einkaufen, in einem Supermarkt, in einer Buchhandlung
c) Gespräche in einem Hotel/ in einem Restaurant, Treffen im Cáfe, Termin beim Arzt.

| Module:5 | Korrespondenz | 6 hours |
|---|---|---|

Leseverständnis, Mindmapmachen, Korrespondenz- Briefe, Postkarten, E-Mail

**Lernziel :**

Wortschatzbildung und aktiverSprachgebrauch

| Module:6 | Aufsatzschreiben | 6 hours |
|---|---|---|

**Aufsätze :**

Meine Universität, Das Essen, mein Freund odermeine Freundin, meine Familie, einFest in Deutschlandusw.

| Module:7 | Übersetzungen | 6 hours |
|---|---|---|

Übersetzungen : (Deutsch – Englisch / Englisch –Deutsch)

**Lernziel :**

| | | |
|---|---|---|
| Grammatik – Wortschatz – Übung | | |
| **Module:8** | **Trainierung den Sprachfähigkeiten** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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| **Text Book(s)** | |
| 1. | Netzwerk A1, Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Ernst Klett Sprachen GmbH, Stuttgart, 2017 |
| **Reference Books** | |
| 1. | Studio d A1 Deutsch als Fremdsprache, Hermann Funk, Christina Kuhn, Silke Demme: Heuber Verlag, Muenchen, 2012. |
| 2. | Lagune ,Hartmut Aufderstrasse, Jutta Müller, Thomas Storz,. Muenchen, 2012 |
| 3. | Deutsche SprachlehrefürAusländer, Heinz Griesbach, Dora Schulz, 2011, Berlin |
| 4. | Themen Aktuell 1, Hartmurt Aufderstrasse, Heiko Bock, MechthildGerdes, Jutta Müller und Helmut Müller, 2010, Muenchen. |
| | www.goethe.de<br>wirtschaftsdeutsch.de<br>hueber.de, klett-sprachen.de<br>www.deutschtraning.org |

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|---|---|---|---|
| Mode of Evaluation **:** Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test | | | |
| Recommended by Board of Studies | 19-05-2022 | | |
| Approved by Academic Council | No.66 | Date | 16-06-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MSTS601L | Advanced Competitive Coding | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1. To understand the basic concepts of data structures and algorithm.
2. To develop the step by step approach in solving problems with the help programming techniques of data structures.
3. To deploy algorithms in real time applications.

**Course Outcomes**

At the end of the course the student should be able to

1. Provide a basic understanding of core Java concepts
2. Use linear and non-linear data structures to solve practical problems.
3. Identify Bitwise algorithms for solving real world problems.
4. Illustrate various techniques for searching, sorting and hashing
5. Understand and implement Dynamic Programming.
6. Design new algorithms or modify existing algorithms for new application.

| Module:1 | Algorithms | 6 hours |
|---|---|---|

Java Introduction, Features, Structure, Data Types, Basic I/O Operators, Decision making and Control structure, Time & Space complexity

| Module:2 | Math based problems and Bitwise algorithms | 6 hours |
|---|---|---|

Simple Sieve, Segmented & Incremental Sieve, Euler's phi Algorithm, Strobogrammatic Number, Remainder Theorem, Toggle the switch & Alice Apple tree, Binary Palindrome, Booth's Algorithm, Euclid's Algorithm, Karatsuba Algorithm, Longest Sequence of 1 after flipping a bit Swap two nibbles in a byte.

| Module:3 | Arrays , Searching, Sorting and Strings | 6 hours |
|---|---|---|

Block Swap Algorithm , Max product subarray, Maximum sum of hour glass in matrix ,Max Equilibrium Sum ,Leaders in array, Majority element, Lexicographically first palindromic string, Natural Sort order , Weightes substring ,Move hyphen to beginning, Manacher's Algorithm

| Module:4 | Recursion, Back tracking, Greedy Algorithm | 6 hours |
|---|---|---|

Sorted Unique Permutation, Maneuvering, Combination, Josephus trap, Maze Solving, N Queens Problem, Warnsdorff's Algorithm, Hamiltonian Cycle, Kruskal's Algorithm ,Activity Selection Problem, Graph Coloring, Huffman Coding

| Module:5 | Dynamic Programming | 6 hours |
|---|---|---|

Longest Common Subsequence ,Longest Increasing Subsequence , Longest Bitonic Subsequence ,Longest Palindromic Subsequence ,Subset sum problem ,0-1 Knapsack, Traveling Salesman, Coin Change, Shortest Common, Supersequence, Levenshtein Distance problem, Rod Cutting problem, Wildcard pattern matching , Pots of gold game

| Module:6 | Linked list, Stack, Queue | 6 hours |
|---|---|---|

Loop Detection, Sort the bitonic DLL, Segregate even & odd nodes in a LL , Merge sort for DLL ,Minimum Stack, The Celebrity problem, Iterative Tower of Hanoi Stock

| | | |
|---|---|---|
| Span problem, Priority Queue using DLL, Sort without extra Space, Max Sliding Window, Stack permutations | | |
| **Module:7** | **Trees, Graphs , Heaps, Maps** | **6 hours** |
| Recover the BST, Views of tree Vertical order traversal ,Boundary traversal, BFS, DFS, Dial's Algorithm ,Bellman-Ford Algorithm, Topological Sort ,Heap Sort Binomial heap, K-array heap, Winner tree, Hash Map to Tree Map. | | |
| **Module:8** | **Interview Preparation** | **3 hours** |
| Networking, Security, Operating Systems, Data Base Management Systems. | | |
| **Total Lecture hours** | | **45 hours** |

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| **Text Book** | |
| 1. | Mark Allen Weiss, “Data structures and algorithm analysis in C++”, 2019, 4th Edition, Pearson Education. |
| **Reference Books** | |
| 1. | J.P. Tremblay and P.G. Sorenson, “An Introduction to Data Structures with applications”, 2017, Second Edition, Tata Mc Graw Hill. |
| 2. | Richard M. Reese, Jennifer L. Reese, Alexey Grigorev, Java: Data Science Made Easy, 2019 Pocket Publishing. |
| Mode of Evaluation: CAT, Written assignment, Quiz, Project & FAT. | |

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|---|---|---|---|
| Recommended by Board of Studies | 24-02-2023 | | |
| Approved by Academic Council | No. 69 | Date | 16-03-2023 |

| Course code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MENG501P | Technical Report Writing | 0 | 0 | 4 | 2 |
| Pre-requisite | Nil | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives**

1.To develop writing skills for preparing technical reports.
2. To analyze and evaluate general and complex technical information.
3. To enable proficiency in drafting and presenting reports.

**Course Outcome**

At the end of the course, the student will be able to
1.Construct error free sentences using appropriate grammar, vocabulary and style.
2. Apply the advanced rules of grammar for proofreading reports.
3. Interpret information and concepts in preparing reports.
4. Demonstrate the structure and function of technical reports.
5. Improve the ability of presenting technical reports.

| Indicative Experiments | |
|---|---|
| 1. | **Basics of Technical Communication**<br>General and Technical communication,<br>Process of communication, Levels of communication |
| 2. | **Vocabulary& Editing**<br>Word usage: confusing words, Phrasal verbs<br>Punctuation and Proof reading |
| 3. | **Advanced Grammar**<br>Shifts: Voice, Tense, Person, Number<br>Clarity: Pronoun reference, Misplace and unclear modifiers |
| 4. | **Elements of Technical writing**<br>Developing paragraphs, Eliminating unnecessary words, Avoiding clichés and slang<br>Sentence clarity and combining |
| 5. | **The Art of condensation**<br>Steps to effective precis writing,<br>Paraphrasing and summarizing |
| 6. | **Technical Reports:** Meaning, Objectives, Characteristics and Categories |
| 7. | **Formats of reports and Prewriting**: purpose, audience, sources of information, organizing the material |
| 8. | **Data Visualization**<br>Interpreting Data - Graphs - Tables – Charts - Imagery - Info graphics |
| 9. | **Systematization of Information:** Preparing Questionnaire<br>Techniques to Converge Objective-Oriented data in Diverse Technical Reports |
| 10. | **Research and Analyses:** Writing introduction and literature review, Reference styles, Synchronize Technical Details from Magazines, Articles and e-content |
| 11.. | **Structure of Reports**<br>Title – Preface – Acknowledgement - Abstract/Summary – Introduction - Materials and Methods – Results – Discussion - Conclusion - Suggestions/Recommendations |
| 12. | **Writing the Report:** First draft, Revising,<br>Thesis statement, Developing unity and coherence |
| 13. | **Writing scientific abstracts:** Parts of the abstract, Revising the abstract<br>Avoiding Plagiarism, Best practices for writers |
| 14. | **Supplementary Texts**<br>Appendix – Index – Glossary – References – Bibliography - Notes |
| 15 | **Presentation** |

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|---|---|---|---|---|
| | Presenting Technical Reports<br>Planning, creating anddigital presentation of reports | | | |
| | | | **Total Laboratory hours :** | **60 hours** |
| **Text Book(s)** | | | | |
| 1. | Raman, Meenakshi and Sangeeta Sharma, (2015).Technical Communication: Principles and Practice, Third edition, Oxford University Press, New Delhi. | | | |
| **Reference Books** | | | | |
| 1. | Aruna, Koneru, (2020). English Language Skills for Engineers. McGraw Hill Education, Noida. | | | |
| 2. | Rizvi,M. Ashraf (2018)Effective Technical Communication Second Edition. McGraw Hill Education, Chennai. | | | |
| 3. | Kumar, Sanjay and Pushpalatha, (2018). English Language and Communication Skills for Engineers, Oxford University Press. | | | |
| 4. | Elizabeth Tebeaux and Sam Dragga, (2020).The Essentials of Technical Communication, Fifth Edition, Oxford University Press. | | | |
| Mode of Evaluation **:** Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test | | | | |
| Recommended by Board of Studies | 19-05-2022 | | | |
| Approved by Academic Council | No. 66 | Date | 16-06-2022 | |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MSTS501P | Qualitative Skills Practice | 0 | 0 | 3 | 1.5 |
| Pre-requisite | Nil | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives:**

1. To develop the quantitative ability for solving basic level problems.
2. To improve the verbal and professional communication skills.

**Course Outcome:**

At the end of the course, the student will be able to

1. Execute appropriate analytical skills.
2. Solve problems pertaining to quantitative and reasoning ability.
3. Learn better vocabulary for workplace communication.
4. Demonstrate appropriate behavior in an organized environment.

| | | |
|---|---|---|
| **Module:1** | **Business Etiquette: Social and Cultural Etiquette; Writing Company Blogs; Internal Communications and Planning: Writing press release and meeting notes** | **9 hours** |

Value, Manners- Netiquette, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information,. Analysis, Determining, Selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph., Body– Make it relevant to your audience.

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| **Module:2** | **Time management skills** | **3 hours** |

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, Working under pressure and adhering to deadlines

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| **Module:3** | **Presentation skills – Preparing presentation; Organizing materials; Maintaining and preparing visual aids; Dealing with questions** | **7 hours** |

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions.

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|---|---|---|
| **Module:4** | **QuantitativeAbility-L1–Numberproperties; Averages; Progressions; Percentages; Ratios** | **11 hours** |

Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, increase and Decrease or Successive increase, Types of ratios and proportions.

| | | |
|---|---|---|
| **Module:5** | **Reasoning Ability - L1 – Analytical Reasoning** | **8 hours** |

Data Arrangement (Linear and circular & Cross Variable Relationship), Blood Relations, Ordering / ranking / grouping, Puzzle test, Selection Decision table.

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| **Module:6** | **Verbal Ability -L1 – Vocabulary Building** | **7 hours** |

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| Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies. | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |
| **Reference Books** | | |
| 1. | Kerry Patterson, Joseph Grenny, Ron McMillan and Al Switzler, (2017).2nd Edition, Crucial Conversations: Tools for Talking when Stakesare High .McGraw-Hill Contemporary, Bangalore. | |
| 2. | Dale Carnegie,(2016).How to Win Friends and Influence People. Gallery Books, New York. | |
| 3. | Scott Peck. M, (2003). Road Less Travelled. Bantam Press, New York City. | |
| 4. | SMART, (2018). Place Mentor, 1st edition. Oxford University Press, Chennai. | |
| 5. | FACE, (2016). Aptipedia Aptitude Encyclopedia. Wiley publications, Delhi. | |
| 6. | ETHNUS, (2013). Aptimithra. McGraw – Hill Education Pvt .Ltd, Bangalore. | |
| **Websites:** | | |
| 1. | **www.chalkstreet.com** | |
| 2. | **www.skillsyouneed.com** | |
| 3. | **www.mindtools.com** | |
| 4. | **www.thebalance.com** | |
| 5. | **www.eguru.ooo** | |
| Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test | | |
| Recommended by Board of Studies | 19-05-2022 | |
| Approved by Academic Council | No.66 | Date 16-06-2022 |

| Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|
| MSTS502P | Quantitative Skills Practice | 0 | 0 | 3 | 1.5 |
| Pre-requisite | Nil | Syllabus version | | | |
| | | 1.0 | | | |

**Course Objectives:**

1. To develop the students' advanced problem solving skills.
2. To enhance critical thinking and innovative skills.

**Course Outcome:**

At the end of the course, the student will be able to

1. Create positive impression during official conversations and interviews.
2. Demonstrate comprehending skills of various texts.
3. Improve advanced level thinking ability in general aptitude.
4. Develop emotional stability to tackle difficult circumstances.

| | | |
|---|---|---|
| **Module:1** | **Resume skills – Resume Template; Use of power verbs; Types of resume; Customizing resume** | **2 hours** |

Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout-Understanding different company's requirement, Digitizing career portfolio.

| | | |
|---|---|---|
| **Module:2** | **Interview skills – Types of interview; Techniques to face remote interviews and Mock Interview** | **3 hours** |

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview, Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds.

| | | |
|---|---|---|
| **Module:3** | **Emotional Intelligence - L1 – Transactional Analysis; Brain storming; Psychometric Analysis; SWOT analysis** | **12 hours** |

Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure ,Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways, SWOT analysis.

| | | |
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| **Module:4** | **Quantitative Ability - L3–Permutation - Combinations; Probability; Geometry and menstruation; Trigonometry; Logarithms; Functions; Quadratic Equations; Set Theory** | **14 hours** |

Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations, Basic concepts of Venn Diagram.

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| **Module:5** | **Reasoning ability - L3 – Logical reasoning; Data Analysis and Interpretation** | **7 hours** |

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| Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data Interpretation-Advanced, Interpretation tables, pie charts & bar chats. | | |
| | | |
| **Module:6** | **Verbal Ability - L3 – Comprehension and Critical reasoning** | **7 hours** |
| Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument. | | |
| | | |
| | **Total Lecture hours:** | **45 hours** |

**Reference Books**

| | |
|---|---|
| 1. | Michael Farra and JIST Editors,(2011).Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Jist Works, Saint Paul, Minnesota. |
| 2. | Flage Daniel E, (2003).The Art of Questioning: An Introduction to Critical Thinking. Pearson, London. |
| 3. | David Allen, (2015).Getting Things done: The Art of Stress-Free productivity. Penguin Books, New York City. |
| 4. | SMART, (2018). Place Mentor 1st edition. Oxford University Press, Chennai. |
| 5. | FACE, (2016).Aptipedia Aptitude Encyclopedia. Wileypublications, Delhi. |
| 6. | ETHNUS, (2013).Aptimithra. McGraw-Hill Education Pvt Ltd, Bangalore. |

**Websites:**

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|---|---|
| 1. | www.chalkstreet.com |
| 2. | www.skillsyouneed.com |
| 3. | www.mindtools.com |
| 4. | www.thebalance.com |
| 5. | www.eguru.ooo |

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| Mode of Evaluation: Continuous Assessment Tests, Quizzes, Assignment, Final Assessment Test | | | |
| Recommended by Board of Studies | 19-05- 2022 | | |
| Approved by Academic Council | No.66 | Date | 16-06-2022 |