NATIONAL INSTITUTE OF TECHNOLOGY MIZORAM
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

INTEGRATED DUAL DEGREE PROGRAMME (B.TECH & M.TECH)
(WITH SPECIALISATION IN DATA SCIENCE)

COURSE STRUCTURE AND SYLLABUS

1st Semester				
S. N	**Course Code**	**Course Name**	**L-T-P**	**Credit**
1	CSL 4101	Advanced Data Structures & Algorithms	3-0-0	3
2	CSL 4102	Algorithmic Graph Theory	3-0-0	3
3	CSL 4103	Machine Learning	3-0-0	3
4	CSL 4104	Fundamentals of Data Science	3-0-0	3
5	CSL 41XX	Elective-I	3-0-0	3
Laboratory				
6	CSP 4101	Programming Lab	0-0-3	1.5
7	CSP 4103	Machine Learning Lab	0-0-3	1.5
Total Credits			**15-0-6**	**18**

2nd Semester				
S.N	**Course Code**	**Course Name**	**L-T-P**	**Credit**
1	CSL 4201	Big Data Analytics	3-0-0	3
2	CSL 4202	Advanced Artificial Intelligence	3-0-0	3
3	CSL 4203	Advanced Database Systems	3-0-0	3
4	CSL 42XX	Elective-II	3-0-0	3
5	CSL 42XX	Elective-III	3-0-0	3
Laboratory				
6	CSP 4201	Big Data Lab	0-0-3	1.5
7	CSP 4202	Advanced Artificial Intelligence Lab	0-0-3	1.5
Total Credits			**15-0-6**	**18**

3rd Semester

S. N	**Course Code**	**Course Name**	L-T-P	**Credit**
1	CSD 4301	Project Phase - I	0-0-16	8

4th Semester

S.N	Course Code	**Course Name**	L-T-P	**Credit**
1	CSD 4401	Project Phase - I	0-0-24	12

List of Electives

S.N.	Name of Subjects
1.	Network Security & Cryptography
2.	Human Computer Interaction
3.	Internet of Things
4.	Optimization Techniques
5.	Performance Evaluation of Computing Systems
6	Natural Language Processing
7	Computer Vision

SYLLABUS

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: **Advanced Data Structures and Algorithms**

L T P Course Code: CSL 4101 Credit: 3

3 0 0

Unit – I **Lecture:6**

Review of Basic Data Structure: Abstract data types, Big Asymptotic notations, Recurrence equations, Master theorems, Generating function techniques, Constructive induction.

Unit – II **Lecture:6**

Advanced Search Structures for Dictionary ADT: Splay trees, Amortized analysis, 2-3 trees, 2-3-4 trees, KD Tree, R-Tree, Red-black trees, Randomized structures, Skip lists, Treaps, Universal hash functions**.**

Unit – III **Lecture:8**

Set – Implementation – Basic Operations on Set – Priority Queue – Implementation – Graph Traversals - Advanced Structures for Priority Queues and Their Extensions: Binomial heaps, Leftist heaps, Skewed heaps, Fibonacci heaps and its amortized analysis, Applications to minimum spanning tree algorithms**.**

Unit – IV **Lecture:6**

Issues – Managing Equal Sized Blocks – Garbage Collection Algorithms for Equal Sized Blocks – Storage Allocation for Objects with Mixed Sizes – Buddy Systems – Storage Compaction**.**

Unit – V **Lecture:8**

Searching Techniques – Review of Internal Sorting - External Sorting –Design Techniques – Divide and Conquer – Dynamic Programming – Greedy Algorithm – Backtracking - Branch & Bound – Local Search Algorithms.

Unit – VI **Lecture:8**

Classes of Problems - Computability - P & NP - Reducibility - NP Complete- NP Hard - Approximation & Heuristics Algorithms

Total Lecture: 42

Text book:

1. Introduction to Algorithms, Third Edition by Thomas Cormen, Charles Leiserson, Ronald Rivest, and Clifford Stein. MIT Press, 2009.

Reference Books:

1. Algorithm Design by Jon Kleinberg and ÉvaTardos. Addison-Wesley, 2005.
2. Algorithms by SanjoyDasgupta, Christos Papadimitriou, and UmeshVazirani. McGraw Hill, 2006.
3. The Design and Analysis of Algorithms by Dexter Kozen. Springer, 1992.
4. Algorithms 4/e by Robert Sedgewick and Kevin Wayne. Addison-Wesley Professional, 2011.
5. Data Structures and Network Algorithms by Robert Tarjan. Society for Industrial and Applied Mathematics, 1987.

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Subject: **Algorithmic Graph Theory**

L T P Course Code: CSL 4102 Credit: 3

3 0 0

Unit-I **Lecture: 3**

Introduction: Overview of graph, Complexity, Sub-graph, Isomorphic graph, Path, Walk, Independent set, Representation of graphs, Operation on Graph, NP-completeness, Approximation and randomization of graph algorithms

Unit-II **Lecture: 3**

Tour and Traversals: Graph traversal (DFS, BFS), Path finding, Shortest paths, Longest paths in acyclic graphs, Hamiltonian paths, Eulerian and Hamiltonian Tours, Traveling salesman problem

Unit-III **Lecture: 4**

Spanning Tree and Sub graph: Cut set, Branching, Minimum spanning tree, Prim-Dijkstra-Jarnik algorithm, Boruvka's algorithm, Kruskal's algorithm, Cliques, Moon-Moser bound on maximal cliques, Bron-Kerbosch algorithm, Connectivity (Tutte's synthesis of 3-connected graphs, Seymour's splitter theorem, Connectivity and

Unit-IV **Lecture: 4**

Matching, Covering and Coloring: Matching theory (Edmonds-Gallai decomposition, Ear decompositions, the matching lattice, Edmonds matching theorem, Gale-Shapley's theorem and kernel solvable graphs, T-cuts and T-joins, Chinese postman), Edge cover, Vertex cover, Bipartite graphs, Hopcroft-Karp algorithm for bipartite matching, Stable marriage, Gale-Shipley algorithm for stable marriage, Graph coloring, Planer graph

Unit-V **Lecture: 3**

Flow Problem: Maximum flow problem, Minimum cut problem, Max-flow min-cut theorem, Formulating maximum matching as a flow problem. Augmenting path (Ford-Fulkerson) algorithm

Unit-VI **Lecture: 4**

Extremal problems & Algebraic graph theory: Cayley graphs, Strongly regular graphs, Isoperimetric inequalities, Extremal problems: Szemeredi's regularity lemma and applications, Erdos-Stone theorem, Extremal problems for minors and subdivisions

Unit-VII **Lecture: 4**

Perfect graphs: Polyhedral aspects, Perfect matrices, Shannon capacity, Lovasz theta function, Computing the chromatic and clique number of a perfect graph, Graph entropy and application to sorting, Imperfection ratio and channel assignment problem

Unit-VII **Lecture: 5**

Random Graph: Random graph model, Inhomogeneous random graphs, Random Walk, Random Graph for complex Network, Random walk, Markov Chain, Erdos-Renyi random graph, PageRank algorithm,

Unit-IX **Lecture: 10**

Advanced Graph Theory Application: Introduction, Motivation, Example, Algorithm and Model development, Different applicability of graph, Networks representation using graph, Performance evaluation, State of the art comparison, Outcomes

Total Lecture: 40

Text Books:

1. Gary Chartrand, Ortrund R. Oellermann, Applied and Algorithmic Graph Theory, Mcgraw-hill Education, Europe, 1993.
2. Martin Charles Golumbic, Algorithmic Graph Theory and Perfect Graphs, North Holland Publishing Company, Amsterdam, Netherlands,2004.
3. Alan Gibbons, Algorithmic Graph Theory, Cambridge University Press, Cambridge, U.K.1985.
4. Hanneman, Robert and Mark Riddle, Introduction to Social Network Methods.

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Subject: **Machine Learning**

L	T	P	Course Code: CSL 4103	Credit: 3
3	0	0		

Unit-I **Lecture-8**

Introduction: Overview of machine learning, Different forms of learning, Generative learning, Gaussian parameter estimation, Maximum likelihood estimation, MAP estimation, Bayesian estimation, Bias and variance of estimators, Missing and noisy features, Nonparametric density estimation, Applications, software tools.

Unit-II **Lecture-8**

Classification Methods: Nearest neighbour, Decision trees, Linear Discriminant Analysis, Logistic Regression, Perceptrons, Large Margin classification, Kernel methods, Support Vector Machines, Classification and Regression Trees

Unit-III **Lecture-8**

Graphical and Sequential models, Bayesian networks, Conditional independence, Markov random fields, Inference in graphical models, Belief propagation, Markov models- Hidden Markov models- decoding states from observations- learning HMM parameters.

Unit-IV **Lecture-6**

Clustering Methods: Partitioned based Clustering- K-means, K-medoids; Hierarchical Clustering: Agglomerative, Divisive, Distance measures; Density based Clustering - DBScan; Spectral clustering.

Unit-V: **Lecture-10**

Neural networks: the Perceptron algorithm, Multilayer perceptrons, Back propagation, Nonlinear regression, Multiclass discrimination, Training procedures, Localized network structure, Dimensionality Reduction Interpretation.

Total Lectures- 40

Text Books:

1. T. Hastie, R. Tibshirani and J. Friedman, "Elements of Statistical Learning", Springer, 2009.

2. E.Alpaydin,"MachineLearning",MITPress,2010.

3. K.Murphy,"MachineLearning:AProbabilisticPerspective",MITPress,2012.

Reference Books

1. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press, 2014.

2. John Mueller and Luca Massaron, "Machine Learning For Dummies", John Wiley & Sons, 2016.

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Subject: **Fundamentals of Data Science**

L T P Course Code: CSL 4104 Credit: 3

3 0 0

Unit-I **Lecture-10**

Linear algebra: Vectors, Matrices, Product of Matrix and vector, Rank, Null space, Projections, Eigenvalues and Eigenvectors, Singular value decomposition

Unit-II **Lecture-10**

Probability and Statistics: Basics of probability, Random variable and Distributions, Mean, Variance, Covariance, Covariance matrix, Understanding Univariate and Multivariate normal distributions, Introduction to hypothesis testing, Confidence interval for estimates

Unit-III **Lecture-10**

Optimization: Components of Optimization, Objective Function, Constraints, Bounded and unbounded problem, Monotonic Functions, Convex functions, Unimodal functions, Multimodal function, Classification of Optimization problems, Classification of Optimization techniques, multi-objective Optimization, Saddle point for single objective function, Linear programming, Non-linear programming

Unit-IV **Lecture-10**

Python for data science: Data types, operations, Numpy, Pandas, Matplotlib, Scipy, Scikit-learn

Textbooks:

1. Introduction to Linear Algebra by Gilbert Strang
2. Applied Statistics and Probability for Engineers by Douglas Montgomery
3. Optimization for Engineering Design: algorithm and example by Kalyanmoy Deb

Reference Books:

1. Mastering Python for data science by Samir Madhavan
2. Hands-On Machine Learning with Scikit-Learn & TensorFlow by Aurélien Géron

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Subject: **Programming Lab**

L	**T**	**P**	**Course Code: CSP 4101**	**Credit: 1.5**
0	**0**	**3**		

Problem will be set in consonance with the material covered in CSL 4101

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Subject: **Machine Learning Lab**

L	**T**	**P**	**Course Code: CSP 4103**	**Credit: 1.5**
0	**0**	**3**		

Problem will be set in consonance with the material covered in CSL 4103

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Subject: **Big Data Analytics**

L	T	P	Course Code: CSL 4201	Credit: 3
3	0	0		

Unit-I: (Introduction to Big Data) **Lecture: 4**

Introduction to Big Data Platform, Challenges of Conventional Systems, Intelligent data analysis, Nature of Data, Analytic Processes and Tools, Analysis vs Reporting.

Unit-II (Mining data streams) **Lecture: 8**

Introduction To Streams Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Oneness in a Window, Decaying Window, Real time Analytics Platform(RTAP)

Unit-III (Applications) **Lecture:3**

Case Studies, Real Time Sentiment Analysis, Stock Market Predictions.

Unit-IV (Hadoop) **Lecture: 4**

History of Hadoop, the Hadoop Distributed File System, Components of Hadoop Analysing the Data with Hadoop, Scaling Out, Hadoop Streaming, Design of HDFS, Java interfaces to HDFS Basics

Unit-V (Map Reduce) **Lecture: 7**

Developing a Map Reduce Application, How Map Reduce Works, Anatomy of a Map Reduce Job run, Job Scheduling, Shuffle and Sort, Task execution, Map Reduce Types and Formats, Map Reduce Features, Hadoop environment.

Unit-VI (Frameworks) **Lecture: 8**

Applications on Big Data Using Pig and Hive, Data processing operators in Pig, Hive services, HiveQL, Querying Data in Hive, fundamentals of HBase and ZooKeeper, IBM InfoSphere BigInsights and Streams.

Unit-VII **Lecture: 6**

Predictive Analytics, Simple linear regression, Multiple linear regression, Interpretation 4 of regression coefficients, Visualizations: Visual data analysis techniques, interaction techniques, Systems and applications.

Text Books:

- Fundamentals of Business Analytics by R.N. Prasad, Seema Acharya, Wiley.
- Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses by Michael Minelli ,Michele Chambers, Ambiga Dhiraj

Reference Books:

- An Introduction to Data Science by Jeffery Stanton.
- Big Data and Analytics by Seema Acharya, Subhashini Chellapan

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: **Advanced Artificial Intelligence**

L T P Course Code: CSL 4202 Credit: 3

3 0 0

Unit-I **Lecture: 2**

Introduction: Definition, Scope, Applications, Recent trends

Unit-II **Lecture: 7**

Classical Planning: Introduction, Schema, States, Problem, Search,

Unit-III **Lecture: 4**

Complex Decision Theory and Application: Models, Rewards,

Unit-IV **Lecture: 4**

Reinforcement Learning: Introduction, Types of learning, Model

Unit-V **Lecture:**

Robotics AI: Introduction, Sensor, Planning, Workspace, Configuration Space, Algorithm, Model, Robot Operating system, Finite State Machine for robot

Unit-VI **Lecture: 3**

Statistical Analysis: Introduction, Problem solving analysis (validation), Application

Unit-VII **Lecture:**

Recent AI Development: Introduction, Challenges, Problem solving, Model Development, Performance evaluation, State of the art comparison, Outcomes

Total Lecture: 40

Text Books:

1. S. Russell and P. Norvig, Artificial Intelligence, Pearson.
2. M. Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, Addison Wesley.
3. D. Khemani, A first course in Artificial Intelligence, McGraw Hill Education (India) Pvt. Ltd.
4. S. Kaushik, Artificial Intelligence, CENGAGE Learning.
5. I. Bratko, Prolog Programming for Artificial Intelligence, Pearson.

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Subject: **Advanced Database Systems**

L T P Course Code: CSL 4203 Credit: 3

3 0 0

Unit – I **Lecture: 4**

PL/SQL – Introduction to PL/SQL – Declare, begin statements, Variables, Control Structure, PL/SQL Transactions – Savepoint, Cursor, PL/SQL Database Objects – Procedures, Functions, Packages, Triggers. Programmatic SQL – Embedded SQL, Dynamic SQL, and ODBC Standard - Database and Indexed File Structure.

Unit – II **Lecture:10**

Definition of Transaction and ACID properties. Transaction Processing - Transaction-processing monitors, transactional workflows, main-memory databases, real-time transaction systems, long-duration transactions, transaction management in multi-databases. Concurrency Control – Locks,

Optimistic Concurrency Control (Backward and Forward validations), Timestamp based Concurrency Control - Failure & Recovery- Distributed Database Concepts.

Unit – III **Lecture: 8**

Object-based databases – Complex data types, structured types and inheritance in SQL, table inheritance, array and multiset types in SQL, object identity and reference types in SQL, implementing O-R features, Persistent programming languages, OO vs OR. XML – Structure of XML, Document Schema, Querying and Transformation, API in XML, XML applications.

Unit – IV **Lecture: 8**

Introduction to Data Warehousing – Concepts, Benefits and Problems, DW Architecture – Operational Data, load manager, meta data, DW Data flows – inflow, upflow, meta flow, DW tools and technologies – Extraction, cleansing and transformation tools, DW DBMS, admin and management tools, data marts – reasons and issues, Data Warehousing using Oracle. Data Warehousing Design – Designing, Dimensionality modeling, Design methodology, DW deign using Oracle.

Unit –V **Lecture:5**

On-line Analytical Processing – OLAP BenchMarks, applications, benefits,tools, categories, extensions to SQL, Data mining – introduction, techniques,predictive modelling, tools. Data mining algorithms – Apriori, Decision tree,k-means, Bayesian classifier.

Unit – VI **Lecture:5**

Security and integrity threats, Defence mechanisms, Statistical database auditing & control. Security issue based on granting/revoking of privileges, Introduction to statistical database security. PL/SQL Security – Locks – Implicit locking, types and levels of locks, explicit locking, Oracles' named Exception Handlers - Database Tuning.

Total Lecture: 40

Text Books:

1. Elmasri and Navathe, Fundamentals of Database Systems, Pearson Education.
2. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill.
3. Korth, Silberchatz, Sudarshan , Database System Concepts, McGraw-Hill.
4. Peter Rob and Coronel, Database Systems, Design, Implementation and Management, Thomson Learning.
5. C. J. Date & Longman, Introduction to Database Systems, Pearson Education.

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Subject: **Big Data Lab**

L	T	P	Course Code: CSP 4201	Credit: 1.5
0	0	3		

Problem will be set in consonance with the material covered in CSL 4201

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Subject: **Artificial Intelligence Lab**

L	T	P	Course Code: CSP 4202	Credit: 1.5
0	0	3		

Problem will be set in consonance with the material covered in CSL 4202

SYLLABUS OF ELECTIVE COURSES

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: **CRYPTOGRAPHY & NETWORK SECURITY**

L	T	P	Course Code: CSL 4XXX	Credit: 3
3	0	0		

Prerequisites:
Discrete Structure, Algorithms, and Computer Networks.

Objectives:

1. Have a fundamental understanding of the objectives of cryptography.
2. Become familiar with the cryptographic techniques that provide information.
3. Be able to evaluate the security of communication systems, networks and protocols based on a multitude of security metrics
4. To be familiar with how threats to an organization are discovered, analysed, and dealt with.

Unit – I **Lecture: 10**

Introduction: Basic objectives of cryptography, Overview on Modern Cryptography, secret-key and public-key cryptography, one-way and trapdoor one-way functions, cryptanalysis, attack models. Classical Cryptosystems: Classical Cryptosystems, Cryptanalysis of Classical Cryptosystems, and Shannon's Theory: I, II, III.Cryptanalysis of Symmetric Key Ciphers: Linear Cryptanalysis, Differential Cryptanalysis, Other Cryptanalytic Techniques, Overview on S-Box Design Principles, Modes of operation of Block Ciphers.

Unit – II **Lecture: 8**

Block Ciphers: Modes of operation, DES and its variants, RCS, IDEA, SAFER, FEAL, BlowFish, AES, linear and differential cryptanalysis.Stream Ciphers: Stream chippers based on linear feedback shift registers, SEAL, unconditional security, Pseudorandom functions.

Unit – III **Lecture: 6**

Intractable Problems: Integer factorization problem, RSA problem, modular square root problem, discrete logarithm problem, Deffie-Hellmen problem, known algorithms for solving intractable problems.

Unit – IV **Lecture: 4**

Public Key Encryption: RSA, Rabin and EIGamal schemes, side channel attacks.

Unit – VI **Lecture: 6**

Message Digest: Properties of hash functions, MD2, MD5 and SHA-1, keyed hash functions, attacks on hash functions.: Digital Signature scheme: Certification, public-key infrastructure (PKI).

Unit – IX **Lecture: 6**

Authentication-Kerberos, Authorisation, Access control, Firewalls, Network Intrusion detection systems, Web and IP security, secured socket layer (SSL).

Total Lecture:40

Text Book:

1. Douglas Stinson, “Cryptography Theory and Practice”, 2nd Edition, Chapman & Hall/ CRC.
2. B. A. Forouzan, “Cryptography & Network Security”, Tata Mc Graw Hill.
3. W. Stallings, “Cryptography & Network Security”, Pearson Education.

Reference Book:

1. Joux, “Algorithmic Cryptanalysis”, CRC Press.
2. Wenbo Mao, “Modern Cryptography, Theory & Practice”, Pearson Education.
3. Bruce Schneier ,"Applied Cryptography: Protocols, Algorithms, and Source Code in C ",2nd Edition

Department of Computer Science & Engineering

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Subject: **HUMAN COMPUTER INTERACTION**

L T P Course Code: CSL 4XXX Credit: 3

3 0 0

Unit-I **Lecture: 2**

Introduction: Definition, Application, Challenges, Example, Recent trend and demands

Unit-II **Lecture: 6**

Interaction Design Philosophy: Introduction, Communication, Collaborations, System design, Socialistic behaviour, Performance Analysis

Unit-III **Lecture: 5**

Module and Application: Introduction, Graphical user interface, Designing process and phenomena, Software requirements and specification, Memory management

Unit-IV **Lecture: 5**

Machine Learning: Introduction, Machine learning algorithm and model development, Cost and budget

Unit-V **Lecture:**

Application of HCI in Robotics: Introduction, Robot motion planning and strategies, Sensor requirements and its applicability, Degree of freedom, Algorithm, Model specification, Basics of Robot Operating system, Autonomous machine model for

Unit-VI **Lecture:**

Performance Analysis: Introduction, Algorithmic analysis, Efficiency, Different matrices for performance measure, Application

Unit-VII **Lecture: 9**

Advanced HCI Development: Introduction, Motivation, Issues, Problem solving, Model Development and improvements, Performance evaluation, State of the art comparison, Outcomes

Total Lecture: 40

Text Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, ―Human Computer Interaction, 3rd Edition, Pearson Education, 2004 (UNIT I, II & III)
2. Brian Fling, Mobile Design and Development, First Edition, O'Reilly Media Inc., 2009
3. Wilbert O Galitz, Wiley Dream Tech,The essential guide to user interface design
4. Bill Scott and Theresa Neil, Designing Web Interfaces, First Edition, O'Reilly, 2009.

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Subject: **INTERNET OF THINGS**

L	T	P	Course Code: CSL 4XXX	Credit: 3
3	0	0		

Unit-I **Lecture: 8**

Basics of Networking: Network Types, Layered Network Models, Addressing, TCP/IP transport layer. Introduction to IoT: Evolution of IoT, Technologies of IoT, IoT Networking components, Addressing strategy in IoT.

Unit-II **Lecture: 5**

IoT Sensing and Actuation: Sensor characteristics, Sensorial deviations, Sensing types, Sensing considerations, Actuator types, Actuator characteristics

Unit-III **Lecture: 5**

IoT Communication technologies/protocols: Infrastructure protocols, Discovery protocols, Data protocols, Identification protocols, Device management, Semantic protocols, IoT Interoperability: Standards, Frameworks.

Unit-IV **Lecture: 6**

Introduction to SDN, SDN for IoT, Cloud Computing, Fog Computing, Edge Computing

Unit-V **Lecture: 9**

Data Handling and Analytics in IoT: Introduction to Machine learning, Types of ML, Advantages and Challenges of ML, Selected algorithms in ML-classification, clustering algorithms.

Unit-VI **Lecture: 7**

Smart cities, Smart homes, Smart grid, Connected vehicles, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring

Total Lecture: 40

Textbook:

1. S. Misra, A. Mukherjee, and A. Roy, 2020. Introduction to IoT. Cambridge University Press.

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Subject: **OPTIMIZATION TECHNIQUES**

L	T	P	Course Code: CSL 4XXX	Credit: 3
3	0	0		

Unit-I: (Overview of Real analysis and Linear algebra) **Lecture: 4**

Sets, functions, sequences, continuity, differentiability, gradients, Taylor series expansion; Vectors, matrices, norms, symmetric matrices, eigenvalue decomposition, positive semidefinite and positive definite matrices.

Unit-II: (Convex sets and functions) **Lecture: 8**

Convex sets, examples and properties; Convex functions, strict and strong convexity, examples, and convexity preserving operations; Equivalent definitions of convexity under differentiability assumptions.

Unit-III: (Unconstrained optimisation) **Lecture: 8**

Maxima, minima, stationary point, saddle point, local and global maximum/minimum; First order and second order conditions for optimality; Linear, quadratic and convex optimisation problems, examples; Benefits of convexity.

Unit-IV:(Constrained optimisation) **Lecture: 8**

Constrained optimisation problem, feasible set; Lagrangian, KKT condition; Linear and quadratic optimisation; Duality for convex optimisation — theorem of alternatives, Farka's lemma.

Unit-V(Algorithms for optimisation) **Lecture: 9**

Gradient descent with fixed step size, line search and Armijo-Goldstein rule; Newton method and variations; Conjugate gradient and Quasi-newton methods; Algorithms for constrained optimisation: Projected gradient descent, dual ascent, alternating direction method of multipliers.

Unit-V(Applications) **Lecture: 3**

Applications in statistics, machine learning and computer science.

Text Books

- Boyd, Stephen, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.
- Luenberger, David G., and Yinyu Ye. Linear and nonlinear programming. 4th edition. Springer, 2015.

Reference Books

- Bertsekas, Dimitri P. Nonlinear programming. Belmont: Athena scientific, 1999.
- Nocedal, Jorge and Wright, Stephen. Numerical Optimization. Springer, 1999

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Subject: **PERFORMANCE EVALUATION OF COMPUTING**

L T P Course Code: CSL 4XXX Credit: 3

3 0 0

Unit-I **Lecture: 6**

Introduction: Concept of computing systems, Performance, Statistical model, Probability space, Random Variables, Discrete and Continuous distribution

Unit-II **Lecture: 8**

Performance metrics: Performance metrics for computer architecture, Operating systems, Computer networks, Databases, Software systems, Computational speed, Response time, Throughput, Accuracy, Availability, Reliability, Integrity, Safety, Usability, Scalability, Quality of service, Maintainability, Serviceability, Energy & resource efficiency, Sustainability

Unit-III **Lecture: 8**

Analytical tools for performance evaluation: Workload characterization, Input modelling, Deterministic and nondeterministic systems, Random number generation, Queuing systems, Markovian models, Reliability models, Maintainability models,

Unit-IV **Lecture: 8**

Empirical performance evaluation: Testing, Test benches, Benchmarks: (Types, Strategies, Tools for computer architecture, Operating systems, Computer networks, Databases, Software systems, Security), Reliability, System validation

Unit-V **Lecture:**

Advanced Evaluation Framework: Introduction, Motivation, Problem analysis, Performance, Performance evaluation and improvements, Study of evaluation framework for different domain and its outcomes

Total Lectures: 40

Text Books:

1. K.S. Trivedi, Probability and Statistics with Reliability, Queueing and Computer Science Applications", John Wiley and Sons, 2001.
2. Robert B Cooper, Introduction to Queuing Theory, 2nd Edition, Elsevier, 1981
3. M. E. Taha, Queueing Networks, Springer, 2003
4. Raj Jain, The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling, Wiley- Interscience, 1991

Reference Books

1. William.H.Tranter, K. Sam Shanmugam, Theodore. S. Rappaport, Kurt L. Kosbar, Principles of Communication Systems Simulation, Pearson Education (Singapore), 2004
2. Averill.M.Law and W. David Kelton, Simulation Modeling and Analysis, McGeaw Hill Inc., 2000

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Subject: **NATURAL LANGUAGE PROCESSING**

L T P Course Code: CSL 2XXX Credit: 3

3 0 0

Prerequisites:

1. A previous course on Artificial Intelligence.
2. Courses on Data Structures and Algorithms.

Objectives:

To study concepts of Natural Language Processing, Text Analytics and Multi-linguality.

Unit – I **Lecture: 8**

Natural Language Processing – Linguistic Background- Spoken language input and output Technologies - Morphology - Language Modelling - Mathematical Methods - Statistical Modelling and Classification Finite State methods Grammar for Natural Language Processing – Parsing – Semantic and Logic Form – Ambiguity Resolution – Semantic Interpretation - Computational Semantics.

Unit – II **Lecture: 8**

Information Retrieval architecture - Indexing- Storage – Compression Techniques – Retrieval Approaches – Evaluation - Search engines- commercial search engine features- comparison- performance measures – Document Processing - NLP based Information Retrieval – Information Extraction - Question Answering System.

Unit – III **Lecture: 8**

Categorization – Extraction based Categorization- Clustering- Hierarchical Clustering Document Classification and routing – use of categories and clusters for organising retrieval results – Text Categorization and efficient Summarization using Lexical Chains – Pattern Extraction.

Unit – IV **Lecture: 8**

Multi-linguality – Multilingual Information Retrieval and Speech processing - Multimodality – Text and Images – Modality Integration - Transmission and Storage – Speech coding Evaluation of systems – Human Factors and user Acceptability

Unit – V **Lecture: 8**

Machine Translation – Transfer Metaphor - Interlingua and Statistical Approaches - Discourse Processing – Dialog and Conversational Agents – Natural Language Generation – Surface Realization and Discourse Planning.

Total Lecture:40

Text Books:

1. "Speech and Language Processing": Jurafsky and Martin, Prentice Hall
2. "Statistical Natural Language Processing"- Manning and Schutze, MIT Press
3. “Natural Language Understanding”. James Allen. The Benajmins/Cummings Publishing Company

Reference Books:

1. Cover, T. M. and J. A. Thomas: Elements of Information Theory. Wiley.
2. Charniak, E.: Statistical Language Learning. The MIT Press.
3. Jelinek, F.: Statistical Methods for Speech Recognition. The MIT Press. 4. Lutz and Ascher - "Learning Python", O'Reilly

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: **COMPUTER VISION**

L T P Course Code: CSL 2XXX Credit: 3

3 0 0

Unit-I (Digital Image Formation and low-level processing) **Lecture-8**

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Unit-II (Depth estimation and Multi-camera views) **Lecture-8**

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

Unit-III (Feature Extraction) **Lecture-8**

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Unit-IV (Image Segmentation) **Lecture-8**

Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Unit-V (Motion Analysis) **Lecture-8**

Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Toal Lectures- 40

Textbooks:

- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011
- Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

References:

- Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004
- Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006