|  |
| --- |
|  |
| **ADAMAS UNIVERSITY** |
|  |
| **SCHOOL OF ENGINEERING  AND TECHNOLOGY** |
|  |
| **DEPARTMENT OF  COMPUTER SCIENCE AND ENGINEERING** |
|  |
| **POSTGRADUATE PROGRAM** |
|  |
| **Course Structure and Syllabus** |
|  |
| **M. Tech (Computer Science and Engineering)** |
|  |
| **W.e.f. AY 2022-23** |

|  |
| --- |
|  |
|  |
| **ADAMAS UNIVERSITY, KOLKATA**  **SCHOOL OF ENGINEERING AND TECHNOLOGY**  **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING** |
|  |
| **VISION OF THE UNIVERSITY** |
|  |
| To be an internationally recognized university through excellence in inter-disciplinary education, research and innovation, preparing socially responsible well-grounded individuals contributing to nation building. |
|  |
| **MISSION STATEMENTS OF THE UNIVERSITY** |
|  |
| **M.S 01:** Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology  **M.S 02:** Foster outcomes based education system for continuous improvement in education, research and all allied activities  **M.S 03:** Instill the notion of lifelong learning through culture of research and innovation  **M.S 04:** Collaborate with industries, research centres and professional bodies to stay relevant and up-to-date  **M.S 05:** Inculcate ethical principles and develop understanding of environmental and social realities |
|  |
| **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  **CHANCELLOR / VICE CHANCELLOR** |

|  |
| --- |
|  |
|  |
| **ADAMAS UNIVERSITY, KOLKATA**  **SCHOOL OF ENGINEERING AND TECHNOLOGY**  **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING** |
|  |
| **VISION OF THE SCHOOL** |
|  |
| To develop well-grounded, socially responsible engineers and technocrats in a way to create a transformative impact on Indian society through continual innovation in education, research, creativity and entrepreneurship. |
|  |
| **MISSION STATEMENTS OF THE SCHOOL** |
|  |
| **M.S. 01:** Build a transformative educational experience through disciplinary and inter-disciplinary knowledge, problem solving, and communication and leadership skills.  **M.S. 02:** Develop a collaborative environment open to the free exchange of ideas, where research, creativity, innovation and entrepreneurship can flourish among individual students.  **M.S. 03:** Impact society in a transformative way – regionally and nationally - by engaging with partners outside the borders of the university campus.  **M.S. 04:** Promote outreach programs which strives to inculcate ethical standards and good character in the minds of young professionals. |
|  |
| **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**  **DEAN / SCHOOL CONCERNED** |

|  |  |
| --- | --- |
|  | |
|  | |
| **ADAMAS UNIVERSITY, KOLKATA**  **SCHOOL OF ENGINEERING AND TECHNOLOGY**  **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING** | |
|  | |
| **VISION OF THE DEPARTMENT** | |
|  | |
| Graduates of the Department of Computer Science and Engineering will be recognized as innovative leaders in the fields of computer science and software engineering. This recognition will come from their work in software development in a myriad of application areas, as well as through their work in advanced study and research. The faculty is, and will continue to be, known for their passion for teaching and for their knowledge, expertise, and innovation in advancing the frontiers of knowledge in computer science and software engineering. | |
|  | |
| **MISSION STATEMENTS OF THE DEPARTMENT** | |
|  | |
| **M.S 01:** Our mission is to teach and prepare liberally educated, articulate, and skilled computer scientists and software engineers for leadership and professional careers and for advanced study.  **M.S 02:** A central objective of our program is to contribute to society by advancing the fields of computer science and software engineering through innovations in teaching and research, thus enhancing student knowledge through interactive instruction, global engagement, and experiential learning.  **M.S 03:** The program will serve as a resource to inform society about innovations related to the production and uses of computers and software.  **M.S 04:** To impart moral and ethical values, and interpersonal skills to the students. | |
|  | |
| **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ HEAD OF THE DEPARTMENT** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DEAN / SCHOOL CONCERNED** |

|  |  |
| --- | --- |
|  | |
|  | |
| **ADAMAS UNIVERSITY, KOLKATA**  **SCHOOL OF ENGINEERING AND TECHNOLOGY**  **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING** | |
|  | |
| **Name of the Programme: M.Tech (Computer Science and Engineering)** | |
| **PROGRAMME EDUCATIONAL OBJECTIVES (PEO)** | |
| **PEO 01:** To prepare professionals who will have successful career in industries, academia, research and entrepreneurial endeavors.  **PEO 02:** To prepare graduates who will demonstrate analytical, research, design and implementation skills offering techno-commercially feasible and socially acceptable solutions to real life problems.  **PEO 03:** To prepare graduates who will thrive to pursue life-long learning and contribute to society as an ethical and responsible citizen. | |
|  | |
|  | |
|  | |
| **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ HEAD OF THE DEPARTMENT** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DEAN / SCHOOL CONCERNED** |

|  |  |
| --- | --- |
|  | |
|  | |
| **ADAMAS UNIVERSITY, KOLKATA**  **SCHOOL OF ENGINEERING AND TECHNOLOGY**  **DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING** | |
|  | |
| **Name of the Programme: M.Tech (Computer Science and Engineering)** | |
| **GRADUATE ATTRIBUTES/PROGRAMME OUTCOMES** | |
| **GA 01 / PO 01: Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.  **GA 02 / PO 02: Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching sustained conclusions using first principles of mathematics, natural sciences, and engineering sciences.  **GA 03 / PO 03: Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.  **GA 04 / PO 04: Conduct Investigations of Complex Computing Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.  **GA 05 / PO 05: Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.  **GA 06 / PO 06: The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.  **GA 07 / PO 07: Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.  **GA 08 / PO 08: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.  **GA 09 / PO 09:Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.  **GA 10 / PO 10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.  **GA 11 / PO 11: Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.  **GA 12 / PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.** | |
| **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ HEAD OF THE DEPARTMENT** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ DEAN / SCHOOL CONCERNED** |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | |
| **ADAMAS UNIVERSITY SCHOOL OF ENGINEERING AND TECHNOLOGY DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING PG Program: M.Tech (Computer Science and Engineering)**  **COURSE STRUCTURE** | | | | | | | |
|  | | | | | | | |
| **FIRST YEAR** | | | | | | | |
| **SEMESTER I** | | | | | | | |
| **S.No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **H** | **C** |
| 1 | CSE21841 | Advanced Database Management systems | 3 | 0 | 0 | 3 | 3 |
| 2 | CSE21842 | Soft Computing | 3 | 0 | 0 | 3 | 3 |
| 3 | CSE21843 | Advanced Graph Theory | 3 | 0 | 0 | 3 | 3 |
| 4 | CSE21844 | Foundation of Computer Science | 3 | 1 | 0 | 3 | 4 |
| 5 | CSE22845 | Applied Computing Lab -I | 3 | 0 | 2 | 3 | 2 |
| **Total** | | | **12** | **1** | **2** | **15** | **15** |
|  |  |  |  |  |  |  |  |
| **SEMESTER II** | | | | | | | |
| **S.No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **H** | **C** |
| 1 |  | Elective – I | 3 | 0 | 0 | 0 | 3 |
| CSE21846 | Blockchain and Cryptocurrency |
| CSE21847 | Software Process Management |
| CSE21848 | Natural Language Processing |
| 2 |  | Elective – II | 3 | 0 | 0 | 0 | 3 |
| CSE21849 | Computer Forensics |
| CSE21850 | Software Architecture |
| CSE21851 | Computer Vision |
| 3 |  | Elective – III | 3 | 0 | 0 | 0 | 3 |
| CSE21852 | Introduction to Information Security Management |
| CSE21853 | Software Security |
| CSE21854 | Social Network Analysis |
| 4 | CSE21855 | Research Methodologies | 2 | 0 | 0 | 2 | 2 |
| 5 | CSE21856 | Parallel and Distributed Computing | 3 | 0 | 0 | 3 | 3 |
| 6 | CSE22857 | Applied Computing Lab-II | 0 | 0 | 2 | 2 | 3 |
| **Total** | | | **14** | **0** | **2** | **16** | **17** |
|  |  |  |  |  |  |  |  |
| **1st Year Credits = 32** | | | | | | | |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **SECOND YEAR** | | | | | | | |
| **SEMESTER III** | | | | | | | |
| **S.No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **H** | **C** |
| 1 |  | Elective – IV | 3 | 0 | 0 | 3 | 3 |
| CSE21858 | Advanced Network Security |
| CSE21859 | Data Mining |
| CSE21860 | Computational Biology |
| 2 | CSE25861 | Thesis – I | 0 | 0 | 24 | 24 | 16 |
| 3 | CSE25862 | Seminar – I | 0 | 0 | 6 | 6 | 4 |
| **Total** | | | **3** | **0** | **30** | **33** | **23** |
|  | | | | | | | |
| **SEMESTER IV** | | | | | | | |
| **S.No.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **H** | **C** |
| 1 | CSE25863 | Thesis-II | 0 | 0 | 27 | 27 | 18 |
| 2 | CSE25864 | Seminar-II | 0 | 0 | 6 | 6 | 3 |
| 3 | CSE25865 | Grand Viva | 0 | 0 | 0 | 0 | 4 |
| **Total** | | | **0** | **0** | **33** | **33** | **26** |

**2nd Year Credits Total : 49**

**CREDIT DISTRIBUTION (SEMESTER-WISE)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SEM I** | **SEM II** | **SEM III** | **SEM IV** | **TOTAL** |
| **15** | **17** | **23** | **26** | **81** |

**CREDIT DISTRIBUTION (YEAR-WISE)**

|  |  |  |
| --- | --- | --- |
| **YEAR I** | **YEAR II** | **Total** |
| **32** | **49** | **81** |

**Year- I**

**Semester-I**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21841** | **Advanced Database Management systems** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **Database Management systems** | | | | |
| **Co-requisite** | **NA** | | | | |

**Course Objectives:**

1. To learn different types of databases.
2. To be exposed to query languages.
3. To be familiar with the indexing techniques.

**Course Outcomes:**

On the completion of this course the student will be able to

1. **Understand** the different types of databases.
2. **Illustrate** the concepts of Use query languages.
3. **Apply** indexing techniques.
4. **Examine** case studies on design database.

**Course Description:**

Database management systems are at the core of computer applications that need to store, manipulate, and query data. This course takes a deep dive into how modern database systems function internally, from studying their high-level design to understanding the underlying data structures and algorithms used for efficient data processing. The course covers a range of data management techniques from both commercial systems and cutting-edge research literature, enabling students to apply these techniques to other fields of computer science.

The covered topics include database architecture, storage manager, data models (row, columnar), indexing (tree-based, hash tables), transaction processing (ACID, concurrency control), crash recovery, parallel architectures (multi-core, distributed), cloud databases, and ML in databases. These topics will be valuable to students who plan to work in the data science industry but also to students who want to do research in the area of data management. The programming component of this course will allow students to develop first-hand experience working with database systems that goes beyond writing SQL queries. **Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| **PARALLEL AND DISTRIBUTED DATABASES**  Inter and Intra Query Parallelism – Architecture – Query evaluation – Optimization – Distributed Architecture – Storage – Catalog Management – Query Processing - Transactions – Recovery - Large-scale Data Analytics in the Internet Context – Map Reduce Paradigm - run-time system for supporting scalable and fault-tolerant execution - paradigms: Pig Latin and Hive and parallel  databases versus Map Reduce. | |
| **Unit-II** | **9 Lecture Hours** |
| **ACTIVE DATABASES**  Syntax and Sematics (Starburst, Oracle, DB2) – Taxonomy – Applications – Integrity Management – Workflow Management – Business Rules – Design Principles – Properties – Rule Modularization – Rule Debugging – IDEA methodology – Open Problems. | |
| **Unit-III** | **9 Lecture Hours** |
| **TEMPORAL AND OBJECT DATABASES**  Overview – Data types – Associating Facts – Temporal Query Language – TSQL2 – Time Ontology – Language Constructs – Architecture – Temporal Support – Object Database and Change Management – Change of Schema – Implementing Database Updates in O2 – Benchmark Database Updates – Performance Evaluation. | |
| **Unit-IV** | **9 Lecture Hours** |
| **COMPLEX QUERIES AND REASONING**  Logic of Query Languages – Relational Calculi – Recursive rules – Syntax and semantics of Data log – Fix point semantics – Implementation Rules and Recursion – Rule rewriting methods – Compilation and Optimization – Recursive Queries in SQL – Open issues. | |
| **Unit-V** | **9 Lecture Hours** |
| **SPATIAL, TEXT AND MULTIMEDIA DATABASES**  Traditional Indexing Methods (Secondary Keys, Spatial Access Methods) – Text Retrieval – Multimedia Indexing – 1D Time Series – 2d Color images – Sub pattern Matching – Open Issues – Uncertainties. | |
| **Text Books:**   1. Raghu Ramakrishnan “Database Management System”, Mc Graw Hill Publications, 2000.   **Reference Books:**   1. 1. Carlo Zaniolo, Stefano Ceri “Advanced Database Systems”, Morgan Kauffmann Publishers.VLDB Journal, 1997 2. 2. Abraham Silberschatz, Henry F. Korth and S. Sudharshan, “Database System Concepts”, Sixth Edition, Tata McGraw Hill, 2011 | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | **Understand** the different types of databases. | PO1, PO2, PO3, PO4 |
| CO2 | **Illustrate** the concepts of Use query languages. | PO1, PO2, PO3, PO5, PO7 |
| CO3 | **Apply** indexing techniques. | PO1, PO2, PO3, PO4 |
| CO4 | **Examine** case studies on design database. | PO1, PO2, PO3, |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| **Course**  **Code** | **Course Title** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO  9 | PO  10 | PO  11 | PO  12 |
| CSE21841 | **Advanced Database Management systems** | 3 | 3 | 3 | 2 | 1 | - | 1 | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21842** | **Soft Computing** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **Artificial Intelligence** | | | | |
| **Co-requisite** | **High School Mathematics** | | | | |

**Course Objectives:**

1. To understand theoretical foundations and basics of soft computing.
2. To introduce the ideas of fuzzy sets, fuzzy logic and fuzzy inference system.
3. To impart knowledge on theory and applications of Neural Networks.
4. To introduce basics of genetic algorithms and their applications in optimization and planning.

**Course Outcomes:**

On the completion of this course the student will be able to

1. **Understand** the fundamentals of computing techniques.
2. **Illustrate** the concepts of fuzzy sets, knowledge representation using fuzzy rules,

approximate reasoning, fuzzy inference systems, and fuzzy logic

1. **Study** on various artificial neural network architecture.
2. **Apply** genetic algorithm and its types for solving optimization problem.
3. **Examine** case studies on soft computing techniques on emerging fields.

**Course Description:**

The main objective of the course is to expose the students to soft computing, various types of soft computing techniques, and applications of soft computing. This course introduces soft computing methods which, unlike hard computing, are tolerant of imprecision, uncertainty and partial truth. This tolerance is exploited to achieve tractability, robustness and low solution cost. The principal constituents of soft computing are fuzzy logic, neural network theory, and probabilistic reasoning. The course studies the methods and explores how they are employed in associated techniques such as Case-Based Reasoning and expert systems for pattern recognition, clustering, diagnosis, and control both individually and in hybrid arrangement. The basics of each technique will be discussed, and industrial applications will illustrate the strengths of each approach.**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| **Introduction to data driven concepts:**  Introduction: What is soft computing? Differences between soft computing and hard computing, Soft Computing constituents, Methods in soft computing, Applications of Soft Computing  **Introduction To Fuzzy systems**  Introduction : Fuzzy logic, Crisp sets, Operations of Crisp set, Properties: Fuzzy set and Crisp set | |
| **Unit-II** | **9 Lecture Hours** |
| **Introduction To Fuzzy relations and Classical relations**  Cartesian Product, Classical Relations: cardinality, operations, properties, Fuzzy relations, Membership Functions, Fuzzy Rules & Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making, Defuzzification: Alpha-cuts, lambda-cuts, methods | |
| **Unit-III** | **9 Lecture Hours** |
| **Artificial Neural Network**  Concept, biological neural system, Evolution of neural network, McCulloch-Pitts neuron model, activation functions, feed-forward networks, feedback networks, learning rules – Hebbian, Delta, Perceptron learning, applications of neural networks to pattern recognition systems such as character recognition, face recognition, application of neural networks in image processing. | |
| **Unit-IV** | **9 Lecture Hours** |
| **Genetic Algorithm**  Introduction to Genetic Algorithms: Introduction to Genetic Algorithms (GA), Representation, Operators in GA, Fitness function, population, building block hypothesis and schema theorem.  Genetic algorithms operators: Methods of selection, crossover and mutation, Simple GA(SGA), other variant of GA, generation gap, steady state GA, Applications of GA. | |
| **Unit-V** | **9 Lecture Hours** |
| **Applications of Soft Computing**  Optimization of Travelling Salesman Problem using Genetic Algorithm approach: Problem Representation, algorithms, mutation methods, Hybrid fuzzy controller: neuro-fuzzy system, directive drive motor, Bayesian belief networks, Rocket engine control, etc. | |
| **Text Books:**  1. Principle of soft computing, S.N. Shivanandam, Wiley. ISBN13: 9788126527410, 2011.  2.Neuro-Fuzzy and Soft Computing, Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, Prentice Hall of India, 2003.  3. Fuzzy Sets and Fuzzy Logic-Theory and Applications, George J. Klir and Bo Yuan, Prentice Hall, 1995.  **Reference Books:**  1. Neural Networks Algorithms, Applications, and Programming Techniques”, James A.  Freeman and David M. Skapura, Pearson Education, 2003.  2. Genetic Algorithms in Search, Optimization & Machine Learning”, David E.  Goldberg, Addison Wesley, 1997.  3. An Introduction to Genetic Algorithm, Mitchell Melanie, Prentice Hall, 1998 | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | **Understand** the fundamentals of computing techniques. | PO1, PO2, PO3, PO4 |
| CO2 | **Illustrate** the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy | PO1, PO2, PO3, PO5, PO7 |
| CO3 | **Study** on various artificial neural network architecture. | PO1, PO2, PO3, PO4 |
| CO4 | **Apply** genetic algorithm and its types for solving optimization problem. | PO1, PO2, PO3, |
| CO5 | **Examine** case studies on soft computing techniques on emerging fields. | PO11, PO12, |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| **Course**  **Code** | **Course Title** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO  9 | PO  10 | PO  11 | PO  12 |
| CSE21842 | Soft Computing | 3 | 3 | 3 | 3 | 3 | 1 | - | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21843** | **Advance Graph Theory** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **Data Structure** | | | | |
| **Co-requisite** |  | | | | |

**Course Objectives:**

1. To understand and apply the fundamental concepts in graph theory.
2. To apply graph theory-based tools in solving practical problems.
3. To improve the proof writing skills.
4. To state the theorems and prove formally using various techniques.
5. To understand various graphs algorithms and analyse them.

**Course Outcomes:**

On the completion of this course, the student will be able to

1. **Understand** the different distance measures in graphs. Define the special types of graphs- complete graph, regular graph, bipartite graph and their properties.
2. **Discuss** the properties of trees, Minimal Spanning Tree, Breadth First Search, Depth First Search, Hauffman Trees.
3. **Discuss** the properties of trees, Arboricity, vertex and edge connectivity, auto-morphism groups, reconstruction problem and Mengers theorem.
4. **Interpret** algorithms and methods for Graph Colouring and Connectivity.
5. **Discuss** the properties of Planner Graphs and Ramsey Graphs.

**Course Description:**

This course is aimed to cover a variety of different problems in Graph Theory with an emphasis on applications and modelling. Graph theory is a study of graphs, trees and networks. In this course students will come across a number of theorems and proofs. Theorems will be stated and proved formally using various techniques. Topics that will be discussed include Euler formula, Hamilton paths, planar graphs and coloring problem; the use of trees in sorting and prefix codes; useful algorithms on networks such as shortest path algorithm, minimal spanning tree algorithm and min-flow max-cut algorithm.

**Course Content:**

|  |  |
| --- | --- |
| **Unit-I: Introduction** | **10 Lecture Hours** |
| **Unit Heading:**  Graph – definition; Degree sequences, Different distance measures in graphs, Special types of graphs – complete graph, regular graph, bipartite graph and their properties. Havel-Hakimi theorem and Erdos-Gallai theorem (statement only), hypercube graph, Petersen graph, trees, forests and spanning subgraphs, distances, radius, diameter, center of a graph, the number of distinct spanning trees in a complete graph. | |
| **Unit-II: Trees** | **5 Lecture Hours** |
| **Unit Heading:**  Kruskal and Prim algorithms with proofs of correctness, Dijkstra’s a algorithm, Breadth first and Depth first search trees, rooted and binary trees, Huffman’s algorithm. | |
| **Unit-III: Structure and Symmetry** | **8 Lecture Hours** |
| **Unit Heading:**  Cut vertices, bridges and blocks, auto-morphism groups, reconstruction problem. Trees and Connectivity:Properties of trees, Arboricity, vertex and edge connectivity, Mengers theorem . augmenting path, Hall’s matching theorem, vertex and edge cover, independence number and their connections, Tutte’s theorem for the existence of a 1- factor in a graph | |
| **Unit-IV:**  **Connectivity and Graph Colouring** | **12 Lecture Hours** |
| **Unit Heading:** Graph Connectivity: k-vertex and edge connectivity, blocks, characterizations of 2- connected graphs, Menger’s theorem and applications, Network flows, Ford- Fulkerson algorithm, Supply-demand theorem and the Gale-Ryser theorem on degree sequences of bipartite graphs  **Graph Colouring:**  Chromatic number, Greedy algorithm, bounds on chromatic numbers, interval graphs and chordal graphs (with simplicial elimination ordering), Brook’s theorem and graphs with no triangles but large chromatic number, chromatic polynomials. | |
| **Unit-V:**  **Planar graphs and**  **Ramsey theory** | **10 Lecture Hours** |
| **Unit Heading:**  **Planner Graph**: Embedding a graph on plane, Euler’s formula, non-planarity of K5 and K3,3, classification of regular polytopes, Kuratowski’s theorem (no proof), 5-colour theorem.  **Ramsey Theory**: Bounds on R(p, q), Bounds on Rk(3): colouring with k colours and with no monochromatic K3, application to Schur’s theorem, Erdos and Szekeres theorem on points in general position avoiding a convex m-gon. | |
| **Text Books:**   1. D. B. West, Introduction to Graph Theory, Prentice Hall of India, 2001. 2. J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, Springer-Verlag, 2008   **Reference Books:**   1. R. Diestel, Introduction to Graph Theory, Springer-Verlag, 2010. | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | Understand the different distance measures in graphs. Define the special types of graphs- complete graph, regular graph, bipartite graph and their properties | PO1, PO2 |
| CO2 | Discuss the properties of trees, Minimal Spanning Tree, Breadth First Search, Depth First Search, Hauffman Trees | PO1,PO2, PO3 |
| CO3 | Discuss the properties of trees, Arboricity, vertex and edge connectivity, auto-morphism groups, reconstruction problem and Mengers theorem | PO1,PO2 |
| CO4 | Interpret algorithms and methods for Graph Colouring and Connectivity | PO1, PO2, PO3 |
| CO5 | Discuss the properties of Planner Graphs and Ramsey Graphs. | PO1, PO2, PO3 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual or team work | Communication | Project management and finance | Life-long Learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| **CSE21843** | Advance Graph Theory | 3 | 3 | 3 | - | - | - | - | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21844** | **Foundation of Computing Science** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 60 Hours** | **3** | **1** | **0** | **4** |
| **Pre-requisite/Exposure** | **Discrete Mathematics, Programming Concepts** | | | | |
| **Co-requisite** | **NIL** | | | | |

**Course Objectives:**

1. To develop an in-depth understanding of the Propositional Logic, Propositional Calculus and Predicate Calculus, Inference Rules, Boolean Algebra, Sets, Relation and Function, Algebraic Structures and Morphism,.
2. Students should be able to demonstrate application using the above mathematical tools in computer science engineering.
3. Design grammars and recognizers for different formal languages
4. Prove or disprove theorems in automata theory using its properties
5. Determine the decidability and intractability of computational problems

**Course Outcomes:**

On the completion of this course the student will be able to

**CO1. Define** the fundamental knowledge to state the mathematical skills in basic and advance

algebraic structures.

**CO2**. **Define** the fundamental knowledge to state the mathematical skills in Discrete Structure & Logic and allied fields.

**CO3.** **Define** the basic concepts in formal language theory, grammars, automata theory,

Computability Theory, and complexity theory.

**CO4**. **Demonstrate** abstract models of computing, including deterministic (DFA), non-

Deterministic (NFA), Push Down Automata (PDA) and Turing (TM) machine models

and their power to recognize the languages.

**CO5**. **Prove** and disprove theorems establishing key properties of formal languages and

automata.

**Course Description:**

For any program related to Computer Science study of computational Mathematics is very much important. The purpose of this course is to understand and use (abstract) discrete structures and advance algebraic structure that are backbones of computer science. In particular, this course is meant to introduce logic, proofs, sets, relations, functions, counting, and recurrence relation, with an emphasis on applications in computer science.

**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **12 Lecture Hours** |
| **Discrete Structures:** Sets, Relations and Functions, Morphisms; Posets and Lattices, Boolean algebra, Proof Techniques: Inductive and Deductive Reasoning, Proof by Contradiction; Recurrence Relations, Algebraic Structures – Semigroup, Monoid, Group, Ring and Field. | |
| **Unit-II** | **12 Lecture Hours** |
| **Logic:** Statements and Symbolic Representation, Propositional Calculus and Predicate Calculus, Inference Rules, Satisfiability and Validity, Resolution Principle, Notions of Soundness and Completeness. | |
| **Unit-III** | **15 Lecture Hours** |
| **Automata and Languages:** Strings, Phrase Structured Grammar and Formal Languages: Finite Automata and Regular Expressions, Closure Properties of Regular Languages, Pumping Lemma and Non-Regular Languages. Context Free Languages (CFL) and Pushdown Automata (PDA), Normal Forms of Context Free Languages, Closure Properties of CFLs, Pumping Lemma and Non-Context Free Languages, Deterministic Pushdown Automata and DCFLs. Chomsky Hierarchy of Grammars and Corresponding Acceptors ; Turing Machines, and Type 0 Languages, Recursive and Recursively Enumerable Languages, Turing Computable Functions, Primitive and µ-recursive functions. | |
| **Unit-IV** | **13 Lecture Hours** |
| **Computability:** Church-Turing Thesis, Decision Problems, Decidability and Undecidability, Universal Turing Machine, Halting Problem of Turing Machines, Problem Reduction (Turing and Mapping Reduction). | |
| **Unit-V** | **8 Lecture Hours** |
| **Computational Complexity:** Time and Space Complexity Measures; Class P and Class NP and Co-NP problems NP-Completeness. | |
| **Text Books:**  1. T1. Kenneth H. Rosen,Discrete Mathematics and its Applications, Tata McGraw - Hill.  2. T2. V Somasundaram, Discrete Mathematics with Graph Theory and Combinatory, Tata McGraw- Hill.  3. T3. C L Liu and D P Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, 3rd Edition by, Tata McGraw – Hill.  **Reference Books:**  1. Norman L. Biggs, Discrete Mathematics, 2nd Edition, Oxford University Press.  2. Discrete Mathematics for Computer Science”, Illustrated Edition, Kenneth Bogart, Clifford Stein, Robert L. Drysdale, Key College Publishing. | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | **Define** the fundamental knowledge to state the mathematical skills in basic and advance algebraic structures. | **PO1, PO2** |
| CO2 | **Define** the fundamental knowledge to state the mathematical skills in Discrete Structure & Logic and allied fields. | **PO1, PO2** |
| CO3 | **Define** the basic concepts in formal language theory, grammars, automata theory, Computability Theory, and complexity theory. | **PO1, PO2, PO4** |
| CO4 | **Demonstrate** abstract models of computing, including deterministic (DFA), non- Deterministic (NFA), Push Down Automata (PDA) and Turing (TM) machine models and their power to recognize the languages. | **PO2, PO3, PO5** |
| CO5 | **Prove** and disprove theorems establishing key properties of formal languages and automata. | **PO3, PO4** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| **Course**  **Code** | **Course Title** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO  9 | PO  10 | PO  11 | PO  12 |
| CSE21844 | Foundation of Computing Science | 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE22845** | **Applied Computing Lab-I** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 30 Hours** | **0** | **0** | **2** | **2** |
| **Pre-requisite/Exposure** | **C Programming** | | | | |
| **Co-requisite** | **NIL** | | | | |

**Course Objectives:**

1. To accumulate knowledge about Python programming basics.
2. To learn about designing and programming Python applications.
3. To learn how to apply lists, tuples and dictionaries in Python programs.
4. To understand about PLSQL connection in Python.

**Course Outcomes:**

On the completion of this course the student will be able to

1. **Apply** the basic concept of python programming and to **construct** a real-life application.
2. **Examine** different library and tools associated with python.
3. **Apply** object oriented Python programming concepts to design solutions to problems.
4. **Construct** database connection with Python using PLSQL

**Course Description:**

This course offers an introduction to the fundamental concepts in Python programming. It covers the core concepts using sequential execution, conditional execution, loops, variables and functions. The students get to learn about designing user-defined functions and applying various data structures such as lists, tuples and dictionaries etc. The concepts of object oriented programming in Python is discussed in details. The students will also be enabled to learn about connecting database with Python application.

**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **6 Lecture Hours** |
| 1. Python program to demonstrate basic data types. 2. Python program to demonstrate operators 3. Python program to illustrate sequential execution of statements for solving basic problems such as power of a number, factorial of a number. | |
| **Unit-II** | **6 Lecture Hours** |
| 1. Python program to demonstrate loops. 2. Python program to demonstrate arrays. 3. Python program to demonstrate string handing methods. | |
| **Unit-III** | **6 Lecture Hours** |
| 1. Introduction to Additional useful string methods 2. String formatting, running Python as a script 3. The basics of functions, functional programming | |
| **Unit-IV** | **6 Lecture Hours** |
| 1. Python program to demonstrate list operations 2. Python program to demonstrate tuple operations 3. Python program to demonstrate dictionary operations | |
| **Unit-V** | **6 Lecture Hours** |
| 1. Python program to demonstrate file handling operations 2. Python program to demonstrate various package usage such as numpy, matplotlib etc. 3. Python program to demonstrate database connection using PL/SQL | |
| **Text Books:**   1. “Python Cookbook: Recipes for Mastering Python 3” by Brian K. Jones and David M. Beazley.   Reference Books:   1. “Programming Python” by Mark Lutz. 2. “How to think like a computer scientist: Learning with Python” by Allen B. Downey. | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |
| --- | --- | --- |
| **Components** | **Internal** | **End Term** |
| **Weightage (%)** | **50** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | **Apply** the basic concept of python programming and to construct a real-life application. | **PO1, PO2, PO3** |
| CO2 | **Examine** different library and tools associated with python. | **PO1, PO2, PO3** |
| CO3 | **Apply** object oriented Python programming concepts to design solutions to problems. | **PO4,PO6** |
| CO4 | **Construct** database connection with Python using PLSQL | **PO5** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| **Course**  **Code** | **Course Title** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO  9 | PO  10 | PO  11 | PO  12 |
| CSE22845 | Applied Computing Lab –I | 2 | 2 | 2 | 1 | 1 | 1 | - | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

**Year- I**

**Semester-II**

**Elective – I**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21846** | Blockchain and Cryptocurrency | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45** | **3** | **0** | **0** | **3** |
| **Pre-requisites/Exposure** | **Fundamentals of Cryptography** | | | | |
| **Co-requisites** | **Distributed Databases** | | | | |

**Course Objectives:**

1. Understanding the technical underpinnings of blockchain technology at sufficient depth to perform analysis.
2. Performing analysis of the implications of certain decisions upon blockchain proposals.
3. Apply various blockchain concepts to analyze examples, proposals, case studies, and
4. preliminary blockchain system design discussions.
5. Make decisions about the use (or not) of blockchain technology in systems, and support decisions with relevant arguments.

**Course Outcomes:**

On completion of this course, the students will be able to

CO1. **State** core Blockchain concepts, the benefits, and the limitations of blockchain

technologies.

CO2. **Demonstrate** the key differentiators for blockchain from other technology systems.

CO3. **Apply** various blockchain concepts to analyze examples, case studies.

CO4. **Understand** relevant privacy issues related to blockchain technologies.

**Course Description:**

Blockchain and Cryptocurrency is vastly discussed now days in all research domains to bring the decentralization. This course is to understand Blockchain and its main application cryptocurrency. Students will learn how this system works and how can they utilize and what application can be built. After successful completion of this course, students will be familiar with blockchain and cryptocurrency concepts. Also, they can build their own application using the learned concepts.

|  |  |
| --- | --- |
| **Unit-I** | **14 Lecture Hours** |
| Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof. | |
| **Unit-II** | **12 Lecture Hours** |
| Blockchain: Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain. Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate. | |
| **Unit-III** | **12 Lecture Hours** |
| Cryptocurrency: History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin, Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects – Cryptocurrency Exchange, Black Market and Global Economy. | |
| **Unit-IV** | **7 Lecture Hours** |
| Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Blockchain. | |
| **Text Books:**  1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder,  Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press  2. Wattenhofer, The Science of the Blockchain  **Reference Books:**  1. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies | |

**Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid term** | **Continuous Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)**

**Mapping between COs, POs and PSOs**

|  |  |  |
| --- | --- | --- |
| **Course Outcomes (COs)** | | **Mapped POs and PSOs** |
| **CO1** | **State** core Blockchain concepts, the benefits, and the limitations of blockchain technologies. | **PO1, PO2** |
| **CO2** | **Demonstrate** the key differentiators for blockchain from other technology systems. | **PO1, PO2, PO5** |
| **CO3** | **Apply** various blockchain concepts to analyze examples, case studies. | **PO1, PO5** |
| **CO4** | **Understand** relevant privacy issues related to blockchain technologies. | **PO1, PO2, PO5** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE21846 | Blockchain and Cryptocurrency | 3 | 3 | - | - | 3 | - | - | - | - | - | - | - |

1=weakly mapped

2= moderately mapped

3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21847** | **Software Process Management** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **Software Engineering** | | | | |
| **Co-requisite** | **NA** | | | | |

**Course Objectives:**

1. To acquire knowledge on software process management

2. To acquire managerial skills for software project development.

3. To understand software economics

**Course Outcomes:**

On completion of this course students will be able to:

**CO1. Gain knowledge** of software economics, phases in the life cycle of software development, project organization, project control and process instrumentation

**CO2. Analyze** the major and minor milestones, artifacts and metrics from management and technical perspective

**CO3.** **Design** and develop software product using conventional and modern principles of software project management.

**Course Description:**

This course provides an introduction to the study of software engineering by closely examining the software development process. Several popular software development process models are examined, along with topics on the software lifecycle, quality management, and software configuration management.

**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| Software Process Maturity Software maturity Framework, Principles of Software Process Change, Software Process Assessment, The Initial Process, The Repeatable Process, The Defined Process, The Managed Process, The Optimizing Process. Process Reference Models Capability Maturity Model (CMM), CMMI, PCMM, PSP, TSP). | |
| **Unit-II** | **9 Lecture Hours** |
| Software Project Management Renaissance Conventional Software Management, Evolution of Software Economics, Improving Software Economics, The old way and the new way. Life-Cycle Phases and Process artifacts Engineering and Production stages, inception phase, elaboration phase, construction phase, transition phase, artifact sets, management artifacts, engineering artifacts and pragmatic artifacts, model-based software architectures. | |
| **Unit-III** | **9 Lecture Hours** |
| Workflows and Checkpoints of process Software process workflows, Iteration workflows, Major milestones, minor milestones, periodic status assessments. Process Planning Work breakdown structures, Planning guidelines, cost and schedule estimating process, iteration planning process, Pragmatic planning. | |
| **Unit-IV** | **9 Lecture Hours** |
| Project Organizations Line-of- business organizations, project organizations, evolution of organizations, process automation. Project Control and process instrumentation The seven-core metrics, management indicators, quality indicators, life-cycle expectations, Pragmatic software metrics, metrics automation. | |
| **Unit-V** | **9 Lecture Hours** |
| CCPDS-R Case Study and Future Software Project Management Practices Modern Project Profiles, Next-Generation software Economics, Modern Process Transitions. | |
| **Text Books:**  1. Managing the Software Process, Watts S. Humphrey, Pearson Education  2. Software Project Management, Walker Royce, Pearson Education  **Reference Books:**  1. An Introduction to the Team Software Process, Watts S. Humphrey, Pearson Education, 2000 Process Improvement essentials, James R. Persse, O’Reilly, 2006  2. Software Project Management, Bob Hughes & Mike Cotterell, fourth edition, TMH, 2006  3. Applied Software Project Management, Andrew Stellman & Jennifer Greene, O’Reilly, 2006.  4. Head First PMP, Jennifer Greene & Andrew Stellman, O’Reilly, 2007  5. Software Engineering Project Management, Richard H. Thayer & Edward Yourdon, 2 nd edition, Wiley India, 2004.  6. Agile Project Management, Jim Highsmith, Pearson education, 2004. | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | Gain knowledge of software economics, phases in the life cycle of software development, project organization, project control and process instrumentation | **PO1,PO2,PO7** |
| **CO2** | Analyze the major and minor milestones, artifacts and metrics from management and technical perspective | **PO1,PO2,PO3** |
| **CO3** | Design and develop software product using conventional and modern principles of software project management. | **PO1,PO5** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Computational Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex computing problems | Modern tool usage | Professional Ethics | Life-long Learning | Project Management and Finance: | Communication Efficacy | Societal & Environmental Concern: | Individual & Team Work | Innovation and Entrepreneurship |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE21847 | **Software Process Management** | 3 | 3 | 1 | - | 1 | - | 1 | - | - | - | - | - |

1=weakly mapped 2= moderately mapped 3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21848** | **Natural Language Processing** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **Introduction to probability theory, statistics** | | | | |
| **Co-requisite** | **Python, prior knowledge of some machine learning algorithms**  **and data structures is very useful** | | | | |

**Course Objectives:**

1. To understand key concepts from NLP are used to describe and analyze language

2. To understand semantics and pragmatics of language for processing

3. To apply structured semantic models on information retrieval and natural language

applications

**Course Outcomes:**

On the completion of this course the student will be able to

CO1: **Recall** linguistic phenomena and an ability to model them with formal grammars.

CO2: **Illustrate** proper experimental methodology for training and evaluating empirical NLP

systems

CO3. **Apply** natural language processing techniques to process speech and analyse text.

CO4**. Examine** algorithms of natural language processing

CO5. **Evaluate** different language modeling Techniques

**Course Description:**

The main objective of the course is to enable the fundamental concepts and techniques of natural language processing(NLP). However, extracting useful information has proven extremely challenging. This course introduces natural language processing techniques with sophisticated algorithms for processing large volumes of unstructured data such as textual data. It has also opened up exciting opportunities for exploring and analysing new types of data and for analysing old types of data in new ways. Students will gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information. The course examines NLP models and algorithms using both the traditional symbolic and the more recent statistical approaches.**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| Introduction: Context - Classical Toolkit - Text Pre-processing – Tokenization – Sentence  Segmentation Lexical Analysis: Finite State Morphonology Paradigm based Lexical Analysis - Syntactic Parsing – Deductive Parsing – LR Parsing – Constraint based Grammars –Issues in Parsing  Semantic Analysis: Theories and approaches to Semantic Representation – Fine Grained Lexical  Case studies - Natural Language Generation – Components of a Generator – Approaches to Text  Planning – Linguistic Component | |
| **Unit-II** | **9 Lecture Hours** |
| **Introduction to Corpus**  Corpus Size, Representation, Sampling – Data Capture – Corpus Markup and Annotation –  Multilingual Corpora – Multimodal Corpora -Corpus Annotation Type  Part-of-Speech Tagging: General Framework – POS Tagging Approaches – Other Statistical and Machine Learning Approaches. Statistical Parsing: Basics - Probabilistic Context-Free Grammars - Generative Models Discriminative Models - Beyond Supervised Parsing | |
| **Unit-III** | **9 Lecture Hours** |
| Methods of Word Similarity – Normalized Web Distance Method – Kolmogorov Complexity –  Information Distance – Normalized Web Distance – Applications –Word Sense Inventories and Problem Characteristics – Applications of Word Sense Disambiguation –Approaches to Sense Disambiguation: Supervised, Lightly Supervised and Unsupervised. | |
| **Unit-IV** | **9 Lecture Hours** |
| Modern Speech Recognition: Hidden Markov Model, Architectural Components – Historical Developments – Speech  Recognition Applications – Technical Challenges and Future Research Directions | |
| **Unit-V** | **9 Lecture Hours** |
| Case Studies : Natural Language Processing and Information Retrieval – Question Answering – Generic Question Answering System – Evaluation of Question Answering system – Multilingualism in Question  Answering System Recent trends and Related Works – Information Extraction | |
| **Text Books:**  1. Daniel Jurafsky and James H. Martin Speech and Language Processing (2nd Edition), Prentice Hall; edition, 2008  2. Foundations of Statistical Natural Language Processing by Christopher D. Manning and Hinrich Schuetze, MIT Press, 1999**Reference Books:**  1.James Allen, Natural Language Understanding, Addison Wesley; 2 edition 1994  2.Steven Bird, Ewan Klein and Edward Loper Natural Language Processing with Python, O’Reilly Media; 1 edition, 2009 | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | **Recall** linguistic phenomena and an ability to model them with formal grammars. | PO1, PO2, PO3, PO4, PO5,PO6 |
| CO2 | **Illustrate** proper experimental methodology for training and evaluating empirical NLP systems | PO1, PO2, PO3, PO4, PO6 |
| CO3 | **Apply** natural language processing techniques to process speech and analyse text. | PO1, PO2, PO3, PO4, PO5 |
| CO4 | **Examine** algorithms of natural language processing | PO1, PO2, PO3, |
| CO5 | **Evaluate** different language modeling Techniques | PO1, PO2, |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| **Course**  **Code** | **Course Title** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO  9 | PO  10 | PO  11 | PO  12 |
| CSE21848 | Natural Language Processing | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

**Elective- II**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21849** | **Computer Forensics** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **Object Oriented Programming and HTML** | | | | |
| **Co-requisite** | **NA** | | | | |

**Course Objectives:**

1. To study the fundamentals of Computer Forensics

2. To learn, analyze and validate Forensics Data

3. To study the tools and tactics associated with Cyber Forensics.

**Course Outcomes:**

On the completion of this course the student will be able to

1. Analyze and evaluate the cyber security needs of an organization.
2. Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation.
3. Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.
4. Comprehend and execute risk management processes, risk treatment methods, and key risk and performance indicators
5. Measure the performance and troubleshoot cyber security systems.

**Course Description:**

Computer forensics is the application of investigation and analysis techniques to gather and preserve evidence from a particular computing device in a way that is suitable for presentation in a court of law. The goal of computer forensics is to perform a structured investigation and maintain a documented chain of evidence to find out exactly what happened on a computing device and who was responsible for it.

Computer forensics -- which is sometimes referred to as computer forensic science -- essentially is data recovery with legal compliance guidelines to make the information admissible in legal proceedings. The terms digital forensics and cyber forensics are often used as synonyms for computer forensics.

Digital forensics starts with the collection of information in a way that maintains its integrity. Investigators then analyze the data or system to determine if it was changed, how it was changed and who made the changes. The use of computer forensics isn't always tied to a crime. The forensic process is also used as part of data recovery processes to gather data from a crashed server, failed drive, reformatted operating system (OS) or other situation where a system has unexpectedly stopped working**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| **Introduction:** Computer Forensics Fundamentals – Types of Computer Forensics Technology – Types of Computer Forensics Systems – Vendor and Computer Forensics Services. | |
| **Unit-II** | **9 Lecture Hours** |
| **Computer forensics evidence and capture:** Data Recovery – Evidence Collection and Data Seizure-Duplication and Preservation of Digital Evidence-Computer Image Verification and Authentication. | |
| **Unit-III** | **9 Lecture Hours** |
| **Computer forensic analysis:** Discover of Electronic Evidence Identification of Data – Reconstructing Past Events – Fighting against Macro Threats – Information Warfare Arsenal – Tactics of the Military – Tactics of  Terrorist and Rogues – Tactics of Private Companies | |
| **Unit-IV** | **9 Lecture Hours** |
| **Information warfare:** Arsenal – Surveillance Tools – Hackers and Theft of Components – Contemporary Computer Crime-Identity Theft and Identity Fraud – Organized Crime &Terrorism – Avenues Prosecution and Government Efforts – Applying the First Amendment to Computer Related Crime-The Fourth Amendment and other Legal Issues. | |
| **Unit-V** | **9 Lecture Hours** |
| **Computer forensic cases:** Developing Forensic Capabilities – Searching and Seizing Computer Related Evidence –Processing Evidence and Report Preparation – Future Issues. | |
| **Text Books:**   1. John R. Vacca, “Computer Forensics: Computer Crime Scene Investigation”, Cengage Learning, 2nd Edition, 2005. 2. Marjie T Britz, “Computer Forensics and Cyber Crime: An Introduction”, Pearson Education, 2nd Edition, 2008.   **Reference Books:**   1. MariE-Helen Maras, “Computer Forensics: Cybercriminals, Laws, and Evidence”, Jones & Bartlett Learning; 2nd Edition, 2014. 2. Chad Steel, “Windows Forensics”, Wiley, 1st Edition, 2006. 3. Majid Yar, “Cybercrime and Society”, SAGE Publications Ltd, Hardcover, 2nd Edition, 2013. 4. Robert M Slade, “Software Forensics: Collecting Evidence from the Scene of a Digital Crime”, Tata McGraw Hill, Paperback, 1st Edition, 2004. | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | Analyze and evaluate the cyber security needs of an organization. | PO1, PO2, PO3, PO4 |
| CO2 | Determine and analyze software vulnerabilities and security solutions to reduce the risk of exploitation. | PO1, PO2, PO3, PO5, PO7 |
| CO3 | Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools. | PO1, PO2, PO3, PO4 |
| CO4 | Comprehend and execute risk management processes, risk treatment methods, and key risk and performance indicators | PO1, PO2, PO3, |
| CO5 | Measure the performance and troubleshoot cyber security systems. | PO2, PO5, PO7 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| **Course**  **Code** | **Course Title** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO  9 | PO  10 | PO  11 | PO  12 |
| CSE21849 | **Computer Forensics** | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21850** | Software Architecture | L | T | P | C |
| **Version 1.0** | **Course Duration: 45 Hrs.** | 3 | 0 | 0 | 3 |
| **Pre-requisites/Exposure** | Software Engineering | | | | |
| **Co-requisites** |  | | | | |

**Course Objectives**

1. Understand and apply object-oriented design techniques.
2. Develop and evaluate software architectures
3. Select and use appropriate architectural styles
4. Select and use appropriate software design patterns
5. Express the specifications and design of an application using UML

**Course Outcomes**

On completion of this course, the students will be able to

CO1: **Describe** Software architecture for various software systems.

CO2: **Recognize** and derive Quality attributes for software architectures.

CO3: **Demonstrate** the use of different architectural styles and frameworks.

CO4: **Depict** systems requirement with the help of different UML diagrams.

CO5: **Demonstrate** documentation for architectural patterns.

.

**Catalog Description**

Software architecture is, simply, the organization of a system. This organization includes all components, how they interact with each other, the environment in which they operate, and the principles used to design the software. In many cases, it can also include the evolution of the software into the future. Software architecture in software engineering helps to expose the structure of a system while hiding some implementation details. Architecture focuses on relationships and how the elements and components interact with each other, as does software engineering. In fact, software architecture and software engineering often overlap. They are combined because many of the same rules govern both practices. The different sometimes comes when decisions are focused on software engineering and the software architecture follows. It is important to note that all software architecture is engineering, but not all engineering is software architecture. The software architect is able to distinguish between the details in the software engineering and importance to the internal structure.

**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| **Introduction**  Introduction to Software architecture and requirements, Architecture diagrams: UML Class Diagram, UML Component Diagram, UML Package Diagram, UML Deployment Diagram, UML Activity Diagram, Architecture structure – ABC (Architecture Business Cycle) | |
| **Unit-II** | **9 Lecture Hours** |
| **Understanding Quality Attributes and Achieving Quality**  Introduction to Quality Attributes, Need of quality attributes, Understanding quality attributes: architecture and quality attributes. Case study of quality attributes in software architecture templates, Deriving Quality Attributes for software architectures. | |
| **Unit-III** | **12 Lecture Hours** |
| **Architecture in the life cycle / Architectural Views**  Introduction, Structures and views: Representing views, available notations, Standard views: 4+1 view of Rational Unified Process, Siemens 4 views, SEI's perspectives and views, Case studies Architecture in the agile projects: Architecture and requirements, Implementation and testing, Architecture reconstruction and conformance | |
| **Unit-IV** | **8 Lecture Hours** |
| **Architectural Styles**  Introduction, Data flow styles, Call-return styles, Shared Information styles, Event styles, Case studies for each style. Architectural styles, Pipes and filters, Data abstraction and object oriented organization Event based, implicit invocation, Layered systems, Repositories, Other familiar architectures, Heterogeneous Architectures. | |
| **Unit-V** | **7 Lecture Hours** |
| **Documenting the architecture**  Guidelines and practices, Documenting the Views using UML, Pros and cons of using visual languages, Need for formal languages, Architectural Description Languages, ACME–Designing and documentation, Case studies. | |
| **Text Books:**   1. Software Architecture in Practice, Len Bass, Paul Clements, Rick Kazman, Second Edition, Pearson, ISBN 978-81-775-8996-2. 2. Managing and global Software Projects, Ramesh Gopalaswamy, Tata Mc Graw Hill. Tenth Reprint 2011.   **Reference Materials**   1. Software Engineering - A Practitioner’s Approach, Roger S.Pressman, 7th Edition McGraw Hill, 2010 2. Managing the Software Process, Humphery Watts, Addision Wesley, 1989. | |

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Internal Assessment** | **MTE** | **ETE** |
| **Weightage (%)** | **30** | **20** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Describe** Software architecture for various software systems. | **PO1, PO2, PO12** |
| **CO2** | **Recognize** and derive Quality attributes for software architectures. | **PO1, PO2, PO3, PO12** |
| **CO3** | **Demonstrate** the use of different architectural styles and frameworks. | **PO1, PO2, PO4, PO12** |
| **CO4** | **Depict** systems requirement with the help of different UML diagrams. | **PO1, PO2, PO11, PO12** |
| **CO4** | **Demonstrate** documentation for architectural patterns. | **PO1, PO2, PO12** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| **CSE21850** | Software Architecture | 3 | 3 | 1 | 1 | - | - | - | - | - | - | 1 | 3 |

1=weakly mapped

2= moderately mapped

3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21843** | **Computer Vision** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **Discrete Mathematics, Python Programing** | | | | |
| **Co-requisite** |  | | | | |
|  | | | | | |
| **Course Objectives:** | | | | | |
| 1. To allow students to have a fundamental concepts of machine vision 2. To provide the platform to build computer vision applications from scratch 3. To expose students to state of the art applications in computer vision | | | | | |
|  | | | | | |
| **Course Outcomes:** | | | | | |
| CO1 : | Understand the cognitive concepts of organic vision | | | | |
| CO2 : | Explain fundamental concepts of digital image processing | | | | |
| CO3 : | Apply advance image feature extraction techniques | | | | |
| CO4 : | Analyse deep learning based image processing approaches | | | | |
| CO5 : | Validate modern computer applications | | | | |
|  | | | | | |
| **Course Description:** | | | | | |
| Computer vision is fundamental concept for the current world IT professionals to master. It has huge applications in the field of data science and image processing. The course has been designed to allow the student to explore fundamental concepts behind human vision and map it to digital image processing techniques. They can learn advanced techniques, deep learning based approaches and dissect modern computer vision applications. | | | | | |

**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| **Introduction :**  Biological Image Sensing: From Retina to Visual Cortex. Cognitive aspect of image understanding. Visual knowledge representation.  Digital Image Sensing : CCD vs CMOS sensors, Lenses, Focal Lengths, Aperture, Field of View, Depth of Field, Color spaces – RGB, CMYK, LAB  Challenges of Computer Vision.  Applications of Computer Vision. | |
| **Unit-II** | **12 Lecture Hours** |
| **Digital Image Processing :**  Digital image representation, grayscale vs color image, alpha channels, multispectral images, 3d images.  **Grayscale image processing :** Thresholding, Contrast enhancement, Histogram equalization, Edge Detection, Gradient detection, Texture Analysis, Shape based Analysis. Image features: shape-based features, texture-based features, intensity histograms, marginal intensity histograms.  **Spatial filter based approaches:** Sobel, Prewitt, Gabor, Gaussian, Laplacian. Noise removal, Sharpening  Morphological transformations: structuring element dilation, erosion, opening, closing | |
| **Unit-III** | **9 Lecture Hours** |
| **Region based Approaches:** Region Growing, Normalized Cuts, Watershed Algorithm.  **Gradient based feature extraction:** HOG, SIFT, SURF. | |
| **Unit-IV** | **8 Lecture Hours** |
| **Neural Network based approaches:** Multi-layered perceptron, backpropagation, Convolutional neural networks(CNN).  **Applications of CNN:** Image classification, localization, segmentation, enhancement. | |
| **Unit-V** | **7 Lecture Hours** |
| Realtime image processing: Video analysis, optical flow, depth estimation.  **Case Studies:**  Fingerprint verification,  Digit recognition,  Face Recognition,  Aerial Imaging,  Microscopic Image analysis,  Autonomous driving | |
| **Text Books:**  **1.**  **Digital Image Processing, 4th Edition Rafael C. Gonzalez, University of Tennessee 2. Deep Learning – Goodfellow, Bengio, Courville** | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | Understand the cognitive concepts of organic vision | PO1, PO2 |
| CO2 | Explain fundamental concepts of digital image processing | PO1, PO2, PO3, PO4 |
| CO3 | Apply advance image feature extraction techniques | PO2, PO3, PO4, PO5 |
| CO4 | Analyse deep learning based image processing approaches | PO2, PO3, PO4, PO5 |
| CO5 | Validate modern computer applications | PO2, PO3, PO4, PO5 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| **Course**  **Code** | **Course Title** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO  9 | PO  10 | PO  11 | PO  12 |
| CSE21843 | Computer Vision | 2 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - |

1 = Weakly Mapped, 2 = Moderately Mapped, 3= Strongly Mapped

**Elective -III**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21852** | **Introduction to Information Security Management** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **Computer Forensics** | | | | |
| **Co-requisite** | **NA** | | | | |

**Course Objectives:**

* To understand of information assurance as practiced in computer operating systems, distributed systems, networks and representative applications.
* To demonstrate the familiarity with prevalent network and distributed system attacks, defences against them, and forensics to investigate the aftermath.
* Appraise a basic understanding of cryptography, how it has evolved, and some key encryption techniques used today.
* To learn how to conduct security audit.

**Course Outcomes:**

On completion of this course students will be able to:

CO1**. Define** the basics of OSI security model and Classical Encryption Technique.

CO2**. Understand** and identify the application of Public Key Encryption Techniques and practices.

CO3**. Demonstrate** the application of Data Authentication and Authorization.

CO4**. Examine** the basics concept of Network Security and Web Security.

CO5**. Understand** the process of identifying vulnerability in software and hardware devices.

**Course Description:**

This course is designed to teach the fundamentals of security management. The course is not technical in nature, but relies on the student’s previous understanding of security systems. The course instead looks at security from a managerial perspective with regards to design, implementation, maintenance, and disaster recovery.

**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| **Information Security and its necessity:** Basics Principles of Confidentiality, Integrity Availability Concepts Policies, procedures, Guidelines, Standards, Administrative Measures and Technical Measures.  Basics of Cloud Computing, Application of Cloud.  Information Security issues in Cloud Computing: Benefits and major issues related to information Security. | |
| **Unit-II** | **9 Lecture Hours** |
| **Standards available for Information Securities :** A brief overview on Cobit, Cadbury, ISO 27001, Open Web Application Security Project (OWASP), Open Source Security Testing Methodology Manual (OSSTMM) etc. , Certifiable Standards.  Vulnerability, Threat and Remedies: Introduction to BCP / DRP / Incident management, Segregation and Separation of Duties & Roles and responsibilities, IT ACT 2000.  **Information Security Assessments :** Vulnerability Assessment and Penetration Testing (VAPT), Web Application Audits, IT assessments or audits, Assessment of Network Equipment, Assessment of Security Devices (Web Filtering, Firewalls, IDS / IPS, Routers etc.), Data Centre Assessment, Business Continuity and Disaster Recovery Plans (BCP/DRP) assessments | |
| **Unit-III** | **9 Lecture Hours** |
| **Security of Application Software:** SAP Security, Desktop Security, RDBMS Security.  Inbuilt Securities Provided in Windows and Linux : Types of audits in Windows environment, Server Security, Security for active directories (Group Policy), AntiVirus, Malware, End point protection, Shadow Passwords, SUDO (Super-user do) users etc. | |
| **Unit-IV** | **9 Lecture Hours** |
| **Security issues in Web Application:** Open Web Application Security Project (OWASP), Cross-site scripting (XSS), SQL injection, Cross-Site Request Forgery (CSRF), Password Vulnerabilities, Password Vulnerabilities, Completely Automated Public Turing test to tell Computers and Humans Apart (CAPTCHA), Session Hijacking, Local and Remote File Inclusion, Audit Trails, Web Server Issues, etc | |
| **Unit-V** | **9 Lecture Hours** |
| **Technological Proficiency and Hardware/Software Required**  Hardware Backdoor, Semiconductor Doping, Hardware Side-Channel Attacks, Products Affected, Attack Motivation, Hardware Lifecycle Trust, Classification of Hardware Trojans. | |
| **Text Books:**  **1. “ The Web Application Hacker's Handbook: Discovering and Exploiting Security Flaws”, Dafydd Stuttard, Marcus Pinto, Wiley**  **2. “ Hacking: The Art of Exploitation”, Jon Erickson, 2nd edition, No Starch Press**  **Reference Books:**  **1. “Exploiting Software - How to Break Code”, Greg Hoglund and Gary McGraw, Addison Wesley** | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Define** the basics of OSI security model and Classical Encryption Technique. | **PO1,PO2** |
| **CO2** | **Understand** and identify the application of Public Key Encryption Techniques and practices. | **PO1,PO2** |
| **CO3** | **Demonstrate** the application of Data Authentication and Authorization. | **PO1,PO5** |
| **CO4** | **Examine** the basics concept of Network Security and Web Security. | **PO2, PO3** |
| **CO5** | **Understand** the process of identifying vulnerability in software and hardware devices. | **PO5,PO7** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Computational Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex computing problems | Modern tool usage | Professional Ethics | Life-long Learning | Project Management and Finance: | Communication Efficacy | Societal & Environmental Concern: | Individual & Team Work | Innovation and Entrepreneurship |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE21852 | **Introduction to Information Security Management** | 3 | 3 | 1 | - | 2 | - | 1 | - | - | - | - | - |

1=weakly mapped 2= moderately mapped 3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21853** | Software Security | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours - 45** | **3** | **0** | **0** | **3** |
| **Pre-requisites/Exposure** | **Undergraduate in Computer Science** | | | | |
| **Co-requisites** | **Programming skill** | | | | |

**Course Objectives:**

1. Comprehend the basic terminologies in computer security including Confidentiality, Integrity and Availability (CIA).
2. Identify and describe different types of widely used encryption algorithms such as DES, AES and RSA and their applications in the real life.
3. Master the use the proper authentication methods based on the Application's domain and its security requirements.
4. Know how to implement and employ the proper access control mechanism.
5. Differentiate between the various types of malwares and implement the proper techniques to protect against them.
6. Understands the causes and consequences of the buffer over flow attack and the various ways to prevent, detect, and mitigate the system from this attack.

**Course Outcomes:**

On completion of this course, the students will be able to

CO1. **Define** basic terminologies in computer security including Confidentiality, Integrity and Availability (CIA).

CO2. **Implement** and employ the proper access control mechanism.

CO3. **Demonstrate** the causes and consequences of the buffer over flow attack and the various ways to prevent, detect, and mitigate the system from the attack.

CO4. **Differentiate** between the various types of malwares.

**Course Description:**

This course includes theory and practice of software security, focusing in particular on some common software security risks, including buffer overflows, race conditions and random number generation, and on identification of potential threats and vulnerabilities early in design cycle. Emphasizes methodologies and tools for identifying and eliminating security vulnerabilities, techniques to prove absence of vulnerabilities, ways to avoid security holes in new software, and essential guidelines for building secure software: how to design software with security in mind from the ground up and to integrate analysis and risk management throughout the software life cycle.

**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **8 Lecture Hours** |
| Security fundamentals: CIA triad, Policies, Threats, Role of Trust, Operational Issues, Security life cycle, Standard notions of security, Software Security Problems. | |
| **Unit-II** | **12 Lecture Hours** |
| Principles of Cryptography: Basic Terminology, Symmetric and Asymmetric encryption, Block and Stream Ciphers, Cryptanalysis Scheme, Substitution Ciphers, Digital Signatures, Public-Key Cryptosystems, Hash Functions, Digital Envelopes**.** | |
| **Unit-III** | **14 Lecture Hours** |
| Authentication Protocols: Authentication Using Symmetric Keys, Mutual Authentication Attack, Reflection Attack, Authentication Using Public Keys, Session Key, Public Key Authentication with Timestamp, Zero Knowledge Proof (ZKP), TCP-based Authentication, Naïve Session Key Protocol  Access Control: Authentication vs. Authorization, Access Control Principles, Lampson’s Access Control Matrix, Discretionary Access Control (DAC), Mandatory Access Control (MAC), Role-Based Access Control (RBAC), Attribute-Based Access Control (ABAC). | |
| **Unit-IV** | **11 Lecture Hours** |
| Malware: Malware Terminology, Classification of Malware, Virus Phases and Structure, Virus Classifications, Worms, Morris Worm, Malicious Mobile Code, Social Engineering, Payload – Attack Agents Bots, Stealthing Rootkit, Rootkit Classification Characteristics, Generic Decryption (GD) Host-Based Behaviour-Blocking Software  Security Issues: Defensive Programming, Security by Design, Injection Attacks, Cross Site Scripting (XSS) Attacks, Validating Input Syntax, Input Fuzzing, Correct Algorithm Implementation, Preventing Race Conditions. | |
| **Text Books:**  1. William Stallings, Lawrie Brown, Computer Security: Principles and Practice, 4th Edition, Pearson, Dec 12, 2017. ISBN-13: 978-1292220611 • ISBN-10: 1292220619  2. Charles P. Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5th Edition, Prentice Hall, Jan 14, 2015.ISBN-13: 978-0134085043 • ISBN-10: 9780134085043  **Reference Books:**  1. Gary McGraw, Software Security: Building Security, 1st Edition, ‎ Addison-Wesley. | |

**Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid term** | **Continious Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)**

**Mapping between COs, POs and PSOs**

|  |  |  |
| --- | --- | --- |
| **Course Outcomes (COs)** | | **Mapped POs and PSOs** |
| **CO1** | **Define** basic terminologies in computer security including Confidentiality, Integrity and Availability (CIA). | **PO1, PO2** |
| **CO2** | **Implement** and employ the proper access control mechanism. | **PO1, PO2, PO3** |
| **CO3** | **Demonstrate** the causes and consequences of the buffer over flow attack and the various ways to prevent, detect, and mitigate the system from the attack. | **PO1, PO5** |
| **CO4** | **Differentiate** between the various types of malwares. | **PO1, PO2, PO3** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE21853 | Software Security | 3 | 3 | 2 | - | 1 | - | - | - | - | - | - | - |

1=weakly mapped

2= moderately mapped

3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CSE21854 | Social Network Analysis | L | T | P | C |
| **Version 1.0** | **Course Duration: 45 Hrs.** | 3 | 0 | 0 | 3 |
| **Pre-requisites/Exposure** | Fundamental of computer network, Graph Theory | | | | |
| **Co-requisites** |  | | | | |

**Course Objectives**

1. Understand the concept of semantic web and related applications.
2. Learn knowledge representation using ontology.
3. Understand human behaviour in social web and related communities.
4. Learn visualization of social networks.

**Course Outcomes**

On completion of this course, the students will be able to

CO1: **Develop** semantic web related applications.  
CO2: **Represent** knowledge using ontology.  
CO3: **Description** of Web community

CO4: **Predict** human behaviour in social web and related communities.  
CO5: **Visualize** social networks.

.

**Catalog Description**

Social network analysis (SNA) is the process of investigating social structures through the use of networks and graph theory. It characterizes networked structures in terms of *nodes* (individual actors, people, or things within the network) and the *ties*, *edges*, or *links* (relationships or interactions) that connect them. Social networks provide and limit opportunities for individual choices, whereas at the same time individuals initiate, construct, maintain, and break up relationships and by doing so determine the global structure of the network. Which network structures and positions create strong opportunities or, on the contrary, a strong constraint depends on the instrumental value of the relationships under study.

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| **Introduction**  Introduction to Semantic Web: Limitations of current Web - Semantic Web Development- Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis. | |
| **Unit-II** | **9 Lecture Hours** |
| **Ontology: Modelling, Aggregating and Knowledge Representation**  Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language - Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations. | |
| **Unit-III** | **9 Lecture Hours** |
| **Extraction and Mining Communities in Web Social Networks**  Extracting evolution of Web Community from a Series of Web Archive - Detecting communities in social networks - Definition of community - Evaluating communities - Methods for community detection and mining - Applications of community mining algorithms - Tools for detecting communities social network infrastructures and communities - Decentralized online social networks - Multi-Relational characterization of dynamic social network communities. | |
| **Unit-IV** | **9 Lecture Hours** |
| **Predicting Human Behavior and Privacy Issues**  Understanding and predicting human behaviour for social communities - User data management - Inference and Distribution - Enabling new human experiences - Reality mining - Context - Awareness - Privacy in online social networks - Trust in online environment - Trust models based on subjective logic - Trust network analysis - Trust transitivity analysis - Combining trust and reputation - Trust derivation based on trust comparisons - Attack spectrum and countermeasures. | |
| **Unit-V** | **9 Lecture Hours** |
| **Visualization and Applications of Social Networks**  Graph theory - Centrality - Clustering - Node-Edge Diagrams - Matrix representation - Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node-Link Diagrams - Hybrid representations - Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks. | |
| **Text Books:**   1. Social Networks and the Semantic Web‖, Peter Mika, First Edition, Springer 2007. 2. Handbook of Social Network Technologies and Applications‖, Borko Furht , 1st Edition, Springer, 2010.   **Reference Books:**   1. Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively, Dion Goh and Schubert Foo, IGI Global Snippet, 2008. 2. Web Mining and Social Networking – Techniques and applications, Guandong Xu ,Yanchun Zhang and Lin Li, First Edition, Springer, 2011. | |

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Internal Assessment** | **MTE** | **ETE** |
| **Weightage (%)** | **30** | **20** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Develop** semantic web related applications. | **PO2, PO3, PO4** |
| **CO2** | **Represent** knowledge using ontology. | **PO2, PO3, PO4, PO12** |
| **CO3** | **Description** of Web community | **PO2, PO3, PO4, PO12** |
| **CO4** | **Predict** human behavior in social web and related communities. | **PO2, PO3, PO4, PO6** |
| **CO4** | **Visualize** social networks. | **PO2, PO3, PO5** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE21854 | Social Network Analysis | - | 3 | 3 | 3 | 1 | 1 | - | - | - | - | - | 2 |

1=weakly mapped

2= moderately mapped

3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21855** | **Research Methodologies** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 30 Hours** | **2** | **0** | **0** | **2** |
| **Pre-requisite/Exposure** | **Knowledge on Data Acquisition and Visualization** | | | | |
| **Co-requisite** | **NA** | | | | |

**Course Objectives:**

1. To identify and discuss the role and importance of research in the social sciences.
2. To identify and discuss the issues and concepts salient to the research process.
3. To identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project.

**Course Outcomes:**

On the completion of this course the student will be able to

1. Discuss different methodologies and techniques used in research work.
2. Explain basic computer skills necessary for the conduct of research.
3. Assess the basic function and working of analytical instruments used in research.

**Course Description:**

Computer forensics is the application of investigation and analysis techniques to gather and preserve evidence from a particular computing device in a way that is suitable for presentation in a court of law. The goal of computer forensics is to perform a structured investigation and maintain a documented chain of evidence to find out exactly what happened on a computing device and who was responsible for it.

Computer forensics -- which is sometimes referred to as computer forensic science -- essentially is data recovery with legal compliance guidelines to make the information admissible in legal proceedings. The terms digital forensics and cyber forensics are often used as synonyms for computer forensics.

Digital forensics starts with the collection of information in a way that maintains its integrity. Investigators then analyze the data or system to determine if it was changed, how it was changed and who made the changes. The use of computer forensics isn't always tied to a crime. The forensic process is also used as part of data recovery processes to gather data from a crashed server, failed drive, reformatted operating system (OS) or other situation where a system has unexpectedly stopped working**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **10 Lecture Hours** |
| **Motivation and objectives –** Research methods vs. Methodology. Types of research – Descriptive  vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical,  concept of applied and basic research process, criteria of good research.  Defining and formulating the research problem, selecting the problem, necessity of defining the  problem, importance of literature review in defining a problem, literature review-primary and  secondary sources, reviews, monograph, patents, research databases, web as a source, searching  the web, critical literature review, identifying gap areas from literature and research database,  development of working hypothesis. | |
| **Unit-II** | **10 Lecture Hours** |
| Accepts of method validation, observation and collection of data, methods of data collection,  sampling methods, data processing and analysis strategies and tools, data analysis with statically  package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing. | |
| **Unit-III** | **10 Lecture Hours** |
| Computer and its role in research, Use of statistical software SPSS, GRETL etcin research.  Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated  Annealing, Neural Network based optimization, Optimization of fuzzy systems. | |
| **Text Books:**   1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition. 2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press .   **Reference Books:**   1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers. 2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | Discuss different methodologies and techniques used in research work. | PO1, PO2, PO3, PO4 |
| CO2 | Explain basic computer skills necessary for the conduct of research. | PO1, PO2, PO3, PO5, PO7 |
| CO3 | Assess the basic function and working of analytical instruments used in research. | PO1, PO2, PO3, PO4 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| **Course**  **Code** | **Course Title** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO  9 | PO  10 | PO  11 | PO  12 |
| CSE21855 | **Research Methodologies** | 3 | 3 | 3 | 2 | 1 | - | 1 | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21856** | **Parallel and Distributed Computing** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours -45** | **3** | **0** | **0** | **3** |
| **Pre-requisites/Exposure** | **Java, Computer Networking, Operating systems** | | | | |
| **Co-requisites** | **---** | | | | |

**Course Objectives:**

1. To formulate and evaluate a hypothesis by proposing, implementing and testing a project.

2. To relate one project to prior research via a review of related literature.

3. To understand the fundamental questions in parallel and distributed computing and analyze different solutions to these questions.

4. To understand different parallel and distributed programming paradigms and algorithms, and gain practice in implementing and testing solutions using these.

**Course Outcomes:**

On completion of this course, the students will be able to

CO1. **Apply** the fundamentals of parallel and distributed computing including parallel architectures and paradigms.

CO2. **Apply** parallel algorithms and key technologies.

CO3. **Develop** and execute basic parallel and distributed applications using basic programming models and tools.

CO4. **Analyze** the performance issues in parallel computing and trade-offs.

**Catalog Description:**

This course covers the architecture and enabling technologies of parallel and distributed computing systems and their innovative applications. We will cover scalable multiprocessors,

distributed clusters, P2P networks, computational Grids, virtual machines, and Internet Clouds. Case studies include IBM BlueGene/L, Google search-engine, TeraGrid, e-Science, DataGrid, Gnuttela, BitTorrent, content-delivery networks, VM Monitors, IBM BlueCloud, Amazon Elastic Clouds, Google Clouds, etc. The course aims to acquaint Master and Ph.D. students in computer science, electrical and computer engineering with state-of-the-art supercomputers and distributed computing systems for high-performance computing, e-commerce, and web-scale Internet applications.

|  |  |
| --- | --- |
| **Unit-I** | **7 Lecture Hours** |
| **Introduction**  Characterization of Distributed Systems- Introduction, Examples of distributed systems, Resource sharing and the Web Challenges, System Models- Architectural models, Fundamental Models Theoretical Foundation for Distributed System: Limitation of Distributed system, absence of global clock, shared memory, Logical clocks, Lamport’s& vectors logical clocks, Causal ordering of messages, global state, termination detection. | |
| **Unit-II** | **8 Lecture Hours** |
| Distributed Mutual Exclusion: Classification of distributed mutual exclusion, requirement of mutual exclusion theorem, Token based and non token based algorithms, performance metric for distributed mutual exclusion algorithms. Distributed Deadlock Detection: system model, resource Vs communication deadlocks, deadlock prevention, avoidance, detection & resolution, centralized dead lock detection, distributed dead lock detection, path pushing algorithms, edge chasing algorithms | |
| **Unit-III** | **8 Lecture Hours** |
| Agreement Protocols- Introduction, System models, classification of Agreement Problem, Byzantine agreement problem, Consensus problem, Interactive consistency Problem, Solution to Byzantine Agreement problem, Application of Agreement problem, Atomic Commit in Distributed Database system. Distributed Objects and Remote Invocation- Communication between distributed objects, Remote procedure call, Events and notifications, Java RMI case study. Distributed Shared Memory-Architecture and motivations. Algorithms for implementing DSM. Memory Coherence. | |
| **Unit-IV** | **10 Lecture Hours** |
| Security- Overview of security techniques, Cryptographic algorithms, Digital signatures Cryptography pragmatics, Case studies- Needham Schroeder, Kerberos, SSL and Millicent. Distributed File Systems: File service architecture, Sun Network File System, The Andrew File System, Recent advances, Transactions and Concurrency Control: Transactions, Nested transactions, Locks, Optimistic Concurrency control, Timestamp ordering, Comparison of methods for concurrency control. Distributed Transactions: Flat and nested distributed transactions, Atomic Commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery. Replication: System model and group communication, Fault - tolerant services, highly available services, Transactions with replicated data. | |
| **Unit-V** | **12 Lecture Hours** |
| Distributed Algorithms- Introduction to communication protocols, Balanced sliding window protocol, Routing algorithms, Destination based routing, APP problem, Deadlock free Packet switching, Introduction to Wave and traversal algorithms, Election algorithm CORBA Case Study- CORBA RMI, CORBA services.  Introduction to Big Data: Big Data Definition, Characteristic Features, Structure, Applications - Big Data vs Traditional Data - Risks of Big Data - Challenges of Conventional Systems - Web Data – Evolution of Analytic Scalability - Evolution of Analytic Processes, Tools and methods - Analysis vs Reporting - Modern Data Analytic Tools.  Introduction definition and evolution of Cloud Computing; Enabling Technologies, Service and Deployment Models Popular Cloud Stacks and Use Cases; Benefits, Risks, and Challenges of Cloud Computing Economic Models and SLAs. Topics in Cloud Security; Common cloud providers and their associated cloud stacks and popular cloud use case scenarios. | |
| **Text Books:**   1. "Distributed System: Concepts and Design”, Coulouris, Dollimore, Kindberg, Pearson Education.   **Reference Books:**  1. “Advanced Concept in Operating Systems", Singhal&Shivaratri, McGraw Hill  2. "Distributed Algorithms", Gerald Tel, Cambridge University | |

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Continuous Class Assessment** | **MTE** | **ETE** |
| **Weightage (%)** | **30** | **20** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and PPOs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Apply** the fundamentals of parallel and distributed computing including parallel architectures and paradigms. | **PO1,PO2,PO6** |
| **CO2** | **Apply** parallel algorithms and key technologies. | **PO1, PO2,PO3,PO5** |
| **CO3** | **Develop** and execute basic parallel and distributed applications using basic programming models and tools. | **PO1, PO4,PO5,PO6** |
| **CO4** | **Analyze** the performance issues in parallel computing and trade-offs. | **PO4,PO2,PO6** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual or team work | Communication | Project management and finance | Life-long Learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE21856 | Parallel and Distributed Computing | 3 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - |

1=weakly mapped 2= moderately mapped 3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE22857** | **Applied Computing Lab-II** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours- 45** | **0** | **0** | **2** | **3** |
| **Pre-requisites/Exposure** | **C Programming** | | | | |
| **Co-requisites** | **--** | | | | |

**Course Objectives:**

1. To formulate and evaluate a hypothesis by proposing, implementing and testing a project.
2. To relate one project to prior research via a review of related literature.
3. To understand the fundamental questions in parallel and distributed computing and analyze different solutions to these questions.
4. To understand different parallel and distributed programming paradigms and algorithms, and gain practice in implementing and testing solutions using these.

**Course Outcomes:**

On completion of this course, the students will be able to

CO1. **Build** a communication between two sockets over a network.

CO2. **Apply** the basic concept of python programming and to **construct** a real-life application.

CO3. **Develop** a client server communication between multiple computing systems.

CO4. **Examine** different library and tools associated with python.

**Catalog Description:**

This course covers the architecture and enabling technologies of parallel and distributed computing systems and their innovative applications. We will cover scalable multiprocessors,

distributed clusters, P2P networks, computational Grids, virtual machines, and Internet Clouds. Case studies include IBM BlueGene/L, Google search-engine, TeraGrid, e-Science, DataGrid, Gnuttela, BitTorrent, content-delivery networks, VM Monitors, IBM BlueCloud, Amazon Elastic Clouds, Google Clouds, etc. The course aims to acquaint Master and Ph.D. students in computer science, electrical and computer engineering with state-of-the-art supercomputers and distributed computing systems for high-performance computing, e-commerce, and web-scale Internet applications.

**Course Content:**

**Experiment 1:**

Familiar Socket programming.

**Experiment 2:**

Database creation and update.

**Experiment 3:**

Building large client server applications.

**Experiment 4:**

Basics of compiler writing using lex and yacc.

**Experiment 5:**

Introduction to python Object, varibles and data types.

**Experiment 6:**

Introduction to duck typing, equality vs. identity testing.

**Experiment 7:**

Introduction to Additional useful string methods

**Experiment 8:**

String formatting, running Python as a script

**Experiment 9:**

The basics of imports, Data Structures, Functions, Functional Programming

**Experiment 10:**

Object-Oriented Python, Standard Library, Third-Party Tools.

**Text Books:**

1.“Python Cookbook: Recipes for Mastering Python 3” by Brian K. Jones and David M. Beazley.

**Reference Books:**

1. “Programming Python” by Mark Lutz.

2. “How to think like a computer scientist: Learning with Python” by Allen B. Downey.

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |
| --- | --- | --- |
| **Components** | **Continuous Class Assessment** | **ETE** |
| **Weightage (%)** | **50** | **50** |

**Relationship between the Course Outcomes (Cos) and Program Outcomes (Pos)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and Pos** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Build** a communication between two sockets over a network. | **PO2,PO3,PO4** |
| **CO2** | **Apply** the basic concept of python programming and to **construct** a real-life application. | **PO1,PO3,PO4,PO5** |
| **CO3** | **Develop** a client server communication between multiple computing systems. | **PO1, PO2,PO3,PO4,PO6** |
| **CO4** | **Examine** different library and tools associated with python. | **PO1, PO2,PO5, PO6** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual or team work | Communication | Project management and finance | Life-long Learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE22857 | Applied Computing Lab-II | 3 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - |

1=weakly mapped 2= moderately mapped 3=strongly mapped

**Year- II**

**Semester-III**

**Elective – IV**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21858** | Advanced Network Security | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45** | **3** | **0** | **0** | **3** |
| **Pre-requisites/Exposure** | **Computer Networks** | | | | |
| **Co-requisites** |  | | | | |

**Course Objectives:**

The objective of this course is to expose students to advanced topics in network security. Topics covered will include network security issues like authentication, anonymity, traceback, denial of service, encryption, forensics etc. in both wired and wireless networks. At the conclusion of the course, students will be expected to get a clear and in-depth understanding of state of the art in network security attacks and defences.

**Course Outcomes:**

On completion of this course, the students will be able to

CO1. **Describe** network security services and mechanisms.

CO2. **Demonstrate** the concept of Data integrity, Authentication, Digital Signatures.

CO3. **Define** the terms vulnerability, threat and attack

CO4. **Understand** Various network security applications, IPSec, Firewall, IDS, Web security, Email security, and Malicious software etc.

**Course Description:**

This course is about the realisation of IT Security on the level of network infrastructure. Usually, security is implemented at single points of a network (e.g. at firewalls or on important servers). The perspective from a network infrastructure often is not taken care of. The growing complexity of Network structures brings along many risks for secure traffic and high availability. You will learn what kind of dangers there are on a network level and how efficient security measures can be implemented.

|  |  |
| --- | --- |
| **Unit-I** | **11 Lecture Hours** |
| **Introduction**  Application Security: Introduction – Overview of Attacks Against Applications, Attacking SUID Programs, Environment Attacks, Input Argument Attacks, File Access Attacks, Smashing the Stack for Fun and Profit, Format String Attacks, Assembly Primer, ELF File Format, PLT and GOT, Data and BSS Overflow, Array Overflow, Non-terminated String Overflow, Heap Overflow, Tools and Defences. | |
| **Unit-II** | **11 Lecture Hours** |
| Network Security: Introduction – Overview of Network Attacks, Network Protection -IDS, Types of IDS’s, Issues in Intrusion Detection, Challenges in Intrusion Detection, Taint Analysis, Network Based IDS, Problems in NIDS, Impact Analysis, TCP Overview – Connection Setup/Teardown, Packet Sniffing, Detecting Sniffers on your network, IP Spoofing, ARP Poisoning, UDP Hijacking, Fragmentation Attack- Ping of Death, Evasion & Denial of Service, UDP Hijacking, TCP Spoofing, TCP Hijacking – Mitnick attack, Joncheray attack, SYN Flood Attack, Denial of Service Attack, Port Scanning Techniques, ICMP, ICMP Attacks – ICMP Echo Attacks, Smurf Attacks, ICMP Redirect Attacks, WLAN, 802.11 | |
| **Unit-III** | **12 Lecture Hours** |
| Wireless Security Overview, Attacks Against Wireless Networks – Eavesdropping, WEP Attacks, Injection Attacks -, WEP Encryption, WEP Attacks, FMS Attack, Denial of Service, Man-in-the-Middle Attack, Protection Mechanisms and Tools, War Driving, Vulnerabilities in Internet Applications(SMTP, FTP, DNS, Remote Access), SPAM, DNS Zones, Zone Transfer, BIND, DNS Spoofing, DNS Cache Poisoning, IPSec – Introduction, Tunnel & Transfer Modes, IPSec Authentication Header, Encapsulating Security Header and Payload, IPSec Key Exchange, VPNs, FTP Protocol, Exploiting FTP, FTP Bounce | |
| **Unit-IV** | **10 Lecture Hours** |
| Web Security: HTTP Challenge Response Protocol, Web-based Authentication, Man-in-the-Middle Attacks, Cookies, Sessions, CGI, Active Server Pages (ASP), Servlets, Java Server Pages, PHP, Web Framework, Client-side Scripting , DOM and BOM, Javascript Security, Browser Security, AJAX, Web Attacks, SQL Injection, XSS, Authentication Attacks, Authorization Attacks, Command Injection Attacks, Server-Side Includes(SSI) | |
| **Text Books:**  1. Charlie Kaufman, Radia Perlman and Mike Speciner, “Network Security: PRIVATE Communication in a PUBLIC world”, Second Edition, Prentice Hall, 2002  2. Jonathan Katz, Yahuda Lindell, Introduction to Modern Cryptography, CRC Press  **Reference Books:**  1. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach | |

**Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid term** | **Continuous Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)**

**Mapping between COs, POs and PSOs**

|  |  |  |
| --- | --- | --- |
| **Course Outcomes (COs)** | | **Mapped POs and PSOs** |
| **CO-1** | **Describe** network security services and mechanisms. | **PO1, PO2** |
| **CO-2** | **Demonstrate** the concept of Data integrity, Authentication, Digital Signatures. | **PO1, PO2, PO5** |
| **CO-3** | **Define** the terms vulnerability, threat and attack | **PO1, PO5** |
| **CO-4** | **Understand** Various network security applications, IPSec, Firewall, IDS, Web security, Email security, and Malicious software etc. | **PO1, PO2, PO5** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE21858 | Advanced Network Security | 3 | 3 | - | - | 3 | - | - | - | - | - | - | - |

1=weakly mapped

2= moderately mapped

3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CSE21859 | **Data Mining** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **Data Warehouses, Data Analysis** | | | | |
| **Co-requisite** | **High School Mathematics** | | | | |

**Course Objectives:**

1. To understand major principles and techniques in data mining.
2. To introduce the ideas of develop better understanding of how data mining technology can be applied to various kind of data.
3. To impart knowledge on data analysis.
4. To introduce basics algorithms and concepts to analyze data.

**Course Outcomes:**

On the completion of this course the student will be able to

1. **Understand** the fundamentals of data mining concepts.
2. **Illustrate** basic types of data, data quality, pre-processing techniques, measure of similarity and

dissimilarity.

1. **Study** on data exploration, summary statistics, visualization techniques
2. **Apply** various algorithms to classify data.
3. **Examine** some basics of anomaly detection.

**Course Description:**

The main objective of the course is to enable organizations to accumulate vast amounts of data. However, extracting useful information has proven extremely challenging. This course introduces data mining methods with sophisticated algorithms for processing large volumes of data. It has also opened up exciting opportunities for exploring and analysing new types of data and for analysing old types of data in new ways. Data mining techniques can be used to support a wide range business intelligence application such as customer profiling, targeted marketing, workflow management and fraud detection. The course studies the methods and explores how they are employed mining techniques such as market expert systems for pattern recognition, clustering, diagnosis, and control both individually and in hybrid arrangement. The basics of each technique will be discussed, and industrial applications will illustrate the strengths of each approach.**Course Content:**

|  |  |
| --- | --- |
| **Unit-I** | **9 Lecture Hours** |
| **Introduction to data driven concepts:**  Introduction: What is data mining? Origin of data mining, Data mining tasks, Types of data, Data pre-processing: Sampling, Dimensionality reduction, feature creation, variable transformation, knowledge discovery process. | |
| **Unit-II** | **9 Lecture Hours** |
| **Introduction to KDD**  Importance of data mining, drawbacks of traditional data analysis, processing, data mining architecture.  **Introduction To Classification**  Basic concepts, Approach to solve classification problem, Decision Tree: working, building, measures for selecting best split, overfitting, evaluating, Rule-based classifier, Nearest neighbour classifiers, etc | |
| **Unit-III** | **9 Lecture Hours** |
| **Association Rule Learning**  Problem definition, Frequent Itemset generation: Apriori algorithm, Pruning, rule generation, FP-Growth, Evaluation of association patterns, Handling categorical data, sequential patterns, etc. | |
| **Unit-IV** | **9 Lecture Hours** |
| **Cluster Analysis**  K-Means, Agglomerative Hierarchical clustering, DBSCAN, clustering evaluation, Prototype-based clustering, Density-based clustering, Graph-based clustering, | |
| **Unit-V** | **9 Lecture Hours** |
| **Anomaly Detection**  Basics concepts, statistical approaches, detecting outliers, proximity-based outlier detection, density-based outlier detection.  **Applications of Data Mining and Case Studies**  Different case studies from industries on data ming,etc | |
| **Text Books:**   1. Introduction to data mining, Pang-Ningtan, Michael Steinbach, Vipin Kumar, Pearson 2. Data mining: Concepts and Techniques, by Jiawei Han and Micheline Kamber, Morgan Kaufmann, ISBN 1-55860-489-8. 3. Principles of Data Mining, by David Hand, Heikki Mannila, Padhraic Smyth, The MIT Press, ISBN 0-262-08290-X   **Reference Books:**   1. Reference books include "Data Mining: Concepts and Techniques" by Jiawei Han and Micheline Kamber, Elsevier, 2006. | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | **Understand** the fundamentals of data mining concepts. | PO1, PO2, PO3, PO4, PO5 |
| CO2 | **Illustrate** basic types of data, data quality, pre-processing techniques, measure of similarity and dissimilarity. | PO1, PO2, PO3, PO4 |
| CO3 | **Study** on data exploration, summary statistics, visualization techniques | PO1, PO2, PO3, PO4, PO5 |
| CO4 | **Apply** various algorithms to classify data. | PO1, PO2, PO3, |
| CO5 | **Examine** some basics of anomaly detection. | PO1, PO2, PSO1, |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long learning |
| **Course**  **Code** | **Course Title** | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO  9 | PO  10 | PO  11 | PO  12 |
| CSE21859 | Data Mining | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE21860** | **Computational Biology** | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours – 45 Hours** | **3** | **0** | **0** | **3** |
| **Pre-requisite/Exposure** | **C Programing** | | | | |
| **Co-requisite** | **NIL** | | | | |

**Course Objectives:**

1. To understand the fundamental concepts in Biology
2. To understand the algorithms used for Biological problems
3. To introduce the basic concepts and techniques of Machine Learning.
4. To understand and apply the fundamental concepts in graph theory.
5. To computationally formulate and apply different biological problems

**Course Outcomes:**

On the completion of this course, the student will be able to

1. **Understand** the basic concepts of biology and bioinformatics
2. **Discuss** the bioinformatics algorithm used for biological problems.
3. **Analyze** fundamental issues and challenges of machine learning
4. **Discuss** the different distance measures in graphs. Define the special types of graphs- complete graph, regular graph, bipartite graph and their properties.
5. **Apply** the concept of computation for biological problems

**Course Description:**

The objective of the course is to introduce students to the rapidly evolving field of biology and bioinformatics. The term "bioinformatics" often means different things to different scientists, and our goal is not to cover all those things. Rather, we will aim to cover in the lectures the most fundamental topics, such as sequence alignment and pattern finding, and then explore some of the frontier areas. We will also learn to solve different biological problems on the basis of Machine learning and Graph Theoretic Approach. After completing this course, the students will gain an understanding of the computational in the analysis of large biological data set. They will understand how some of the commonly used bioinformatics tools work, how to use these tools effectively, and how to read and evaluate research articles in the field.

**Course Content:**

|  |  |
| --- | --- |
| **Unit-I: Introduction** | **5 Lecture Hours** |
| **Unit Heading:**  Basic Biology: What is life? The unity and the diversity of living things. Prokaryotes and Eukaryotes, Yeast and People, Evolutionary time and relatedness, Living parts: Tissues, cells, compartments and organelles, Central dogma of molecular biology, Concept of DNA, RNA, Protein and metabolic pathway. What is Bioinformatics? Recent challenges in Bioinformatics. Biological databases: Their needs and challenges. Example of different biological databases – sequence, structure, function, microarrray, pathway, etc. | |
| **Unit-II: Bioinformatics Algorithm** | **10 Lecture Hours** |
| **Unit Heading:**  Simple Alignment, Needleman Wunsch Algorithm, Global and local Alignment,  Smith-waterman Algorithm, Divide and Conquer, Dynamic Programming, Substitution patterns, Variation of blast search, Multiple alignment - computational approach. Hidden Markov Model: Alignment and Predictor, Greedy algorithm in Bioinformatics, Biological content search on Biological database, Exhaustive Search. | |
| **Unit-III: Concept of Machine Learning** | **10 Lecture Hours** |
| **Unit Heading:**  Why Machine learning, Types of Machine Learning - Supervised Learning - Unsupervised Learning – reinforcement, The Curse of dimensionality, Over fitting and linear regression, Bias and Variance,  Linear Regression, Polynomial Regression, Features, Scaling, Cost Function, Gradient Descent, Learning Rate, Supervised Learning, Linear classifier, Logistic Regression, Multi-class Classification, Bias and Variance.  Unsupervised Learning, Clustering, K-Means, Optimization Using Evolutionary Techniques, Number of Clusters, Expectation Maximization, Dimensionality Reduction | |
| **Unit-IV:**  **Concept of Graph Theory** | **10 Lecture Hours** |
| **Unit Heading:**  Graph – definition; Degree sequences, Different distance measures in graphs, Special types of graphs – complete graph, regular graph, bipartite graph and their properties. Havel-Hakimi theorem and Erdos-Gallai theorem (statement only), hypercube graph, Petersen graph, trees, forests and spanning subgraphs, distances, radius, diameter, center of a graph, the number of distinct spanning trees in a complete graph. | |
| **Unit-IV:**  **Computational Biology** | **10 Lecture Hours** |
| Genomics and Proteomics: Interaction, Structure, Functional Clustering: GraphTheoretic approach, Machine Learning algorithm. | |
| **Text Books:**   1. Dan E.Krane, Michael L. Raymer. Fundamental Concepts of Bioinformatics. Pearson   Education, 2006   1. Jones, Neil C., and Pavel Pevzner. An introduction to bioinformatics algorithms. MIT   press, 2004.   1. D. Gusfield, Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology, Cambridge University Press, 1997.   **Reference Books:**   1. D. W. Mont, Bio-Informatics: Sequence and Genome Analysis, CSHL Press. 2. Forsdyke, Donald R. Evolutionary bioinformatics. Springer Science &amp; Business Media,   2010. | |

**Modes of Evaluation: Quiz/Assignment/Presentation/Extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
| **Course Outcomes (COs)** | | **Mapped Program Outcomes** |
| CO1 | Understand the different distance measures in graphs. Define the special types of graphs- complete graph, regular graph, bipartite graph and their properties | PO1, PO2 |
| CO2 | Discuss the properties of trees, Minimal Spanning Tree, Breadth First Search, Depth First Search, Hauffman Trees | PO1,PO2, PO3 |
| CO3 | Discuss the properties of trees, Arboricity, vertex and edge connectivity, auto-morphism groups, reconstruction problem and Mengers theorem | PO1,PO2 |
| CO4 | Interpret algorithms and methods for Graph Colouring and Connectivity | PO1, PO2, PO3 |
| CO5 | Discuss the properties of Planner Graphs and Ramsey Graphs. | PO1, PO2, PO3 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual or team work | Communication | Project management and finance | Life-long Learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE21860 | Computational Biology | 3 | 3 | 3 | - | - | - | - | - | - | - | - | - |

1 = Weakly Mapped  
2 = Moderately Mapped  
3 = Strongly Mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CSE25861 | Thesis (Part – I) | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours-240** | **0** | **0** | **24** | **16** |
| **Pre-requisites/Exposure** | **Basic idea of the required subjects** | | | | |
| **Co-requisites** |  | | | | |

**Course Objectives:**

* To be able to design, develop, document, and test software using current techniques.
* To understand the fundamentals of computer architecture and computing theory.
* To be able to solve problems working in group settings.
* To demonstrate the ability to give presentations and write technical reports.
* To demonstrate understanding of the importance of social and ethical issues related to the profession.

**Course Outcomes:**

On completion of this course, the students will be able to

CO1**. Identify** a real world problem

CO2. **Utilize** the modern tools to solve the problems

CO3. **Discuss** in a group to promote team spirit and leadership quality among the students

CO4. **Plan** a projects involving both technological aspects and finance

CO5. **Identify** newer areas of in depth study and research and lifelong learning

**Catalog Description:**

The course encourages students to take thesis works that are based on current trends and technologies in various subjects, which will augment the theory subjects. The students will form a group to do their thesis work. This teaming is to encourage team spirit and to insist the importance of team work. The students typically undergo group formation, finalization of area of work, testing, generation and verification of results, and possible research publication procedure.

**Course Content:**

The Evaluation of the thesis work are to be carried out in the following way:

1. In-depth study of a topic proposed by the supervisor

2. Continuous Evaluation through guide.

3. An open pre-submission seminar by the student.

4. End-semester University Examination (An open seminar followed by a Viva voce)

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **-** | **-** | **100** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Investigate** a real world problem | **PO2, PO3** |
| **CO2** | **Utilize** the modern tools to solve the problems | **PO2, PO3** |
| **CO3** | **Discuss** in a group to promote team spirit and leadership quality among the students | **PO1, PO9, PO11** |
| **CO4** | **Plan** a projects involving both technological aspects and finance | **PO3, PO7, PO9, PO10, PO11** |
| **CO5** | **Identify** newer areas of in depth study and research and lifelong learning | **PO7, PO9, PO11, PO12** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long Learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE25861 | Thesis (Part – I) | 1 | 2 | 3 | - | - | - | 2 | - | 1 | 1 | 3 | 1 |

1=weakly mapped

2= moderately mapped

3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE25862** | Seminar -I | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact hour-90** | **0** | **0** | **6** | **4** |
| **Pre-requisites/Exposure** | **Knowledge on Computer domain** | | | | |
| **Co-requisites** | **--** | | | | |

**Course Objectives:**

* To **develop** skills in doing literature survey, technical presentation and report preparation.
* To **enable** project identification and execution of preliminary works on final semester project

**Course Outcomes:**

On completion of this course, the students will be able to

CO1. **Identify** the advanced technologies and globalization

CO2. **Develop** communication and representation skills towards becoming a good team leader and

manager

CO3. **Plan** for lifelong learning towards industry readiness

CO4. **Build** the ability to identify an engineering problem, analyze it and propose a work plan to

solve it.

**Catalog Description:**

The course involves presentation and report submission by every student. Reference search and technical writing skills along with effective presentation skills are focused. The course strengthens the research attributes including literature survey.

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Identify** the advanced technologies and globalization | **PO1, PO2, PO3** |
| **CO2** | **Develop** communication and representation skills towards becoming a good team leader and manager | **PO9, PO10** |
| **CO3** | **Plan** for lifelong learning towards industry readiness | **PO1, PO12** |
| **CO4** | **Build** the ability to identify an engineering problem, analyze it and propose a work plan to solve it. | **PO1, PO2, PO3, PO4, PO5, PO6** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual or team work | Communication | Project management and finance | Life-long Learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| **CSE25862** | Seminar -I | 3 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 |

1=weakly mapped

2= moderately mapped

3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| CSE25863 | Thesis (Part – II) | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hours -270** | **0** | **0** | **27** | **18** |
| **Pre-requisites/Exposure** | **Basic idea of the required subjects** | | | | |
| **Co-requisites** |  | | | | |

**Course Objectives:**

1. To be able to design, develop, document, and test software using current techniques.

2. To understand the fundamentals of computer architecture and computing theory.

3. To be able to solve problems working in group settings.

4. To demonstrate the ability to give presentations and write technical reports.

5. To demonstrate understanding of the importance of social and ethical issues related to the profession.

**Course Outcomes:**

On completion of this course, the students will be able to

CO1**. Identify** a real world problem

CO2. **Utilize** the modern tools to solve the problems

CO3. **Discuss** in a group to promote team spirit and leadership quality among the students

CO4. **Plan** a projects involving both technological aspects and finance

CO5. **Identify** newer areas of in depth study and research and lifelong learning

**Catalog Description:**

The course encourages students to take thesis works that are based on current trends and technologies in various subjects, which will augment the theory subjects. The students will form a group to do their thesis work. This teaming is to encourage team spirit and to insist the importance of team work. The students typically undergo group formation, finalization of area of work, testing, generation and verification of results, and possible research publication procedure.

**Course Content:**

The Evaluation of the thesis work are to be carried out in the following way:

1. In-depth study of a topic proposed by the supervisor

2. Continuous Evaluation through guide.

3. An open pre-submission seminar by the student.

4. End-semester University Examination (An open seminar followed by a Viva voce)

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **-** | **-** | **100** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Investigate** a real world problem | **PO2,PO3** |
| **CO2** | **Utilize** the modern tools to solve the problems | **PO2,PO3, PO11** |
| **CO3** | **Discuss** in a group to promote team spirit and leadership quality among the students | **PO1, PO9** |
| **CO4** | **Plan** a projects involving both technological aspects and finance | **PO3,PO7, PO9,PO10, PO11** |
| **CO5** | **Identify** newer areas of in depth study and research and lifelong learning | **PO7, PO9, PO11,PO12** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual and team work | Communication | Project management and finance | Life-long Learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE25863 | Thesis (Part – II) | 1 | 2 | 3 | - | - | - | 2 | - | 3 | 1 | 3 | 1 |

1=weakly mapped 2= moderately mapped 3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE25864** | Seminar –II | **L** | **T** | **P** | **C** |
| **Version 1.0** | **Contact Hour - 60** | **0** | **0** | **6** | **4** |
| **Pre-requisites/Exposure** | **Knowledge on Computer Domain** | | | | |
| **Co-requisites** | **--** | | | | |

**Course Objectives:**

* To **develop** skills in doing literature survey, technical presentation and report preparation.
* To **enable** project identification and execution of preliminary works on final semester project

**Course Outcomes:**

On completion of this course, the students will be able to

CO1. **Identify** the advanced technologies and globalization

CO2. **Develop** communication and representation skills towards becoming a good team leader and

manager

CO3. **Plan** for lifelong learning towards industry readiness

CO4. **Build** the ability to identify an engineering problem, analyze it and propose a work plan to

solve it.

**Catalog Description:**

The course involves presentation and report submission by every student. Reference search and technical writing skills along with effective presentation skills are focused. The course strengthens the research attributes including literature survey.

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Identify** the advanced technologies and globalization | **PO1, PO2, PO3** |
| **CO2** | **Develop** communication and representation skills towards becoming a good team leader and manager | **PO9, PO10** |
| **CO3** | **Plan** for lifelong learning towards industry readiness | **PO1, PO12** |
| **CO4** | **Build** the ability to identify an engineering problem, analyze it and propose a work plan to solve it. | **PO1, PO2, PO3, PO4, PO5, PO6** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual or team work | Communication | Project management and finance | Life-long Learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE25864 | Seminar -II | 3 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 |

1=weakly mapped

2= moderately mapped

3=strongly mapped

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CSE25865** | Grand Viva | **L** | **T** | **P** | **C** |
| **Version 1.0** |  | **0** | **0** | **0** | **4** |
| **Pre-requisites/Exposure** | **Willing to knowledge acquisition** | | | | |
| **Co-requisites** | **--** | | | | |

**Course Objectives:**

1. To Give an overview of emerging technology and relate to subject.
2. To enable students to improve their reasoning ability.
3. To give the students a outline of technical question.
4. To expound Idea dissemination for a new technology by assessment of pupil’s knowledge.

**Course Outcomes:**

On completion of this course, the students will be able to

CO1**. Understand** importance of knowledge acquisition.

CO2**. Conceptualize** the real-life scenario, based on viva question.

CO3. **Formalize** and practical implementation with emerging application.

CO4**. Expound** understanding in technology up gradation.

**Catalog Description:**

The course tests the technical knowledge acquired during the study, spoken skills, and the ability to think logically under time pressure. The course proves extremely useful for placement interviews

**Course Content:**

Scientific approach to resolve open end question, Theoretical Vs Practical exploration, in research paradigms, epistemology and ontology in management research, positivism vs. interpretivism, subjectivism vs. objectivism.

Foundations of confidence building in answering question, Categories of theory, theory building vs. theory testing, conceptualization and hypothesis testing. Analyze the conformity of the system to the functional requirements Appreciate importance of fundamental knowledge and its application.

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Components** | **Mid Term** | **Class Assessment** | **End Term** |
| **Weightage (%)** | **20** | **30** | **50** |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

|  |  |  |
| --- | --- | --- |
| **Mapping between COs and POs** | | |
|  | **Course Outcomes (COs)** | **Mapped Program Outcomes** |
| **CO1** | **Understand** importance of knowledge acquisition. | **PO4,PO10,** |
| **CO2** | **Conceptualize** the real-life scenario, based on viva question | **PO10 PO3,PO5,PO6, PO8,PO9,PO2,** |
| **CO3** | **Formalize** and practical implementation with emerging application. | **PO1, PO12, PO2, PO3,PO5,PO6** |
| **CO4** | **Expound** understanding in technology up gradation. | **PO2, PO3,PO5,PO6,PO7,P09,PO11** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Engineering Knowledge | Problem analysis | Design/development of solutions | Conduct investigations of complex problems | Modern tool usage | The engineer and society | Environment and sustainability | Ethics | Individual or team work | Communication | Project management and finance | Life-long Learning |
| Course Code | Course Title | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CSE25865 | GrandViva | 2 | 3 | 3 | 1 | 3 | 3 | 1 | 1 | 2 | 3 | 1 | 1 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CONSOLIDATED CO-PO MAPPING TABLE** | | | | | | | | | | | | | | |
| **Code** | **Course Title** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| CSE21841 | Advanced Database Management systems | 3 | 3 | 3 | 2 | 1 | - | 1 | - | - | - | - | - |
| CSE21842 | Soft Computing | 3 | 3 | 3 | 3 | 3 | 1 | - | - | - | - | - | - |
| CSE21843 | Advance Graph Theory | 3 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| CSE21844 | Foundation of Computing Science | 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - |
| CSE22845 | Applied Computing Lab –I | 2 | 2 | 2 | 1 | 1 | 1 | - | - | - | - | - | - |
| CSE21846 | Blockchain and Cryptocurrency | 3 | 3 | - | - | 3 | - | - | - | - | - | - | - |
| CSE21847 | Software Process Management | 3 | 3 | 1 | - | 1 | - | 1 | - | - | - | - | - |
| CSE21848 | Natural Language Processing | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - |
| CSE21849 | Computer Forensics | 3 | 3 | 3 | 2 | 2 | - | 2 | - | - | - | - | - |
| CSE21850 | Software Architecture | 3 | 3 | 1 | 1 | - | - | - | - | - | - | 1 | 3 |
| CSE21843 | Computer Vision | 2 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - |
| CSE21852 | Introduction to Information Security Management | 3 | 3 | 1 | - | 2 | - | 1 | - | - | - | - | - |
| CSE21853 | Software Security | 3 | 3 | 2 | - | 1 | - | - | - | - | - | - | - |
| CSE21854 | Social Network Analysis | - | 3 | 3 | 3 | 1 | 1 | - | - | - | - | - | 2 |
| CSE21855 | Research Methodologies | 3 | 3 | 3 | 2 | 1 | - | 1 | - | - | - | - | - |
| CSE21856 | Parallel and Distributed Computing | 3 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - |
| CSE22857 | Applied Computing Lab-II | 3 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - |
| CSE21858 | Advanced Network Security | 3 | 3 | - | - | 3 | - | - | - | - | - | - | - |
| CSE21859 | Data Mining | 3 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - |
| CSE21860 | Computational Biology | 3 | 3 | 3 | - | - | - | - | - | - | - | - | - |
| CSE25861 | Thesis (Part – I) | 1 | 2 | 3 | - | - | - | 2 | - | 1 | 1 | 3 | 1 |
| CSE25862 | Seminar -I | 3 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 |
| CSE25863 | Thesis (Part – II) | 1 | 2 | 3 | - | - | - | 2 | - | 3 | 1 | 3 | 1 |
| CSE25864 | Seminar -II | 3 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 1 | - | 1 |
| CSE25865 | GrandViva | 2 | 3 | 3 | 1 | 3 | 3 | 1 | 1 | 2 | 3 | 1 | 1 |
|  | **AVERAGE** | 2.7 | 2.8 | 2.5 | 2 | 2 | 1.5 | 1.4 | 1 | 1.6 | 1.4 | 2 | 1.5 |