# ANNEXURE - I

# DEPARTMENT OF INFORMATION TECHNOLOGY

Course Structure & Syllabus
for
Master of Technology in Information Technology (1st year)
w.e.f Academic Session 2025 – 26

SCHOOL OF ENGINEERING & TECHNOLOGY
NAGALAND UNIVERSITY
(KOHIMA CAMPUS)
MERIEMA – 797004

## About the Program

In the 2-year M. Tech in Information Technology Programme, students delve into advanced topics spanning Cloud Computing, Network Security, Information Processing, and Data Privacy. They gain insights into ongoing research endeavors and tackle open challenges within these domains, equipping themselves to embark on research pursuits in Information Technology. Graduates inclined towards further academic exploration have the option to pursue a PhD degree. Various research avenues await in fields such as Cloud Computing, IoT, Machine Learning, Deep Learning, AI, Data Analytics, Social Networking, Digital Marketing, Computer Networks, Mobile Adhoc Networks, Image Processing, Machine Vision, Virtual Reality, and Augmented Reality.

### Recommendation to Students

Students looking forward to research in the domain areas listed above should select this course. It will groom them towards further research.

Students interested in IT Industry careers as Data Analysts, Security Analysts or IT Architects will find this programme useful.

### Duration of Course

**2 Years**

### Who Should opt for the Program

- Graduates in Information Technology, Computer Science or Electronics and Communication, MCA, M.Sc. in Computer Science

- IT Professionals Seeking Career Advancement: Working professionals in the IT industry who aspire to advance their careers and take on leadership roles or specialize in specific domains such as data science, artificial intelligence, or cloud computing.

- Engineers with a Background in IT: Engineers from other disciplines (such as electronics and communication, electrical engineering, or mechanical engineering) who wish to transition into the IT sector or acquire expertise in IT-related areas for career diversification or advancement.

- Aspiring Researchers and Academicians: Individuals interested in pursuing research careers or academic positions in universities and research institutions, where an MTech degree serves as a stepping stone towards a PhD or a career in academia.

- Entrepreneurs and Innovators: Entrepreneurs and innovators looking to develop technical expertise and gain insights into emerging technologies to drive innovation or, start tech ventures, or lead technology-driven initiatives in various sectors.

### Eligibility Criteria for Admission

Nagaland University's general rules and regulations are applied for admission criteria. More specifically, admissions to MTech in Information Technology would be processed by the school’s admission committee based on an entrance examination (with a minimum of 55% marks) conducted at the department level (GATE or CUET qualified candidates may be directly shortlisted, with the cut-off marks decided by admission committee), followed by a counselling

procedure by the department. The candidates sponsored by Companies or government organizations may be directly shortlisted and selected by an interview process set up by the school's admission committee. **Each year, ten students can be admitted.**

## Professional Opportunities

The prospects for students who pursue an MTech in Information Technology are generally promising, given the increasing demand for skilled IT professionals in various industries. Here are some potential career prospects for MTech graduates in Information Technology:

**Employment Opportunities:** MTech graduates in Information Technology have a myriad of professional opportunities available in both public and private sectors. They can pursue careers in IT companies, software development firms, consulting agencies, research institutions, government entities, and academia.

**Specialized Roles**: With advanced knowledge and skills acquired during their MTech program, graduates can pursue specialized roles in cybersecurity, data science, artificial intelligence, cloud computing, networking, software engineering, and more.

**Career Advancement**: The MTech degree equips graduates with the expertise needed to take on leadership roles and advance their careers in the IT industry. They may progress to positions such as project managers, IT consultants, technology architects, senior software engineers, or research scientists.

**Research and Development:** MTech graduates interested in research can pursue opportunities in research and development (R&D) organizations, where they can contribute to cutting-edge projects, develop new technologies, and publish research papers in leading journals and conferences.

**Entrepreneurship:** Some MTech graduates may choose to start their technology ventures or work in startups, leveraging their technical skills and domain knowledge to innovate and create new products, services, or solutions in the IT sector.

**Global Opportunities:** IT professionals with an MTech degree often have opportunities to work abroad or collaborate on international projects, especially in fields like cybersecurity, data analytics, and artificial intelligence that have global significance.

**Lifelong Learning:** The MTech program provides a solid foundation for continuous learning and professional development. Graduates can pursue certifications, attend workshops, participate in conferences, and engage in lifelong learning to stay updated with the latest trends and advancements in the field.

# Course Structure of M. Tech in Information Technology

| **Semester 1** | | | | | | |
|---|---|---|---|---|---|---|
| **S.N.** | **Course code** | **Course title** | **L** | **T** | **P** | **Credits** |
| 1 | ITPG101 | Foundations of Computing Science | 3 | 1 | 0 | 4 |
| 2 | ITPG102 | Algorithm Design and Analysis | 3 | 1 | 0 | 4 |
| 3 | ITPGE100* | Elective -I | 3 | 1 | 0 | 4 |
| 4 | ITPGE100* | Elective -II | 3 | 1 | 0 | 4 |
| 5 | ITPGT114 | Advanced Algorithms Lab | - | - | 3 | 3 |
| 6 | ITPGT105 | Seminar-I | - | - | - | 3 |
| | | Total Credits | | | | 22 |

| Semester 2 | | | | | | |
|---|---|---|---|---|---|---|
| **S.N.** | **Course code** | **Course title** | **L** | **T** | **P** | **Credits** |
| 1 | ITPG201 | Advanced Computer Architecture (ACA) | 3 | 1 | 0 | 4 |
| 2 | ITPG202 | Database Engineering | 3 | 1 | 0 | 4 |
| 3 | ITPGE200* | Elective III | 3 | 1 | 0 | 4 |
| 4 | ITPGE200* | Elective IV | 3 | 1 | 0 | 4 |
| 5 | ITPGT214 | Advanced Database Lab | 0 | 0 | 3 | 3 |
| 6 | ITPGT205 | Seminar-II | | | | 3 |
| | | Total | | | | 22 |
| | | | | | | |
| | | | | | | |
| | | **Total credit** | | | | **44** |

| **Elective I** | | | | | | |
|---|---|---|---|---|---|---|
| **S.N.** | **Course code** | **Course title** | **L** | **T** | **P** | **Credits** |
| 1 | ITPGE101 | Advanced Machine Learning | 3 | 1 | 0 | 4 |
| 2 | ITPGE102 | Software Architecture and Design Patterns | 3 | 1 | 0 | 4 |
| 3 | ITPGE103 | Parallel and Distributed Algorithms | 3 | 1 | 0 | 4 |

| **Elective II** | | | | | | |
|---|---|---|---|---|---|---|
| **S.N.** | **Course code** | **Course title** | **L** | **T** | **P** | **Credits** |
| 1 | ITPGE104 | Biometrics | 3 | 1 | 0 | 4 |
| 2 | ITPGE105 | Business Intelligence & Big Data | 3 | 1 | 0 | 4 |
| 3 | ITPGE106 | Soft Computing | 3 | 1 | 0 | 4 |

| **Elective III** | | | | | | |
|---|---|---|---|---|---|---|
| **S.N.** | **Course code** | **Course title** | **L** | **T** | **P** | **Credits** |
| 1 | ITPGE201 | Embedded Systems | 3 | 1 | 0 | 4 |
| 2 | ITPGE202 | Advanced Graph Theory | 3 | 1 | 0 | 4 |
| 3 | ITPGE203 | Predictive Analytics for Internet of Things | 3 | 1 | 0 | 4 |
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| **Elective IV** | | | | | | |
|---|---|---|---|---|---|---|
| **S.N.** | **Course Code** | **Course Title** | **L** | **T** | **P** | **Credits** |
| 1 | ITPGE204 | Text Mining and Analytics | 3 | 1 | 0 | 4 |
| 2 | ITPGE205 | Advanced-Data Visualization and Analytics | 3 | 1 | 0 | 4 |
| 3 | ITPGE206 | Advanced Machine Learning for Biomedical Data Analysis | 3 | 1 | 0 | 4 |
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# Detailed Syllabus

## 1. Foundations of Computing Science

### Course Objectives:

- Understand fundamental discrete structures, proof techniques, and algebraic structures.

- Explore formal logic, including propositional and predicate calculus, along with soundness and completeness concepts.
- Study automata theory, language hierarchies, Turing machines, and their computational capabilities.
- Analyze computability and computational complexity, including decision problems, NP-completeness, and space complexity.

## Course Outcomes:

- Apply discrete mathematical structures and logical reasoning to computational problems.
- Demonstrate an understanding of formal language theory and automata concepts.
- Analyze problems in terms of computability and recognize decidable and undecidable problems.
- Classify problems based on computational complexity and understand the implications of NP-completeness.

Detailed contents:

Unit 1: Discrete Structures -- Sets, Relations and Functions; Proof Techniques, Algebraic Structures, Morphisms, Posets, Lattices and Boolean Algebras.

Unit 2: Logic -- Propositional calculus and Predicate Calculus, Satisfiability and validity, Notions of soundness and completeness

Unit 3: Languages & Automata Theory -- Chomsky Hierarchy of Grammars and the corresponding acceptors, Turing Machines, Recursive and Recursively Enumerable Languages; Operations on Languages, closures with respect to the operations.

Unit 4: Computability -- Church-Turing Thesis, Decision Problems, Decidability and Undecidability, Halting Problem of Turing Machines; Problem reduction (Turing and mapping reduction).

Unit 5: Computational Complexity -- Time Complexity -- Measuring Complexity, The class P, The class NP, NP-Completeness, Reduction, co-NP, Polynomial Hierarchy. Space Complexity -- Savich's Theorem, The class PSPACE.

**Recommended Books**

**Text Books and References:**

1. J.P. Trembley and R. Manohar -- Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill Book Co.,

2. Michael Sipser -- Introduction to The Theory of Computation, Thomson Course Technology.

3. John E. Hopcroft and J.D.Ullman -- Inrtroduction to Automata Theory, Languages and Computation, Narosa Pub. House, N. Delhi.

4. H.R. Lewis and C.H. Papadimitrou -- Elements of the Theory of Computation, Prentice Hall, International, Inc.

## 2. Algorithm Design and Analysis

### Course Objectives:

- Understand fundamental algorithmic paradigms, complexity analysis, and optimization techniques.
- Explore graph algorithms, NP-completeness, and approximation strategies for computational problems.
- Study randomized algorithms and linear programming for problem-solving in diverse domains.
- Investigate specialized topics, including geometric, numerical, and internet algorithms.

### Course Outcomes:

- Apply algorithmic paradigms and complexity analysis techniques to optimize problem-solving.
- Implement efficient graph algorithms and analyze NP-complete problems using reductions.
- Utilize randomized and approximation algorithms for tackling computational challenges.
- Solve real-world problems using geometric, numerical, and internet-based algorithmic techniques.

Detailed contents:

Unit 1: Algorithmic paradigms: Dynamic Programming, Greedy, Branch-and-bound; Asymptotic complexity, Amortized analysis;

Unit 2: Graph Algorithms: Shortest paths, Flow networks;

Unit 3: NP-Completeness and Approximation Algorithms: Polynomial time, Polynomial time verification, NP-completeness and reducibility, profs, NP-completeness examples, Vertex Cover problem, Travelling Salesman Problem, Set Covering Problem

Unit 4: Randomized algorithms;

Unit 5: Linear programming;

Special topics: Geometric algorithms (range searching, convex hulls, segment intersections, closest pairs, Priority Search trees, Quadtrees and k-D trees, Plan Sweep Technique), Numerical algorithms (integer, matrix and polynomial multiplication, FFT, extended Euclid's algorithm, modular exponentiation, primality testing, cryptographic computations), Internet algorithms (text pattern matching, tries, information retrieval, data compression, Web caching).

**Recommended Books**

References: 1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, Introduction to Algorithms, MIT Press, 3rd Edition, 2009.

2. Michael T. Goodrich and Roberto Tamassia, Algorithm Design Foundations, Analysis, and Internet Examples, John Wiley & Sons, Inc., 2nd Edition, 2009.

3. Gilles Brassard and Paul Bratley, Fundamentals of Algorithmics, Prentice Hall, 1996.

## 3.Advanced Computer Architecture (ACA)

**Course Objectives**

- Understand the basics of computer architecture and its classifications (SISD, SIMD, MIMD, etc.).
- Learn about advanced microprocessor designs like RISC, CISC, and multicore technologies.
- Explore storage systems and interconnect technologies used in modern computing.
- Study parallel programming models and tools used in high-performance computing.

**Course Outcomes**

- Identify and classify different computer architectures and their applications.
- Explain modern processor designs and their performance optimizations.
- Analyze storage solutions and system interconnects for better computing performance.
- Use parallel programming techniques to solve computational problems effectively.

Detailed contents:

Unit 1: System Architecture

History /Evolution, Definition: Hardware /Software Architecture, Flynn's Classification: SISD, SIMD, MISD, MIMD. Physical Models: PVP, MPP, SMP& Cluster of Workstations (COW). Memory Architectures: Shared, Distributed & Hybrid. Performance Metrics & Benchmarks (Micro/Macro) Architectural Trends based on TOP 500 List of Supercomputers.

Unit 2: Advanced Microprocessor Techniques

CISC, RISC, EPIC, Superscalar, Super-pipelined Architectures, Superscalar/ Super-pipelined, In Order Execution /Out of Order Execution (OOO), ILP, TLP, Power Wall, Moore's Law Redefined, Multicore Technologies, Intel's Tick-Talk Model. Study of State-of-the- ART Processors: Intel / AMD X86-64 Bit Series, Introduction to Graphics Processing Units (GPU-NVIDIA)

Unit 3: System Interconnects

SAN: System Area Networks, Storage Area Networks including InfiniBand, Gigabit Ethernet, Scalable Coherent Interface (SCI) Standard

Unit 4: Storage

Internal/External, Disk Storage, Areal Density, Seek Time, Disk Power, Advanced RAID Levels, SATA vs SAS Disks, Network Attached Storage (NAS), Direct Attached Storage (DAS), I/O Performance Benchmarks.

Unit 5: Software Architecture

Parallel Programming Models: Message Passing, Data Parallel, MPI/ PVM. Typical HPCC Software Stack including Cluster Monitoring Tools, Public Domain Software like GANGLIA, CUDA Programming Environment. Case Studies: IBM SP System, C-DAC's latest PARAM Systems [PARAM Yuva-II], Sequent NUMA Q

## 4. Database Engineering

### Course Objectives:

- Understand relational model constraints, normalization techniques, and database design principles.
- Learn query processing, optimization techniques, and evaluation strategies for relational expressions.
- Explore object-oriented and object-relational database concepts, standards, and design methodologies.
- Study advanced database security models, transaction processing, and real-world database management systems.

### Course Outcomes:

- Apply relational database design principles and normalization techniques to optimize database structures.
- Implement efficient query processing and optimization strategies to improve database performance.
- Develop object-relational database models and understand their applications in modern databases.
- Analyze security mechanisms, advanced transaction processing, and real-world database case studies.

Detailed contents:

Unit 1: Relational Model Constraints, update operations, transactions, and dealing with constraint violations, Relational database design algorithms, MVDs and 4NF, JD and 5NF, inclusion dependencies, other dependencies and normal forms.

Unit 2: Query Processing & Optimization Measures of Query Cost, Selection Operation, Sorting, Join Operation, Other Operations, Evaluation of Expressions. Transformation of Relational Expressions, Estimating Statistics of Expression Results, Choice of Evaluation Plans, Materialized Views, Advanced Topics in Query Optimization.

Unit 3: Object & Object-Relational Databases Concepts of Object databases, Object database standards, languages and design, Object-relational and Extended-Relational Systems.

Unit 4: Security, Advanced Modeling Database Security Enhanced data models for advanced applications – active databases, temporal databases, spatial and multimedia databases, deductive databases.

Unit 5: Advanced Transaction Processing - Transaction-Processing Monitors, Transactional Workflows, E-Commerce, Main-Memory Databases, Real-Time Transaction Systems, Long-Duration Transactions. Case studies: PostgreSQL, IBM DB2, Oracle, Microsoft SQL server.

**Text Books:**

1. Fundamentals of Database Systems, Elmasri Navrate Pearson Education, V edition.
2. Database System Concepts, Silberschatz, Korth, McGraw hill, VI edition.

**Reference Books:**

1. Database Systems Design, Implementation, and Management, Peter Rob & Carlos Coronel 7th Edition.
2. Introduction to Database Systems, C.J. Date Pearson Education.
3. Oracle for Professionals, The X Team, S. Shah and V. Shah, SPD.
4. Database Systems Using Oracle: A Simplified Guide to SQL and PL/SQL, Shah, PHI.
5. Fundamentals of Database Management Systems, M.L. Gillenson, Wiley Student Edition.

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## Advanced Database lab

**Course Objectives:**

- To explore the features of a Database Management Systems.
- To interface a database with front-end tools.
- To understand the internals of a database system

**Course Outcomes:**

- Ability to use databases for building web applications.
- Gaining knowledge about the internals of a database system.

Experiments

1. Basic SQL
2. Intermediate SQL
3. Advanced SQL
4. ER Modeling
5. Database Design and Normalization
6. Accessing Databases from Programs using JDBC
7. Building Web Applications using PHP & MySQL
8. Indexing and Query Processing
9. Query Evaluation Plans
10. Concurrency and Transactions
11. Big Data Analytics using Hadoop

References

1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, 6th edition, Tata McGraw Hill, 2011
2. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, 4th Edition, Pearson/Addision wesley, 2007

## Advanced Algorithm Lab

**Course Objectives:**

Algorithms / Exercises from different units in the syllabus will be implemented in Lab. The student writes their programs in Python language.

**Course Outcomes:**

After the lab course the student will be

● Equipped with the skill set to prove the correctness through strategies such as loop invariants and bound functions.

● Able to write programs by the principles of algorithmic design. Recommended Exercises: ● convert a recursive programme to an iterative programme

● Write programs for various paradigms such as Divide and Conquer, Dynamic Programming and Greedy Method.

● Analyze randomized algorithms

● Code various sorting algorithms

● Write code for geometric and string algorithms

**Text Book**: Thomas H Cormen, Charles E Leiserson, Ronald Rivest, Cliffor Stein., Introduction to algorithms, 3rd edition, (July 31, 2009)

## Advanced Machine Learning (Elective -I)

**Course Objectives:**

- To understand the fundamentals of machine learning and its applications in classification, regression, and reinforcement learning.
- To explore advanced machine learning techniques, including Bayesian modeling, Gaussian processes, and approximate inference.
- To study deep learning models, such as CNNs and RNNs, and their applications in various domains.
- To learn evaluation metrics, cross-validation techniques, and statistical approaches to assess machine learning models.

**Course Outcomes:**

- Apply machine learning techniques, including supervised and unsupervised learning, to solve practical problems.
- Implement advanced machine learning methods like Bayesian networks and Gaussian processes.
- Design deep learning models and apply them to tasks in computer vision, NLP, and generative modeling.
- Evaluate machine learning models using appropriate metrics and validation techniques for reliable performance.

Detailed contents:

Unit 1 Introduction to Machine Learning, Examples of Machine Learning applications - Learning associations, Classification, Regression, Unsupervised Learning, Reinforcement Learning. Supervised learning- Input representation, Hypothesis class, Version space, Vapnik-Chervonenkis (VC) Dimension.

Unit 2 Advanced machine learning topics: Bayesian modelling and Gaussian processes, randomized methods, Bayesian neural networks, approximate inference.

Unit 3 Deep learning: regularization, convolutional neural networks, recurrent neural networks, variational autoencoders, generative models, applications.

Unit 4 Applications of machine learning in natural language processing: recurrent neural networks, backpropagation through time, long short-term memory, attention networks, memory networks, neural Turing machines, machine translation, question answering, speech recognition, syntactic and semantic parsing, GPU optimization for neural networks.

Unit 5 Evaluation in ML: metrics, cross-validation, statistics, addressing the multiple comparisons problem.

**Text Books**:

1 Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012

2. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016

**Reference Books**:

1. Bayesian Reasoning and Machine Learning David Barber, Cambridge University Press, 2012.

2. Richard o. Duda, Peter E. Hart and David G. Stork, pattern classification, John Wiley & Sons Inc.,2001.

3. Chris Bishop, Neural Networks for Pattern Recognition, Oxford University Press, 1995.

## Software Architecture and Design Patterns (Elective-I)

**Course Objectives:**

- To understand the fundamental concepts, principles, and practices of software architecture, including patterns, models, and quality attributes.
- To learn techniques for creating, documenting, and reconstructing software architectures to meet desired quality attributes.
- To explore methods for evaluating architectural designs and decision-making using techniques like ATAM and CBAM.
- To study and apply design patterns (creational, structural, and behavioral) to solve recurring software design problems.
- To analyze real-world case studies to understand the practical applications of architectural principles in various domains.

**Course Outcomes:**

- Explain the software architecture business cycle and the role of architectural patterns, structures, and views in system design.
- Design and document software architectures that achieve desired quality attributes using appropriate architectural styles and patterns.
- Evaluate and improve software architectures using structured methods like ATAM and CBAM.
- Apply creational, structural, and behavioral design patterns to address design challenges in software systems.
- Analyze and derive insights from real-world case studies, such as the World Wide Web, Air Traffic Control, and Celsius Tech, for practical architectural solutions.

Detailed contents:

Unit: 1 Envisioning Architecture: The Architecture Business Cycle, What is Software Architecture, Architectural patterns, reference models, reference architectures, architectural structures and views. Creating an Architecture: Quality Attributes, Achieving qualities, Architectural styles and patterns, designing the Architecture, Documenting software architectures, Reconstructing Software Architecture.

Unit: 2 Analysing Architectures: Architecture Evaluation, Architecture design decision making, ATAM, CBAM.

Unit: 3 Moving from one system to many: Software Product Lines, Building systems from off-the-shelf components, Software architecture in future.

Unit: 4 Patterns: Pattern Description, Organizing catalogues, role in solving design problems, Selection and usage. Creational and Structural patterns: Abstract factory, builder, factory method, prototype, singleton, adapter, bridge, composite, façade, flyweight, Proxy.

Unit: 5 Behavioural patterns: Chain of responsibility, command, Interpreter, iterator, mediator, memento, observer, state, strategy, template method, visitor. Case Studies: A case study in utilizing architectural structures, The World Wide Web - a case study in interoperability, Air Traffic Control – a case study in designing for high availability, Celsius Tech – a case study in product line development.

**Text Books**:

1. Software Architecture in Practice, second edition, Len Bass, Paul Clements & Rick Kazman, Pearson Education,2003.
2. Design Patterns, Erich Gamma, Pearson Education, 1995.

**Reference Books:**

1. Beyond Software architecture, Luke Hohmann, Addison Wesley, 2003.
2. Software architecture, David M. Dikel, David Kane and James R. Wilson, Prentice Hall PTR, 2001
3. Software Design, David Budgen, second edition, Pearson Education, 2003.
4. Head First Design patterns, Eric Freeman & Elisabeth Freeman, O'REILLY, 2007.
5. Design Patterns in Java, Steven John Metsker & William C. Wake, Pearson Education, 2006.

## Parallel and Distributed Algorithms (Elective -I)

**Course Objectives:**

- To understand the principles and techniques of developing parallel and distributed algorithms for shared memory and message-passing models.
- To explore the key classes of parallel algorithms and their complexity and correctness models.
- To study advanced topics like message passing, pipelining, and load balancing in parallel and distributed computing.
- To learn programming constructs for shared and distributed memory systems and apply them to sorting and numerical algorithms.

**Course Outcomes:**

- Develop parallel algorithms using shared memory and message-passing models, optimizing computation speed through parallel and cluster computing.
- Apply partitioning, divide-and-conquer strategies, and pipelining techniques in parallel programs.
- Implement synchronous computations, load balancing, and data-parallel programming using languages and tools such as OpenMP.
- Design and analyze distributed shared memory systems and implement algorithms like sorting and numerical computations in distributed environments.

Detailed contents:

Unit: 1 To learn parallel and distributed algorithms development techniques for shared memory and message passing models. To study the main classes of parallel algorithms. To study the complexity and correctness models for parallel algorithms. Basic Techniques, Parallel Computers for increase Computation speed, Parallel & Cluster Computing.

Unit: 2 Message Passing Technique- Evaluating Parallel programs and debugging, Portioning and Divide and Conquer strategies examples.

Unit: 3 Pipelining- Techniques computing platform, pipeline programs examples.

Unit: 4 Synchronous Computations, load balancing, distributed termination examples, programming with shared memory, shared memory multiprocessor constructs for specifying parallelise sharing data-parallel programming languages and constructs, open MP.

Unit: 5 Distributed shared memory systems, constant memory, distributed shared memory, programming primitives, algorithms: sorting and numerical algorithms.

**Text Book**:

1. Parallel Programming, Barry Wilkinson, Michael Allen, Pearson Education, 2nd Edition.

**Reference Book**:

1. Introduction to Parallel Algorithms by Jaja from Pearson, 1992.

## Biometrics (Elective- II)

**Course Objectives:**

- To understand the fundamentals of biometric security, its benefits, and performance metrics.
- To explore various biometric technologies, including finger scan, facial scan, iris scan, and voice scan, along with their strengths and limitations.
- To study additional biometric methods such as hand scan, retina scan, and behavioral biometrics like signature and keystroke analysis.
- To examine the applications of biometric systems, focusing on privacy, biometric standards, and their integration into network security.

**Course Outcomes:**

- Explain the principles of biometric security, including verification, identification, and accuracy metrics such as false match and false non-match rates.
- Analyze the components, operation steps, and technologies behind various biometric systems like finger scan, facial scan, iris scan, and voice scan.
- Compare different physiological and behavioral biometrics, understanding their applications and limitations.
- Design privacy-aware biometric systems, leveraging biometric standards, middleware, and network security measures to address real-world challenges.

Detailed contents:

Unit: 1 Introduction – Benefits of biometric security – Verification and identification – Basic working of biometric matching – Accuracy – False match rate – False non-match rate – Failure to enrol rate – Derived metrics– Layered biometric solutions.

Unit: 2 Finger scan – Features – Components – Operation (Steps)– Competing finger Scan technologies – Strength and weakness. Types of algorithms used for interpretation, Facial Scan - Features – Components – Operation (Steps) – Competing facial Scan technologies – Strength and weakness.

Unit: 3 Iris Scan - Features – Components – Operation (Steps) – Competing iris Scan technologies – Strength and weakness. Voice Scan - Features – Components – Operation (Steps) – Competing voice Scan (facial) technologies Strength and weakness.

Unit: 4 Other physiological biometrics – Hand scan – Retina scan– AFIS (Automatic Finger Print Identification Systems) – Behavioral Biometrics – Signature scan- keystroke scan.

Unit: 5 Biometrics Application – Biometric Solution Matrix – Bio privacy – Comparison of privacy factor in different biometrics technologies – Designing privacy sympathetic biometric systems. Biometric standards – (BioAPI, BAPI) – Biometric middleware, Biometrics for Network Security, Statistical measures of Biometrics, Biometric transactions.

**Text Books**:

1. Biometrics – Identity Verification in a Networked World – Samir Nanavati, Michael Thieme, Raj Nanavati, WILEY- Dream Tech.
2. Biometrics for Network Security- Paul Reid, Pearson Education.

**Reference Book**:

1. Biometrics- The Ultimate Reference- John D. Woodward, Jr. Wiley Dreamtech.

## Business Intelligence & Big Data (Elective – II)

**Course Objectives:**

- To introduce the fundamental concepts of data science, including working with large-scale data and the tools used for data analysis and management.
- To explore the applications of data in various domains such as journalism, education, and business, emphasizing data-driven decision-making.
- To understand the principles of Business Intelligence (BI), its foundations, technologies, and its role in bridging the analysis gap.
- To study the implementation strategies for BI solutions through case studies and real-world examples.

**Course Outcomes:**

- Apply data science techniques such as data scraping, cleaning, and analysis to handle and process large datasets effectively.
- Analyze the use of data in applications like journalism, education, and business, demonstrating insights into real-world data applications.
- Explain the foundational concepts of Business Intelligence (BI), including its cycle, technologies, and multidimensional analysis.

- Design and implement BI solutions by leveraging frameworks, identifying opportunities, and learning from industry case studies.

Detailed contents:

Unit:1 Data Science – Introduction, working with data at scale, data scientist, the SMAQ stack for big data, scraping, cleaning & selling big data.

Data Hand Tools- free data tools for journalists.

Data Issues- Introduction, anonymization, risk of de-anonymization, Big data & semantic web, metadata.

Unit: 2 Applications of Data: - Product & Process – Twitter archive, data journalism & data tools, newsroom stack, bridging the data divide, data analysis path, Big data in education & academic disciplines, Discussion of Facebook.

Unit: 3 BI foundations - Understanding BI, Describing BI, Defining BI cycle, Enabling BI, Bridging the Analysis Gap Multidimensional analysis, Operation Systems, BI Systems.

Unit: 4 Defining BI Technologies- The High-level view, Reporting & Analysis, the data warehouse and Data warehousing Framework, Identifying BI opportunities.

Unit: 5 Implementing a BI solution- implementation strategy, Fundamental decisions, Case studies- Audi AG, The Frank Russell Company.

**Text Books**:

1. Elizabeth Vitt, Michael Luckevich, Stacia Misner, "Business Intelligence", Microsoft Press, 2010.
2. Big Data Now, O'Reily Radar Team.

**Reference Books:**

1. Rajiv Sabherwal, Irma Becerra- Fernandez, "Business Intelligence-Practices, Technologies and Management", John Wiley 2011.
2. Larissa T. Moss, ShakuAtre, "Business Intelligence Roadmap", Addison –Wesley IT Series.
3. Yuli Vasiliev, "Oracle Business Intelligence: The Condensed Guide to Analysis and Reporting", SPD Shroff, 2012.

## Soft Computing (Elective – II)

**Course Objectives:**

- To understand fundamental concepts and techniques of Artificial Intelligence (AI), including problem-solving and heuristic search methods.
- To explore the architecture and training algorithms of Artificial Neural Networks (ANN) for supervised and unsupervised learning.
- To study the concepts of classical and fuzzy sets, fuzzy relations, and their operations for decision-making processes.

- To learn the applications of fuzzy logic and genetic algorithms in optimization and reasoning tasks.

**Course Outcomes:**

- Apply AI techniques such as heuristic search and problem-solving methods to solve complex problems.
- Analyze and implement various models of Artificial Neural Networks for supervised and unsupervised learning.
- Use fuzzy set theory and fuzzy logic for approximate reasoning and decision-making in uncertain environments.
- Implement genetic algorithms to solve optimization problems like the Traveling Salesman Problem (TSP) and search techniques

Detailed contents:

Unit: 1 AI Problems and Search: AI problems, Techniques, Problem Spaces and Search, Heuristic Search Techniques- Generate and Test, Hill Climbing, Best First Search Problem reduction, Constraint Satisfaction and Means-End Analysis. Approaches to Knowledge Representation- Using Predicate Logic and Rules.

Unit: 2 Artificial Neural Networks: Introduction, Basic models of ANN, important terminologies, Supervised Learning Networks, Perceptron Networks, Adaptive Linear Neuron, Backpropagation Networks. Associative Memory Networks. Training Algorithms for pattern association, BAM and Hopfield Networks.

Unit: 3 Unsupervised Learning Network- Introduction, Fixed Weight Competitive Nets, Maxnet, Hamming Network, Kohonen Self-Organizing Feature Maps, Learning Vector Quantization, Counter Propagation Networks, Adaptive Resonance Theory Networks. Special Networks-Introduction to various networks.

Unit: 4 Introduction to Classical Sets (crisp Sets) and Fuzzy Sets- operations and Fuzzy sets. Classical Relations and Fuzzy Relations- Cardinality, Operations, Properties and Composition. Tolerance and equivalence relations. Membership functions- Features, Fuzzification, membership value assignments, Defuzzification.

Unit: 5 Fuzzy Arithmetic and Fuzzy Measures, Fuzzy Rule Base and Approximate Reasoning Fuzzy Decision-making Fuzzy Logic Control Systems, Genetic Algorithm- Introduction and basic operators and terminology. Applications: Optimization of TSP, Internet Search Technique.

**Text Books**:

1. Principles of Soft Computing- S N Sivanandam, S N Deepa, Wiley India, 2007.
2. Soft Computing and Intelligent System Design -Fakhreddine O Karray, Clarence D Silva, Pearson Edition, 2004.

**Reference Books:**

1. Artificial Intelligence and Soft Computing- Behavioural and Cognitive Modeling of the Human Brain Amit Konar, CRC Press, Taylor and Francis Group.
2. Artificial Intelligence – Elaine Rich and Kevin Knight, TMH, 1991, 2008.
3. Artificial Intelligence – Patric Henry Winston – Third Edition, Pearson Education.

## Embedded Systems (Elective – III)

**Course Objectives:**

- To understand the architecture, components, and classification of embedded systems.
- To develop programming skills in high-level and assembly languages for embedded applications.
- To learn real-time operating systems and their role in designing embedded solutions.
- To explore the tools and techniques for embedded software development, testing, and debugging.

**Course Outcomes:**

- Apply fundamental concepts to design and analyze embedded systems for real-world applications.
- Develop embedded software using programming languages and object-oriented approaches.
- Implement real-time operating systems to manage tasks and optimize performance in embedded systems.
- Use appropriate tools and techniques to test, debug, and simulate embedded hardware and software systems.

Detailed contents:

Unit: 1 Introduction to Embedded Systems: Embedded Systems, Processor Embedded into a System, Embedded Hardware Units and Devices in a System, Embedded Software, Complex System Design, Design Process in Embedded System, Formalization of System Design, Classification of Embedded Systems.

Unit: 2 8051 and Advanced Processor Architecture: 8051 Architecture, 8051 Micro controller Hardware, Input/ output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/output, Interrupts, Introduction to Advanced Architectures, Real World Interfacing, Processor and Memory Organization - Devices and Communication Buses for Devices Network: Serial and parallel Devices & ports, Wireless Devices, Timer and Counting Devices, Watchdog Timer, Real Time Clock, Networked Embedded Systems, Internet Enabled Systems, Wireless and Mobile System protocols.

Unit: 3 Embedded Programming Concepts: Software programming in Assembly language and High-Level Language, Data types, Structures, Modifiers, Loops and Pointers, Macros and Functions, object-oriented Programming, Embedded Programming in C++ & JAVA.

Unit: 4 Real–Time Operating Systems: OS Services, Process and Memory Management, Real-Time Operating Systems, Basic Design Using an RTOS, Task Scheduling Models, Interrupt Latency, Response of Task as Performance Metrics - RTOS Programming: Basic functions and Types of RTOSES, RTOS VxWorks, Windows CE.

Unit: 5 Embedded Software Development Process and Tools: Introduction to Embedded Software Development Process and Tools, Host and Target Machines, Linking and Locating Software, Getting Embedded Software into the Target System, Issues in Hardware-Software Design and Co-Design - Testing, Simulation and Debugging Techniques and Tools: Testing on Host Machine, Simulators, Laboratory Tools.

**Text Book**:

1. Embedded Systems, Raj Kamal, Second Edition TMH.

**Reference Books:**

1. Embedded/Real-Time Systems, Dr.K.V.K.K.Prasad, DreamTech Press.
2. The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Pearson.
3. The 8051 Microcontroller, Third Edition, Kenneth J.Ayala, Thomson.
4. An Embedded Software Primer, David E. Simon, Pearson Education.
5. Micro Controllers, Ajay V Deshmukhi, TMH.

## Advanced Graph Theory (Elective-III)

**Course Objectives**

- Learn the fundamental properties and applications of trees, spanning trees, and optimization techniques in graph theory.
- Understand concepts of matching, independent sets, and algorithms for solving matching problems in bipartite graphs.
- Explore graph connectivity, paths, flows, and theorems like Menger's for solving connectivity-related problems.
- Study graph coloring techniques, properties of random graphs, and extremal problems, along with their real-world applications.

**Course Outcomes**

- Apply tree structures and spanning tree concepts to solve optimization problems.
- Analyze matching problems in bipartite graphs and implement efficient matching algorithms.
- Solve connectivity and path problems in graphs using theorems and algorithms effectively.
- Use graph coloring, random graph properties, and extremal graph concepts in practical scenarios.

Detailed contents:

Unit 1: Trees: Basic Properties, Spanning Trees and Enumeration, Enumeration of Trees, Spanning Trees in Graphs, Decomposition and Graceful Labeling, Optimization and Trees, Minimum Spanning Tree.

Unit 2: Matching and Factors: Matchings in Bipartite Graphs, Hall's Matching Condition, Min-Max Theorems, Independent Sets, Tutte's 1-Factor Theorem, Maximum Bipartite Matching , Weighted Bipartite Matching, Stable Matching, Faster Bipartite Matching

Unit 3: Connectivity and Paths: Cuts and Connectivity, Flows in Directed Graphs, Connectivity and Menger's Theorem, Edge-Connectivity, Blocks, K-connected Graphs and k-edge-connected Graphs, 2-connected Graphs, Applications of Menger's Theorem

Unit 4: Graph Coloring: Vertex Colorings and Upper Bounds: Definitions , Upper bounds, Brooke's Theorem, Structure of k-chromatic Graphs, Graphs with Large Chromatic Number, Critical Graphs, Counting Proper Colorings, Chordal Graphs, A Hint of Perfect Graphs, Line Graphs and Edge Colorings, Characterization of Line Graphs.

Unit 5: Random Graph: Existence and Expectation, Properties of Almost All Graphs, Threshold Functions, Evolution and Properties of Random Graphs, Connectivity, Cliques and Colorings, Extremal Problems: Paths and Cycles, Complete Subgraphs, Hamilton Paths and Cycles, Szemeredi's Regularity Lemma and its simple applications, Encodings of Graphs, Branchings and Gossip, List Colorings and Choosability, Circumference

**Textbooks / References**

1. Douglas B. West, Introduction to Graph Theory, Prentice-Hall, 3rd Edition, 2008

2. Béla Bollobás, Modern Graph Theory, Springer, 1998.

## Predictive Analytics for Internet of Things (Elective-III)

**Course Objectives:**

- Understand the Fundamentals of IoT.
- Explore IoT Applications.
- Learn IoT Data Representation &.
- Understand IoT Communication Protocols.
- Study IoT Data Analytics and Cloud Integration.
- Develop Industry-Specific Data Visualization Skills.
- Explore Geospatial Analytics and Anomaly.

**Course Outcomes:**

- Explain IoT Fundamentals.
- Analyze IoT Applications.
- Apply IoT Data Analytics.
- Demonstrate IoT Communication Protocols.
- Utilize Cloud and Big Data Technologies.
- Design IoT Data Visualization Solutions.
- Perform Geospatial Analytics & Anomaly Detection.

Detailed contents:

Unit 1: Introduction to IoT - Definitions, frameworks and key technologies. Challenges to solve in IoT - Key hardware and software elements. Applications: smart transportation, smart cities, smart living, smart energy, smart health, and smart learning.

Unit 2: Real-World Data representation and visualization, Introduction to Data Analytics for IoT. IoT Analytics- Definition, Challenges, Devices, Connectivity protocols, data messaging protocols- MQTT, HTTP, CoAP, Data Distribution Services (DDS)

Unit 3: IoT Data Analytics – Elastics Analytics Concepts, Scaling. Cloud Analytics and Security, AWS / Azure / ThingWorx. Design of data processing for analytics, application of big data technology to storage,

Unit 4: Exploring and visualizing data, solution for industry-specific analysis problem. Visualization and Dashboard – Designing visual analysis for IoT data- creating dashboard – creating and visualizing alerts.

Unit 5: Basics of geospatial analytics- vector based methods-raster based methods- storage of geospatial data - processing of geospatial data- Anomaly detection forecasting. case study: pollution reporting problem.

**Textbooks / References**:


1. Vijay Madisetti and ArshdeepBahga, "Internet of Things: A Hands-on Approach", Hardcover – Import, 2014.
2. Andrew Minteer, Analytics for Internet of Things, Packt Publications Mumbai 2017
3. Kai Hwang, Min Chen, Big Data Analytics for Cloud, IoT and Cognitive Computing Hardcover, 2017


## Text Mining and Analytics (Elective -IV)

**Course Objectives**

- Understand the fundamentals of Natural Language Processing (NLP), including words, language modeling, and part-of-speech tagging.
- Explore syntactic and semantic parsing, text representation techniques, and word vector models.
- Study advanced NLP models, including BERT, neural language models, and sequence architectures like RNN and LSTM.
- Learn the principles of transformer networks and their applications in text classification, sentiment analysis, translation, and summarization.

**Course Outcomes**

- Apply language modeling techniques and perform basic NLP tasks like POS tagging and named entity recognition.
- Represent and transform text data using vector space models and modern word vector techniques like Word2Vec and GloVe.
- Implement and evaluate neural network models like RNN, LSTM, and transformer-based architectures.

- Solve complex NLP problems such as sentiment analysis, machine translation, and text summarization.

Detailed contents:

Unit 1: Introduction to Natural Language Processing -Words -Regular Expressions -N-grams -Language modelling - Part-of-Speech Tagging - Named Entity Recognition

Unit 2: Syntactic and Semantic Parsing – Morphological Analysis Text Representation and Transformation - Vector space models -Bag-of-Words -Term Frequency - Inverse Document Frequency - Word Vector representations: Word2vec, GloVe, FastText,

Unit 3: BERT – Topic Modelling Neural language models - Recurrent Neural Network - Long Short-Term Memory Networks

Unit 4: Encoder decoder architecture - Attention mechanism - Transformer networks

Unit 5: Text classification – Sentiment Analysis – Neural Machine Translation - Question answering - Text Summarization.

**Textbook / References**


1. Daniel Jurafsky and James H. Martin, “Speech and Language Processing,” 3rd edition, 2020. [Available on: https://web.stanford.edu/~jurafsky/slp3/ed3book_dec302020.pdf]
2. Christopher Manning and Hinrich Schutze, “Foundations of statistical natural language processing,” MIT press, 1999.
3. Jacob Eisenstein, “Introduction to natural language processing,” Illustrated edition, The MIT press, 2019.
4. Bengfort, Benjamin, Rebecca Bilbro, and Tony Ojeda. Applied text analysis with python: Enabling language-aware data products with machine learning. " O'Reilly Media, Inc.", 2018.
5. Yoav Goldberg, "Neural network methods for natural language processing," Synthesis lectures on human language technologies 10, no. 1 (2017): 1-309.


## Advanced-Data Visualization and Analytics (Elective- IV)

### Course Objectives:

- Understand the principles of effective data visualization and its importance in data communication.
- Learn to use Python libraries (Seaborn, Plotly Express, Pygal) for creating various visualizations.
- Develop skills in visualizing time series, geospatial, and multimodal data for analysis.
- Gain proficiency in business analytics tools (Tableau, Power BI) and data storytelling techniques.

### Course Outcomes:

- Apply design principles to create clear and insightful data visualizations.

- Implement Python-based visualizations and interactive network topologies.
- Analyze and visualize complex data types, including time series and geospatial data.
- Build interactive dashboards and communicate insights effectively through data storytelling.

Detailed contents:

Unit 1: Overview of Data Visualization – Importance and benefits of good data visualization– Design principles - Introduction to python libraries for visualization: seaborn, plotly express, pygal- Exploring Data – Reduce Items and Attributes: Filter and Aggregate - Creation of basic visualization: Histogram, Bar (Vertical and Horizontal) and Line Chart, Box plot, Scatter plot (Examples and Exercises to be given for practice). Color palettes – Creation of 3D Charts.

Unit 2: Creation of Advanced Visualization: Heat Map– Facet Grid - Interaction Techniques: Manipulate View – Creation of interactive Network topologies and Trees

Unit 3: Visualization of Time series data: summary statistics and plotting aggregated views - Visualization of seasonality, trends and noise– working with multiple time series data – Case study - Visualization of Geospatial data: spatial join - overlaying geospatial data to maps and adding special cues – Case Study- Visualization of multimodal data and analysis. Study sensor data and health care, genome and biomedical data.

Unit 4: Business Analytics and Visualization Tools: Tableau, PowerBI, Creating Interactive Dashboards and charts to organize data using visualization principles-

Unit 5: Data Storytelling – reading data in-depth, identifying critical messages and communicating these messages in the most effective way

**Textbooks/References**:


1. Tamara Munzner, Visualization Analysis and Design, A K Peters Visualization Series, CRC Press, 2014.
2. Scott Murray, Interactive Data Visualization for the Web, O'Reilly, 2013.
3. VanderPlas J. Python data science handbook: essential tools for working with data O'Reilly Media. Inc", 2016
4. Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, 2012
5. Nathan Yau, Visualize This: The Flowing Data Guide to Design, Visualization and Statistics, John Wiley & Sons, 2011.


## Advanced Machine Learning for Biomedical Data Analysis (Elective-IV)

**Course Objectives:**

- Students will learn advanced techniques like deep learning , ensemble methods, and dimensionality reduction methods specifically relevant to biomedical data analysis.

- Acquiring skills to clean, transform, and engineer features from diverse biomedical datasets including genomic data, medical images, electronic health records (EHR), and sensor data.

- Applying machine learning models to tasks like disease classification, patient stratification, biomarker identification, and personalized medicine.

- Discussing the ethical implications of using machine learning in healthcare, including data privacy, bias, and interpretability

**Course Outcomes:**

- Proficiency in advanced machine learning algorithms like deep neural networks,

- Skills to clean, transform, and engineer features from diverse biomedical datasets to optimize model performance.

- Ability to choose appropriate machine learning models based on the characteristics of biomedical data, and effectively evaluate model performance using relevant metrics like AUC, precision, recall, and F1-score.

- Understanding how to integrate and analyze data from multiple sources like genetic, imaging, and clinical data, using techniques like multi-modal fusion.

- Ability to apply machine learning techniques to specific biomedical challenges such as disease prediction, drug discovery, personalized medicine, and clinical decision support systems.

Detailed contents

Unit 1: Introduction to ECG, EEG, MRI and CT datasets

Unit 2: Machine Learning Models for ECG Signal Classification

Unit 3: Hybrid Machine Learning for EEG Signal Classification

Unit 4: Benchmark Deep Learning Algorithms for Biomedical Image Segmentation: SwinUNet: UNet like Pure Transformer – FANet: Feedback Attention Network – MedT: Medical Transformer

Unit 5: Generative Adversarial Network for Synthetic Data Augmentation.

**Textbook / References**:


1. Goodfellow I, Bengio Y, Courville A, & Bengio Y, “Deep learning”, Cambridge: MIT Press, 1st Edition, 2016.
2. Michael Nielsen, “Neural Networks and Deep Learning”, Goodreads (eBook), 2013.
3. Bengio Y, “Learning Deep Architectures for AI, Foundations and Trends in Machine Learning”, new publishers, 2009.
4. Weblink: https://paperswithcode.com/task/ecg-classification .
5. Weblink: https://paperswithcode.com/task/eeg .

6. Weblink: https://paperswithcode.com/task/medical-image-segmentation .
7. Weblink: https://github.com/xinario/awesome-gan-for-medical-imaging .

## Advanced Computer Networks (Elective)

**COURSE OBJECTIVES**

- Students will learn different Network models.
- Students will learn different routing protocols
- Students will learn switching concepts, VLANs
- Students will learn different network protocols.

**COURSE OUTCOMES**

- Students will be able to solve problems relating to routing.
- Students will learn how to configure network switches
- Students will learn Socket programming.

Detailed contents:

Unit 1: Review Computer Networks and the Internet: History of Computer Networking and the Internet, Networking Devices, The Network edge, The Network core, Access Networks and Physical media, ISPs and Internet Backbones. Networking Models: 5-layer TCP/IP Model, 7-layer OSI Model, Internet Protocols and Addressing, Equal Sized Packets Model: ATM.

Unit 2: Network Routing Routing and its concepts: Structure of a Router, Basic Router Configuration, Building a Routing Table, Static Routing, Dynamic Routing – Distance Vector Routing Protocol (RIPv1, RIPv2, EIGRP), Link State Routing Protocols (OSPF).

Unit 3: LAN Switching Switching and its concepts: Structure of a Switch, Basic Switch Configuration, Virtual LANs (VLANs), VLAN Trunking Protocol (VTP), Spanning Tree Protocol (STP), Inter-VLAN Routing.

Unit 4: Wide Area Networks (WANs) Introduction to WANs, Point-to-Point Protocol (PPP) concepts, Frame Relay concepts, Dynamic Host Configuration Protocol (DHCP), Network Address Translation (NAT), IPv6.

Unit 5: Network Programming using Java TCP sockets, UDP sockets (datagram sockets), Server programs that can handle one connection at a time and multiple connections (using multithreaded server), Remote Method Invocation (Java RMI) - Basic RMI Process, Implementation details - Client-Server Application.

**Text Books**


1. Computer Networking: A Top-Down Approach Featuring the Internet, James F. Kurose, Keith W. Ross, Fifth Edition, Pearson Education, 2012.
2. Network Fundamentals, Mark Dye, Pearson Education.
3. Routing Protocols & Concepts, Rick Graziani, Pearson Education.
4. LAN Switching & Wireless, Wayne Lewis, Pearson Education.

5. Accessing the WAN, Bob Vachon, Pearson Education.

**Reference Books**


1. Computer Networks: Principles,Technologies And Protocols For Network Design, Natalia Olifer, Victor Olifer, Wiley India, 2006.
2. Computer Networks, Andrew S. Tanenbaum, Fifth Edition, Prentice Hall.
3. Computer and Communication Networks, Nader F. Mir, Pearson Education, 2007.
4. Data Communications and Networking, Behrouz A. Forouzan, Fourth Edition, Tata McGraw Hill, 2007.
5. Computer Networks, Bhushan Trivedi, Oxford University Press, 2011.
6. Fundamentals of Business Data Communications, Jerry FitzGerald and Alan Dennis, Tenth Edition, Wiley, 2009.


## Cloud Computing (Elective)

**Course Objectives:**

- To understand the fundamental concepts of distributed systems, virtualization, and scalable computing in the context of cloud computing.
- To explore the cloud computing paradigms, including IaaS, PaaS, and SaaS, and their applications in modern enterprises.
- To study techniques for monitoring, managing, and optimizing cloud environments for performance and resource efficiency.
- To analyze governance, data security, legal, and organizational readiness challenges in adopting cloud computing.

**Course Outcomes:**

- Explain distributed system models, virtualization techniques, and their role in building scalable cloud infrastructures.
- Analyze and apply cloud computing paradigms (IaaS, PaaS, SaaS) for various services, including secure data storage and workflow management.
- Design and manage cloud-based applications with a focus on performance optimization and best practices in environments like AWS.
- Assess governance, data security, and legal aspects of cloud computing, ensuring organizational readiness for cloud adoption.

Detailed contents:

Unit 1: Systems Modeling, Clustering and Virtualization: Distributed System Models and Enabling Technologies, Computer Clusters for Scalable Parallel Computing, Virtual Machines and Virtualization of Clusters and Data centers.

Unit 2: Foundations: Introduction to Cloud Computing, migrating into a Cloud, Enriching the ‘Integration as a Service’ Paradigm for the Cloud Era, The Enterprise Cloud Computing Paradigm.

Unit 3: Infrastructure as a Service (IAAS) & Platform and Software as a Service (PAAS / SAAS): Virtual machines provisioning and Migration services, Enhancing Cloud Computing Environments using a cluster as a Service, Secure Distributed Data Storage in Cloud Computing. Workflow Engine for Clouds, Understanding Scientific Applications for Cloud Environments.

Unit 4: Monitoring, Management and Applications: An Architecture for Federated Cloud Computing, SLA Management in Cloud Computing, Performance Prediction for HPC on Clouds, Best Practices in Architecting Cloud Applications in the AWS cloud, Building Content Delivery Networks using Clouds, Resource Cloud Mashups.

Unit 5: Governance and Case Studies: Organizational Readiness and Change management in the Cloud age, Data Security in the Cloud, Legal Issues in Cloud computing, Achieving Production Readiness for Cloud Services.

**Text Books**:


1. Cloud Computing: Principles and Paradigms by Rajkumar Buyya, James Broberg and Andrzej M. Goscinski, Wiley, 2011.
2. Distributed and Cloud Computing, Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, Elsevier, 2012.


**Reference Books**:


1. Cloud Computing: A Practical Approach, Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Tata McGraw Hill, 2011.
2. Enterprise Cloud Computing, Gautam Shroff, Cambridge University Press, 2010.
3. Cloud Computing: Implementation, Management and Security, John W. Rittinghouse, James F. Ransome, CRC Press, 2012.
4. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly, SPD, 2011.
5. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly, SPD, 2011.

**ANNEXURE - II**

# DEPARTMENT OF INFORMATION TECHNOLOGY

Course Structure & Syllabus
for
Master of Technology in Information Technology (2nd year)
w.e.f Academic Session 2025 – 26

SCHOOL OF ENGINEERING & TECHNOLOGY
NAGALAND UNIVERSITY
(KOHIMA CAMPUS)
MERIEMA – 797004

# PROPOSED M.TECH SYLLABUS 2ND YEAR

## Year: 2

## Semester III

| *Sl. No* | *Subject Code* | *Course name* | *Lectures* | *Tutorials* | *Practical* | *Credits* |
|---|---|---|---|---|---|---|
| 1 | ITPGTH1 | M.Tech Thesis | - | - | 20 | 10 |
| 2 | ITPGE3** | Discipline Specific Elective -V | 3 | 1 | - | 4 |
| 3 | ITPG310 | Research Methodology & Proposal Writing | 3 | 1 | | 4 |
| 4 | ITPGE3** | Skill Enhancement Course Elective – VI | 3 | 1 | - | 4 |
| 5 | ITPGE3** | Multidisciplinary Elective - VII | 3 | 1 | - | 4 |
| **Total** | | | **9** | **3** | **20** | **26** |

ITPGE3** - Discipline Specific Elective -V

1. ITPGE301- Game Theory
2. ITPGE302 - Natural Language Processing
3. ITPGE303 – Cloud Computing

ITPGE3** - Skill Enhancement Course Elective – VI

1. ITPGE304 - Multimedia Technology
2. ITPGE305 - Advanced Internet Technology
3. ITPGE306 – Advanced Computer Networks

ITPGE3** - Multidisciplinary Elective – VII

1. ITPGE307 - Cyber Security
2. ITPGE308 - Optimization Techniques
3. ITPGE309 – Image Processing & Computer Vision

## Year: 2

## Semester IV

| *Sl. No* | *Subject Code* | *Course name* | *Lectures* | *Tutorials* | *Practical* | *Credits* |
|---|---|---|---|---|---|---|
| 1 | ITPGTH2 | M.Tech Thesis | - | - | 20 | 10 |
| 2 | ITPGVV1 | Viva - Voce | - | - | - | 8 |
| **Total** | | | **-** | **-** | **-** | **18** |

| **Credit Distribution** | | |
|---|---|---|
| **SL no** | **Year** | **Credit** |
| 1. | 1st | 36* |
| 2. | 2nd | 44 |
| **Total Credit** | | **76** |

**Modified Credit Distribution after Expert's Suggestion**

| **Modified Credit Distribution** | | |
|---|---|---|
| **SL no** | **Year** | **Credit** |
| 1. | 1st | 44 |
| 2. | 2nd | 44 |
| **Total Credit** | | **88** |

**DETAILED SYLLABUS -**
**(ALL COURSES ARE 4 CREDITS)**

## DISCIPLINE SPECIFIC ELECTIVE -V

**Game Theory**

**Course Objectives:**

- To introduce the fundamental concepts and formal definitions of game theory, including strategies, payoffs, and Nash equilibrium.
- To study mixed-strategy equilibria, iterative elimination of strategies, and the minimax theorem for zero-sum games.
- To explore extensive-form games, perfect and imperfect information games, and subgame perfect equilibrium.
- To understand repeated games, Bayesian games, and coalitional games, along with their applications.

**Course Outcomes:**

- Explain the foundational concepts of game theory, including normal form games, pure and mixed strategies, and Nash equilibria.
- Analyze and solve zero-sum games using minimax strategies and understand correlated equilibria.
- Apply concepts of extensive-form games to model and solve perfect and imperfect information games.
- Explore repeated games, Bayesian games, and coalitional games, and apply them to real-world decision-making problems.

## Detailed contents:

Unit 1

Introduction, overview, uses of game theory, some applications and examples, and formal definitions of: the normal form, payoffs, strategies, pure strategy Nash equilibrium, dominant strategies.

Unit 2

Mixed-Strategy Nash Equilibrium pure and mixed strategy Nash equilibria, Iterative removal of strictly dominated strategies, minimax strategies and the minimax theorem for zero-sum game, correlated equilibria.

Unit 3

Extensive-Form Games: Perfect information games: trees, players assigned to nodes, payoffs, backward Induction, subgame perfect equilibrium, introduction to imperfect-information games, mixed versus behavioural strategies.

Unit 4

Repeated Games: Repeated prisoners dilemma, finite and infinite repeated games, limited-average versus future-discounted reward, folk theorems, stochastic games and learning.

Unit 5

Bayesian Games: General definitions, ex ante/interim Bayesian Nash equilibrium. Coalitional Games: Transferable utility cooperative games, Shapley value, Core, applications.

Books/References:


1. A Course in Game Theory by M. J. Osborne and A. Rubinstein, MIT Press.
2. An Introduction to Game Theory by M. J. Osborne, Oxford University Press.
3. Algorithmic Game Theory by N. Nisan, T. Rougharden, E. Tardos and V. V. Vazirani, Cambridge University Press.
4. Fun and Games: A Text on Game theory by K. Binmore, AIBS publisher


**Natural Language Processing**

**Course Objectives:**

- To understand the fundamental concepts of Natural Language Processing (NLP) and the stages involved in text processing and morphology.
- To learn techniques for language modeling, word sense disambiguation, and statistical inference in NLP tasks.
- To explore Hidden Markov Models (HMMs), Part-of-Speech (POS) tagging, and their applications in NLP.
- To study syntax, semantics, and machine translation techniques, including applications like information extraction and question-answering systems.

**Course Outcomes:**

- Explain the various stages of NLP, text processing, and morphological analysis using tools like Finite State Automata.
- Apply statistical techniques such as N-gram models and hypothesis testing for language modeling and word sense disambiguation.
- Implement Markov models, HMM-based POS tagging, and other tagging techniques for NLP applications.
- Analyze and implement advanced concepts like semantic role labeling, machine translation, sentiment analysis, and text mining in real-world NLP tasks.

## Detailed contents:

Unit 1

Introduction, Text Processing, and Morphology: Introduction to NLP, Various stages of NLP, The Ambiguity of Language, Parts of Speech: Nouns and Pronouns, Words: Determiners and adjectives, verbs, Phrase Structure. Character Encoding, Word Segmentation, Sentence Segmentation, Introduction to Corpora, Corpora Analysis. Inflectional and Derivation Morphology, Morphological analysis and generation using Finite State Automata and Finite State transducer.

Unit 2

Language Modelling and Word Sense Disambiguation: Words: Collocations, Frequency, Mean and Variance, Hypothesis testing: The t-test, Hypothesis testing of differences, Pearson's chi-square test, Likelihood ratios. Statistical Inference: N-gram Models over Sparse Data.

Unit 3

Preliminaries of Disambiguation, Supervised Disambiguation: Bayesian classification, An information theoretic approach, Dictionary-Based Disambiguation: Disambiguation based on sense, Thesaurus-based dis- ambiguation, Disambiguation based on translations in a second-language corpus.

Unit 4

Markov Model and POS Tagging: Markov Model: Hidden Markov model, Fundamentals, Probability of properties, Parameter estimation, Variants, Multiple input observation. The Information Sources in Tag- ging: Markov model taggers, Viterbi algorithm, Applying HMMs to POS tagging, Applications of Tagging.

Unit 5

Syntax and Semantics: Shallow Parsing and Chunking, Shallow Parsing with Conditional Random Fields (CRF), Lexical Semantics, WordNet, Thematic Roles, Semantic Role Labelling with CRFs. Statistical Alignment and Machine Translation, Text alignment, Word alignment, Information extraction, Text mining, Information Retrieval, NL interfaces, Sentimental Analysis, Question Answering Systems, Social network analysis.

Books/References:


1. Christopher D. Manning and Hinrich Schutze, "Foundations of Natural Language Processing", 6th Edition, The MIT Press Cambridge, Massachusetts London, England, 2003.
2. Daniel Jurafsky and James H. Martin "Speech and Language Processing", 3rd edition, Prentice Hall, 2009.
3. Nitin Indurkhya, Fred J. Damerau "Handbook of Natural Language Processing", Second Edition, CRC Press, 2010.
4. James Allen, "Natural Language Understanding", Pearson Publication 8th Edition. 2012.


**Cloud Computing**

**Course Objectives:**

- To understand the fundamental concepts of distributed systems, clustering, and virtualization in the context of cloud computing.
- To explore the core paradigms of cloud computing, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).
- To study the architecture, management, and best practices for building and maintaining cloud-based applications.
- To analyze governance, organizational readiness, data security, and legal issues in cloud adoption.

**Course Outcomes:**

- Explain the concepts of distributed system models, virtualization, and scalable computing in cloud environments.
- Apply cloud computing paradigms like IaaS, PaaS, and SaaS to various use cases, including secure data storage and scientific applications.
- Design and manage cloud applications using best practices, focusing on architecture, performance, and SLA management.
- Assess organizational readiness and address security and legal challenges to implement production-ready cloud solutions effectively.

## Detailed contents:

Unit 1: Systems Modeling, Clustering and Virtualization: Distributed System Models and Enabling Technologies, Computer Clusters for Scalable Parallel Computing, Virtual Machines and Virtualization of Clusters and Data centers.

Unit 2: Foundations: Introduction to Cloud Computing, migrating into a Cloud, Enriching the 'Integration as a Service' Paradigm for the Cloud Era, The Enterprise Cloud Computing Paradigm.

Unit 3: Infrastructure as a Service (IAAS) & Platform and Software as a Service (PAAS / SAAS): Virtual machines provisioning and Migration services, Enhancing Cloud Computing Environments using a cluster as a Service, Secure Distributed Data Storage in Cloud Computing. Workflow Engine for Clouds, Understanding Scientific Applications for Cloud Environments.

Unit 4: Monitoring, Management and Applications: An Architecture for Federated Cloud Computing, SLA Management in Cloud Computing, Performance Prediction for HPC on Clouds, Best Practices in Architecting Cloud Applications in the AWS cloud, Building Content Delivery Networks using Clouds, Resource Cloud Mashups.

Unit 5: Governance and Case Studies: Organizational Readiness and Change management in the Cloud age, Data Security in the Cloud, Legal Issues in Cloud computing, Achieving Production Readiness for Cloud Services.

Books/References:

1. Cloud Computing: Principles and Paradigms by Rajkumar Buyya, James Broberg and Andrzej M. Goscinski, Wiley, 2011.

2. Distributed and Cloud Computing, Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, Elsevier, 2012.
3. Cloud Computing: A Practical Approach, Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Tata McGraw Hill, 2011.
4. Enterprise Cloud Computing, Gautam Shroff, Cambridge University Press, 2010.
5. Cloud Computing: Implementation, Management and Security, John W. Rittinghouse, James F. Ransome, CRC Press, 2012.
6. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly, SPD, 2011.
7. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly, SPD, 2011

**SKILL ENHANCEMENT COURSE ELECTIVE – VI**

**Multimedia Technology**

COURSE OBJECTIVES

- Students will learn different multimedia elements that are used in animations, presentations and other mass communication.
- Student will learn compression techniques used in multimedia.
- Students will learn the various tools used to generate multimedia elements.
- Students will be acquainted with 3D modelling.

COURSE OUTCOMES

- Students will be able to use image editing software.
- Students will be able to use audio editing software.
- Students will be able to use video editing software.
- Students will be able to design animation projects.

## Detailed contents:

Unit 1

Introduction and elements of multimedia and animation : Animation: Introduction to Multimedia, Characteristics of Multimedia Presentation, Multimedia Architecture and Components, Visual Display System,

Unit 2

Text: Types, Font, Unicode Standard, Text Compression, Image: Types, Image Processing, Standards, Specification, Device Independent Color Models,

Unit 3

Video: Video Signal Transmission, Signal Formats, Broadcasting Standards, Digital Video Standards, Audio: Acoustics, Characteristics of Sound – Elements of Audio System: Microphone, Amplifier, Loudspeaker, Audio Mixer, Digital Audio, MIDI, Animation: Key Frames and Tweening Techniques – 2D and 3D Animation.

Unit 4

Multimedia Systems: Compression Types and Techniques: CODEC, GIF Coding Standards, JPEG, MPEG, Multimedia Database System, Hardware Support for Multimedia, Real Time Protocols, Play Back Architectures, Synchronization, Hypermedia Concepts and Design, Digital Copyrights.

Unit 5

Multimedia Tools and Application Developments: Authoring Tools: Features and Types, Card and Page Based Tools, Icon and Object Based Tools, Time Based Tools, Cross Platform Authoring Tools, Editing Tools, Painting and Drawing Tools, 3D Modeling and Animation Tools, Image Editing Tools, Sound Editing Tools, Digital Movie Tools. Software Life Cycle, ADDIE Model, Conceptualization, Content Collection, Story Board, Script, Authoring Metaphors, Testing, Report Writing, Documentation.

Books/References:


1. Ranjan Parekh, Principles of Multimedia, Second Edition, McGraw-Hill Education, 2017.
2. Tay Vaughan, Multimedia: Making It Work, Ninth Edition, McGraw-Hill, 2014.
3. Ralf Steinmetz, Klara Nahrstedt, Multimedia: Computing, Communications and Applications, Prentice Hall, 1995.


**Advanced Internet Technologies**

COURSE OBJECTIVES

- Students will be exposed to various programming/ scripting languages Javascript, PHP, JSP etc.
- Students will learn Database Management using MySql.
- Students will learn Web services and web application development.
- Students will learn web security concepts.

COURSE OUTCOMES

- Students will be able to create a web application.
- Students will be able to create and store data in databases.
- Students will be able to create contents using Content Management System.
- Students will have the chance to become a Web Application Developer.

Detailed contents:

Unit 1

Introduction to Internet technology: evolution of the internet. TCP/IP: addressing and routing. Internet applications: file transfer protocol, Telnet, Email, Chat, World Wide Web, hypertext transfer protocol.

Unit 2

Introduction to web technologies: web architectures. Client side scripting: HTML; DOM; CSS; JavaScript and jQuery. Server side scripting: Servlet; JSP; PHP; MySQL.

Unit 3

Server side scripting: Servlet; JSP; PHP; MySQL, Sessions, Cookies, Connection to server database

Unit 4

XML processing, AJAX, JSON, Node.Js, SpringBoot, web deployment. Overview of web services. Web application development: search engine; web crawlers; e-commerce portal.

Unit 5

Web Security Concepts: HTTP Authentication; Compare and Contrast; Application Types (BASIC, DI- GEST, FORM and Client CERT). Security Implementation: Retrieving Authentication Information; SQL injection; Form Based Custom authorization; Retrieving SSL authentication.

Books/References:


1. Joseph B. Miller, Internet Technologies and Information Services, 2nd Edition, Greenwood Publishing Group, 2014.
2. Scobey, P., & Lingras, P., Web Programming and Internet Technologies: An E-commerce Approach. Jones & Bartlett Publishers, 2016.
3. Freire, M., & Pereira, M., Encyclopedia of Internet technologies and applications. IGI Global, 2007.
4. Bates, C., Web Programming Building Internet Applications. John Wiley & Sons, 2002.


**Advanced Computer Networks**

COURSE OBJECTIVES

- Students will learn different Network models.
- Students will learn different routing protocols
- Students will learn switching concepts, VLANs
- Students will learn different network protocols.

COURSE OUTCOMES

- Students will be able to solve problems relating to routing.
- Students will learn how to configure network switches
- Students will learn Socket programming.

## Detailed contents:

Unit 1: Review Computer Networks and the Internet: History of Computer Networking and the Internet, Networking Devices, The Network edge, The Network core, Access Networks and Physical media, ISPs and Internet Backbones. Networking Models: 5-layer TCP/IP Model, 7-layer OSI Model, Internet Protocols and Addressing, Equal Sized Packets Model: ATM.

Unit 2: Network Routing Routing and its concepts: Structure of a Router, Basic Router Configuration, Building a Routing Table, Static Routing, Dynamic Routing – Distance Vector Routing Protocol (RIPv1, RIPv2, EIGRP), Link State Routing Protocols (OSPF).

Unit 3: LAN Switching Switching and its concepts: Structure of a Switch, Basic Switch Configuration, Virtual LANs (VLANs), VLAN Trunking Protocol (VTP), Spanning Tree Protocol (STP), Inter-VLAN Routing.

Unit 4: Wide Area Networks (WANs) Introduction to WANs, Point-to-Point Protocol (PPP) concepts, Frame Relay concepts, Dynamic Host Configuration Protocol (DHCP), Network Address Translation (NAT), IPv6.

Unit 5: Network Programming using Java TCP sockets, UDP sockets (datagram sockets), Server programs that can handle one connection at a time and multiple connections (using multithreaded server), Remote Method Invocation (Java RMI) - Basic RMI Process, Implementation details - Client-Server Application.

Books/References:

1. Computer Networking: A Top-Down Approach Featuring the Internet, James F. Kurose, Keith W. Ross, Fifth Edition, Pearson Education, 2012.
2. Network Fundamentals, Mark Dye, Pearson Education.
3. Routing Protocols & Concepts, Rick Graziani, Pearson Education.
4. LAN Switching & Wireless, Wayne Lewis, Pearson Education.
5. Accessing the WAN, Bob Vachon, Pearson Education.
6. Computer Networks: Principles,Technologies And Protocols For Network Design, Natalia Olifer, Victor Olifer, Wiley India, 2006.
7. Computer Networks, Andrew S. Tanenbaum, Fifth Edition, Prentice Hall.
8. Computer and Communication Networks, Nader F. Mir, Pearson Education, 2007.

## Multidisciplinary Elective – VII

### Cyber Security

COURSE OBJECTIVES

- Student will learn different types of cyber attacks, data protection, recovery and forensics.
- Students will learn different algorithms used in cryptography.
- Students will learn the essentials of Network Security.
- Students will learn different access control mechanisms in operating systems, firewall configurations.

COURSE OUTCOMES

- Students will be able to implement encryption algorithms.
- Students will be exposed to SQL injections.
- Students will be able to setup firewalls.
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Detailed contents:

Unit 1

Introduction to Cyber Security: Cyber-attacks, Defence strategies and Techniques: Access Control: Authentication and Authorization, Data Protection, Prevention and Detection, Response, Recovery & Forensics .

Unit 2

Basics of Cryptography: Symmetric and Asymmetric key Cryptography, cryptographic Hash function, Digital signature schemes.

Unit 3

Network Security Essentials: Security at different layers: IPSec protocol, SSL Protocol, authentication and key management protocols, Wireless LAN security, cellphone security. Software Vulnerabilities and attacks: Phishing, Buffer Overflow, Format String Attack, Cross-site Scripting, SQL injection, SYN flooding attack, DNS cache poisoning attack.

Unit 4

Access Control in Operating System: Preliminaries: Discretionary Access Control, Mandatory Access Control, Role based access control Firewalls: Packet Filtering Firewalls, Proxy-Server based Firewall, Policies and firewall configurations: Case studies of personal firewalls: architecture, commands.

Unit 5

Intrusion Prevention and Detection: Types of Intrusion Detection System (IDS): Anomaly vs. Signature based IDS, DDoS attack prevention/Detection, Malware Detection, port and

vulnerability scanning, Packet Sniffing, Intrusion detection and penetration testing using different open-source tools.

Electronic Payment: Secure Electronic Transaction protocol. Books/References:

1. Bernard Menezes and R. Kumar, Cryptography, Network Security and Cyber Laws, Cengage Learning, 2028.

2. William Stallings, Network Security Essentials, Applications and Standards, Pearson Education,2018

**Optimization Techniques**

**Course Objectives**

- Understand the fundamental concepts of optimization techniques and their applications in engineering problems.
- Learn single-variable and multivariable optimization algorithms, including gradient-based and direct search methods.
- Explore constrained optimization techniques, including Kuhn-Tucker conditions and sensitivity analysis.
- Study advanced optimization methods such as quadratic programming, genetic algorithms, and simulated annealing.

**Course Outcomes**

- Formulate and classify optimization problems with proper design variables, constraints, and objectives.
- Apply single-variable and multivariable optimization techniques to solve engineering problems.
- Implement constrained optimization methods and analyze their feasibility and sensitivity.
- Utilize advanced and non-traditional optimization algorithms to address complex real-world scenarios.

## Detailed contents:

Unit 1

Introduction to Optimization Techniques, Optimal Problem Formulation: Design Variables, Constraints, Objective function, Variable bounds, Engineering Optimization Problem,

examples of a few engineering optimization problems, classification of optimization algorithms.

Unit 2

Single variable optimization algorithms: Optimality Criteria, Bracketing Methods, Region Elimination Methods, Point Estimation Method, Gradient Based Method .

Unit 3

Multivariable Optimization algorithms: Optimality Criteria, Unidirectional Search, Direct Search Methods, Gradient based methods.

Unit 4

Constrained optimization algorithms: Kuhn-Tucker Condition, Lagrangian Duality Theory, Transformation Methods, Sensitivity Analysis, Direct search for Constrained Optimization, Feasible Direction Method,

Unit 5

Quadratic Programming, Generalized Reduced Gradient Method, Gradient Projection Method, specialized and non traditional Optimization Algorithms: Integer Programming, Geometric Programming, Genetic Algorithms, Simulated annealing.

Books/References:

1. Kalyanmoy Deb, Optimization for Engineering Design Algorithms & Examples, PHI, 2nd Edition,2012.

2. Martins & Ning, Engineering Design Optimization, Electronic Edition,2021

**Image Processing & Computer Vision**

**Course Objectives:**

- To understand the fundamental concepts of digital image processing, including image representation, transformation, and pixel relationships.
- To explore techniques for image enhancement, segmentation, and compression for efficient storage and processing.
- To study computer vision concepts, including feature extraction, object detection, recognition, and semantic segmentation.
- To introduce machine learning and deep learning techniques and their applications in computer vision tasks.

**Course Outcomes:**

- Explain the steps and elements of digital image processing, including the relationship between pixels and image transformations.

- Apply image enhancement, segmentation, and compression techniques to improve image quality and optimize storage.
- Analyze computer vision tasks such as feature extraction, object detection, and classification using appropriate techniques.
- Implement machine learning and deep learning models like CNNs for solving computer vision problems.

## Detailed contents:

Unit 1

Introduction to Digital Image Processing, basic concept of image formation and representation, steps in digital image processing, elements of digital image processing, relationship between pixels, image transfor- mation.

Unit 2

Image enhancement: spatial domain filtering and spatial domain filtering; sharpening; contrast enhance- ment; restoration. Image segmentation: point; line and edge detection; thresholding; clustering; region growing.Image compression: Image Compression models; error-free compression; Lossy compression; Im- age compression standards.

Unit 4

Overview of Computer Vision, feature extraction in images, image classification techniques, object detection, object recognition, semantic segmentation.

Unit 5

Introduction to machine learning, types of machine learning techniques: supervised and unsupervised techniques. Introduction to deep learning; convolutional neural networks. Applications of machine learning in computer visions.

Books/References:


1. Rafael C., Gonzalez Woods R.E., Digital Image Processing, Third edition, Pearson, 2013.
2. Jain A.K, Fundamentals of Digital Image Processing, Prentice Hall, Englewood Cliffs, 2002.
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2022.
4. David A. Forsyth, Jean Ponce, Computer Vision-A Modern Approach, Pearson Education, 2015.


**Research Methodology & Proposal Writing**

**Course Objectives:**

- To understand the process of identifying, formulating, and investigating research problems effectively.
- To develop skills in literature review, research ethics, and technical writing for effective communication.
- To gain knowledge about intellectual property rights, including patents and international patenting processes.
- To learn report writing and publication techniques using tools like LaTeX.

**Course Outcomes:**

- Identify and formulate research problems with a clear scope, objectives, and methodologies.
- Conduct ethical research, perform literature analysis, and prepare well-structured technical reports.
- Explain the fundamentals of intellectual property rights and the patenting process.
- Write professional research reports, theses, and journal publications using standard tools and formats

## Detailed contents:

Unit 1

Introduction: What is a research problem?, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation

Unit 2

Effective literature studies approaches: analysis Plagiarism, Research ethics Effective technical writing: how to write report.

Unit 3

Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee .

Unit 4

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5

Report Writing: pre-writing considerations, thesis writing, formats of report writing, formats of publications in research journals, use of standard tools like LATEX.

Books/References:


1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3. Halbert, “Resisting Intellectual Property”, Taylor Francis Ltd., 2007.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “ Intellectual Property in New Technological Age”, 2016.