
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 (Information Security)**

# School of Computer Science and Engineering

## M.Tech. Computer Science and Engineering (Information Security)

## CURRICULUM AND SYLLABUS

## (2023-24 Admitted Students)

VIT®
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## VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

## MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

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

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

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

**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 and compassion.

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

To be a world-renowned centre of education, research and service in computing and allied 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, academia and society.

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# School of Computer Science and Engineering

**M.Tech (CSE) - Specialization in Information Security**

## PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

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

2. Graduates will function as successful practising engineer / researcher / teacher / entrepreneur in 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
# Specialization in Information Security

## 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 toanalyze 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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# School of Computer Science and Engineering

## M.Tech (CSE) - Specialization in Information Security

## PROGRAMME SPECIFIC OUTCOMES (PSOs)

1. The 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. The ability to investigate and analyze using appropriate methodologies as well as security principles and apply ethically acceptable security solutions to mitigate cyber security threats.

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
# Specialization in Information Security

## CREDIT STRUCTURE

## Category-wise Credit distribution

| | |
|---|---|
| **Discipline Core** | **24** |
| **Specialization Elective** | **12** |
| **Projects and Internship** | **26** |
| **Open Elective** | **3** |
| **Skill Enhancement** | **5** |
| **Total Credits** | **70** |

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**CURRICULUM**

**M.Tech.-CSE (Information Security) - (2023)**

| Discipline Core | Specialization Elective | Projects and Internship | Open Elective | Skill Enhancement | Total Credits |
|---|---|---|---|---|---|
| 24 | 12 | 26 | 3 | 5 | **70** |

## Discipline Core

| S. No. | Course Code | Course Title | Course Type | Version | L | T | P | J | C |
|---|---|---|---|---|---|---|---|---|---|
| 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 |

## Specialization Elective

| S. No. | Course Code | Course Title | Course Type | Version | L | T | P | J | C |
|---|---|---|---|---|---|---|---|---|---|
| 1 | MCSE608L | Information Security and Risk Management | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 2 | MCSE609L | Cryptosystems | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 3 | MCSE609P | Cryptosystems Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 4 | MCSE610L | Penetration Testing and Vulnerability Assessment | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 5 | MCSE610P | Penetration Testing and Vulnerability Assessment Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 6 | MCSE611L | Malware Analysis | Theory Only | 1.0 | 2 | 0 | 0 | 0 | 2.0 |
| 7 | MCSE611P | Malware Analysis Lab | Lab Only | 1.0 | 0 | 0 | 2 | 0 | 1.0 |
| 8 | MCSE612L | Cyber Security | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |
| 9 | MCSE613L | Digital Forensics | Theory Only | 1.0 | 3 | 0 | 0 | 0 | 3.0 |

## Projects and Internship

| S. No. | Course Code | Course Title | Course Type | Version | L | T | P | J | C |
|---|---|---|---|---|---|---|---|---|---|
| 1 | MCSE696J | Study Oriented Project | PROJECT | 1.0 | 0 | 0 | 0 | 0 | 2.0 |
| 2 | MCSE697J | Design Project | PROJECT | 1.0 | 0 | 0 | 0 | 0 | 2.0 |
| 3 | MCSE698J | Internship I/ Dissertation I | PROJECT | 1.0 | 0 | 0 | 0 | 0 | 10.0 |
| 4 | MCSE699J | Internship II/ Dissertation II | PROJECT | 1.0 | 0 | 0 | 0 | 0 | 12.0 |

## Open Elective

| S. No. | Course Code | Course Title | Course Type | Version | L | T | P | J | C |
|---|---|---|---|---|---|---|---|---|---|
| 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

| S. No. | Course Code | Course Title | Course Type | Version | L | T | P | J | C |
|---|---|---|---|---|---|---|---|---|---|
| 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 |

# Discipline Core

| Course code | Course title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE501L | Data Structures and Algorithms | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | | | Syllabus version | |
| | | | | v. 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**

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

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 | | | |
| | | v. 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**

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

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 | | | |
| | | v. 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 | | | |
| | | v. 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. |

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|---|---|---|---|
| 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 Organization | 3 | 0 | 0 | 3 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | v. 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**

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

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 | 7 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 Organization LAB | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | v. 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**

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

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 | | | |
| | | v. 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**

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

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. | | |
| 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 | | | |
| | | v. 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**

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

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 | |
| | | | | v. 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**

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

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 |

| | | | |
|---|---|---|---|
| **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 | | | |
| 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 | | | |
| | | v. 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**

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

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. |

**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 | | | |
| | | v. 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 | | | | |
| 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 | | | |
| | | v. 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**

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

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<br>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 |

# Discipline Elective

| Course code | INFORMATION SECURITY AND RISK MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| MCSE608L | | 3 | 0 | 0 | 3 |
| Pre-requisite | Nil | Syllabus version | | | |
| | | v.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 | CRYPTOSYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| MCSE609L | | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | v.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 | CRYPTOSYSTEMS LAB | L | T | P | C |
|---|---|---|---|---|---|
| MCSE609P | | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | v.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 |

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|---|---|---|
| | **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 |

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|---|---|---|---|
| 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 | PENETRATION TESTING AND VULNERABILITY ASSESSMENT | L | T | P | C |
|---|---|---|---|---|---|
| MCSE610L | | 2 | 0 | 0 | 2 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | v.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.

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| **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.

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|---|---|---|
| **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.

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| **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.

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

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|---|---|---|---|
| **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 | PENETRATION TESTING AND VULNERABILITY ASSESSMENT LAB | L | T | P | C |
|---|---|---|---|---|---|
| MCSE610P | | 0 | 0 | 2 | 1 |
| Pre-requisite | | Syllabus version | | | |
| | | v.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

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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 |
|---|---|---|---|---|---|
| MCSE611L | **Malware Analysis** | 2 | 0 | 0 | 2 |
| **Pre-requisite** | **NIL** | | | **Syllabus version** | |
| | | | | v.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** |

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|---|---|---|---|
| **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. | Date | |

| Course code | Course title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE611P | **Malware Analysis Lab** | 0 | 0 | 2 | 1 |
| Pre-requisite | NIL | Syllabus version | | | |
| | | v. 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 Outcome**

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<br>• obfuscation and de-obfuscation of the malware using CFF explorer | 3 hours |

| | | |
|---|---|---|
| 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. : 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. | Date | |

| Course code | Course title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE612L | **Cyber Security** | 3 | 0 | 0 | 3 |
| **Pre-requisite** | **Nil** | | | **Syllabus version** | |
| | | | | v. 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 Outcome**

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).

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|---|---|---|
| **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.

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|---|---|---|
| **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.

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| **Module:5** | **Cyber Security Tools** | **6 hours** |

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.

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| **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.

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|---|---|---|
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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

| Course code | Course title | L | T | P | C |
|---|---|---|---|---|---|
| MCSE613L | **Digital Forensics** | 3 | 0 | 0 | 3 |
| **Pre-requisite** | | | | **Syllabus version** | |
| | | | | v.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: 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 | | | |
| Recommended by Board of Studies | 18-11-2022 | | |
| Approved by Academic Council | No. | Date | |