



DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

M.Tech. Computer Science and Engineering (Specialization offered in Data Science and Cyber Security and Forensics)

Program Core

L-T-P C

		L-T-P	C
CSL501	Mathematical Foundations of Computer Science	3-0-0	3
CSL535	Advanced Data Structure	3-0-2	4
CSL502	Advanced Algorithms	3-0-2	4
CSL515	Soft Computing	3-0-2	4

Basic Science Courses/Audit course

L-T-P C

		L-T-P	C
MAL606	Introduction to Research Methodology	2-1-0	3

Open Elective Courses

L-T-P C

		L-T-P	C
	Open Elective – 1	2-0-2	3

*Open electives can be chosen from University list of Open

Elective courses

Project & Dissertations

L-T-P C

		L-T-P	C
CSC501	Seminar	0-0-4	2
CSD501	Minor Project	0-0-8	4
CSD601	Dissertation (Phase-1)	0-0-12	6
CSL602	Dissertation (Phase-2)	0-0-24	12

Program Electives (Cyber Security and Forensics)

L-T-P C

		L-T-P	C
CSL537	Risk Management Principles and Policies	2-0-4	4
CSL544	Cyber Forensics & Malware Analysis Fundamentals	2-0-4	4
CSL546	Cloud and its Security	2-0-4	4
CSL547	Applied Cryptography	2-0-4	4
CSL548	Network Hacking & Security	2-0-4	4
CSL549	Secure coding vulnerabilities and mitigation	2-0-4	4
CSL565	Web Application Security	2-0-4	4
CSL566	Blockchain and Cryptocurrency	2-0-4	4
CSL567	Vulnerability Assessment and Penetration testing	2-0-4	4

Program Electives (Data Science)

L-T-P C

		L-T-P	C
CSL551	Foundation of Data Science	2-0-4	4
CSL530	Statistics with Python	2-0-4	4
CSL556	Data Engineering	2-0-4	4
CSL561	Business Analytics	2-0-4	4
CSL555	Advanced Machine Learning	2-0-4	4
CSL545	Big Data Analytics	2-0-4	4
CSL558	Computer Vision	2-0-4	4
CSL559	Neural Networks and Deep Learning	2-0-4	4

PG Diploma (Specialization offered in Data Science and Cyber Security & Forensics)

Sem	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	L	T	P	Weekly Contact Hours	Credits
I	CSL501 Mathematical Foundations of Computer Science 3-0-0 (3)	CSL535 Advanced Data Structure 3-0-2 (4)	PE-1 2-0-4 (4)	PE-2 2-0-4 (4)	CSC501 Seminar 0-0-4 (2)	CSS501 Community Service (CS)	10	0	14	24	17
II	CSL502 Advanced Algorithms 3-0-2 (4)	CSL515 Soft Computing 3-0-2 (4)	PE-3 2-0-4 (4)	PE-4 2-0-4 (4)	CSD501 Minor Project (5)	CSS502 Community Service (CS) (140Hrs** 2 Credits)	10	0	22	12	23
Summer	Skill based course (3)	Industrial Internship (7)					0	0	0	0	10
EXIT OPTION: PG DIPLOMA; CREDITS = 50											50

*PE – Programme Elective * OE – Open Elective

**Students can utilize the summer/winter break period to complete the remaining 140 Community Service hours every year

M.Tech. Computer Science and Engineering
(Specialization offered in Data Science and Cyber Security and Forensics)

Sem	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	L	T	P	Weekly Contact Hours	Credits
I	CSL501 Mathematical Foundations of Computer Science 3-0-0 (3)	CSL535 Advanced Data Structure 3-0-2 (4)	PE-1 2-0-4 (4)	PE-2 2-0-4 (4)	CSC501 Seminar 0-0-4 (2)	CSS501 Community Service (CS)	10	0	14	24	17
II	CSL502 Advanced Algorithms 3-0-2 (4)	CSL515 Soft Computing 3-0-2 (4)	PE-3 2-0-4 (4)	PE-4 2-0-4 (4)	CSD501 Minor Project (5)	CSS502 Community Service (CS) (140Hrs** 2 Credits)	10	0	22	12	23
III	OE 2-0-2 (3)	MAL606 Research Methodology 2-1-0 (3)	PE-5 2-0-4 (4)	CSD601 Dissertation-I 0-0-12 (6)		CSS601 Community Service (CS)	6	1	18	6	16
IV	CSD602 Dissertation-II 0-0-24 (12)		-	-	-	CSS602 Community Service (CS) ** (2)	0	0	24	--	14
TOTAL CREDITS OF THE M.TECH DEGREE PROGRAMME =											70

*PE – Programme Elective * OE – Open Elective

**Students can utilize the summer/winter break period to complete the remaining 140 Community Service hours every year

M.Tech. Computer Science and Engineering (Part-Time)
(Specialization offered in Data Science and Cyber Security and Forensics)

Sem	Subject 1	Subject 2	Subject 3	Subject 4	L	T	P	Weekly Contact Hours	Credits
I	CSL501 Mathematical Foundations of Computer Science 3-0-0 (3)	CSL535 Advanced Data Structure 3-0-2 (4)	PE-1 2-0-4 (4)	CSS501 Community Service (CS)	8	0	6	14	11
II	CSL502 Advanced Algorithms 3-0-2 (4)	CSL515 Soft Computing 3-0-2 (4)	PE-2 2-0-4 (4)	CSS502 Community Service (CS) (140Hrs 2 Credits)	8	0	8	16	14
III	OE 2-0-2 (3)	MAL606 Research Methodology 2-1-0 (3)	PE-3 2-0-4 (4)	CSS601 Community Service (CS)	6	1	6	07	10
IV	PE-4 2-0-4 (4)	PE-5 2-0-4 (4)	CSD501 Minor Project (5)	CSS602 Community Service (CS) (140Hrs 2 Credits)	4	0	8	12	15
V	CSD601 Dissertation-I 0-0-12 (6)	CSC501 Seminar 0-0-4 (2)			0	0	16	--	8
VI	CSD602 Dissertation-II 0-0-24 (12)				0	0	24	--	12
TOTAL CREDITS OF THE M.TECH DEGREE PROGRAMME =									70

*PE – Programme Elective * OE – Open Elective

**Students can utilize the summer/winter break period to complete the remaining 140 Community Service hours every year

Brief syllabus of M.Tech. CSE program core and elective courses

CSL535 Advanced Data Structures (3-0-2) 4 credits

Introduction to Data Structures, Arrays, recursion, Stacks- Operation on Stack, Pointers and Stacks. Queues- Dynamic Implementation using pointers. Static Lists and Linked Lists- Insertion, deletion, Sorting, Singly Linked List, Doubly Linked List. Storage management- Memory Representation, boundary Tag Systems, Storage Allocation. Trees- Binary Tree, Complete Binary Tree, Binary Search Tree. Graphs- Traversal in Graphs, Spanning Trees, Sorting- Insertion, Selection, Bubble, Quick, Searching- Linear Search, Binary Search, Division Method, Mid Square Method.

CSL502 Advanced Algorithms (3-0-2) 4 Credits

Introduction to general Algorithm Paradigms: Divide and Conquer, Dynamic Programming, Greedy Method and Backtracking; Algorithm analysis, RAM Model, Recurrence relation, Master theorem, Asymptotic vs. Amortized analysis. Breadth First Search and Application, Depth First Search and Application, Euler Tour, Heaps and Application, Divide and Conquer- Recursive Procedures, Binary Search, Integer Multiplication, Advance Sorting. Backtracking (Recursion/DFS), Branch & Bound (Expansion/BFS), Dynamic Programming: General method, Optimization problems, All Pair Shortest Path, Genetic Algorithms, Genetic Algorithmic operators & Process, Solving TSP using GA, Solving 0/1- knapsack using GA. String-Matching problem - String-matching algorithms: Finite Automata for string matching, Rabin-Karp, Knuth-Morris-Pratt algorithm, Boyer-Moore algorithm, Applications: (virus detection/plagiarism, DNA pattern matching (LCS) in Bioinformatics. NP-Hard problems, Reductions, Approximation algorithm, Performance Ratio, Bin Packing Problem, Approx - Travelling Sales Person- Tour.

CSD601 Dissertation-I (0-0-8) 4 Credits

Completion of project, Dissertation and report undertaken as CSD601

CSD501 Minor Project (0-0-8) 4 Credits

A significant project to be carried out for partial fulfillment of the PG diploma/ degree.

CSD602 Dissertation-II (0-0-24) 12 Credits

Completion of projects and report undertaken as CSD602

CSL501 Mathematical Foundations of Computer Science (3-0-0) 3 Credits

Introduction, basic elements of Linear algebra, the matrix and the vector, Linear equations & Matrices, Special type of Matrices & Partition Matrices, Vectors in the Plane, Vector Spaces & Subspaces, Linear Independence, Basis & Dimension, The Rank of a matrix, The standard inner product on R^3 , Inner product spaces, The Gram -Schmidt Process, The Kernel & Range of a Linear Transformation, The Matrix of a Linear transformation, The vector space of Matrices, Eigenvalues & Eigenvectors, Diagonalisation. Diagonalisation of symmetric matrices, Real Quadratic Forms, Complex Eigen values & Eigenvectors, Lines, Planes in R^n , Hyperplanes: Definition, normal vector, normal equation for the hyperplane, decision boundary, Hyper surface, Affine hyper planes, Optimum Separation Hyper plane, Non-linear Classification and the Kernel trick.

CSL515 Soft Computing (3-0-2) 4 Credits

Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Logic Systems: Basics of Fuzzy Logic Theory, Crisp and Fuzzy Sets, Basic Set Operations, Fuzzy Relations, properties of membership functions, Composition of Fuzzy Relations, Fuzzy Inference, Zadeh's Compositional Rule of Inference, Defuzzification, Mathematical Similarities between Neural Networks and Fuzzy Logic Models, Fuzzy Additive Models.

Evolutionary Algorithms: Difficulties with Classical Optimization Algorithms, Genetic Algorithms, Evolution. Strategies, Evolutionary Programming, Genetic Programming, Multi-Modal Function Optimization, Crowding Model, Sharing Function Model. Fuzzy classification and Pattern recognition Algorithm. Learning and Soft Computing: Examples of Applications in Diverse Fields, Basic Tools of Soft Computing, Basic Mathematics of Soft Computing, Learning and Statistical Approaches to Regression and Classification.

CSC501 Seminar

(0-0-4) 2 Credits

Research and development seminar based on problems of practical and theoretical interest. Evaluation will be based on student seminars, written reports, and evaluation of the developed system and/or theories.

Cyber Security and Forensics Electives

CSL547 Applied Cryptography

(2-0-4) 4 Credits

This course deals with the underlying principles of cryptography, an indispensable tool for protecting information in computer system. In this course, students will acquire knowledge on standard algorithms used to provide confidentiality, integrity, and authenticity. Starting from the classical ciphers to modern day ciphers, the course provides exposure regarding construction and cryptanalysis of symmetric key ciphers. It also covers stream cipher, public key ciphers, key exchange algorithm, one way functions, Message Authentication Codes (MAC) and signature schemes. Finally, it concludes with the design rationale of network protocols for key exchange.

CSL537 Risk Management Principles and Policies

(2-0-4) 4 Credits

The goal of this course is to introduce a suite of risk analysis and assessment techniques to the students. It will assist students to develop an understanding of the fundamentals of risk management and to introduce classical as well as state-of-the-art risk analysis techniques. In this course, student will learn about risk

management process, cyber risk exposures, cyber insurance, regulatory environment and how cyber risk management applies to the enterprise. Further, it covers risk assessment, mitigation and treatment of critical risk communication. At the end of this course, student will be able to identify information security related threats, vulnerability; Determine the risk level, define controls and safeguards and utilize a range of popular risk analysis techniques innovatively to examine risk problems.

CSL544 Cyber Forensics and Malware Analysis Fundamentals

(2-0-4) 4 Credits

Digital forensics course plays very crucial role in investigating computer related crime. In this course, the different methods for the identification, investigation and analysis of digital evidences are examined. The course aims to present these concepts in a general setting that is not tied to one particular operating system. During this course, students will learn about core forensics procedures to ensure court admissibility of evidence. This course also includes the different methods for the identification, investigation and analysis of malicious code using various network and system-monitoring tools to examine and assess how malware interacts with the file system, registry, network and other processes in order to detect, analyze, understand, control, and eradicate malware. Further, the students will be able to utilize memory forensic techniques to examine, predict and compare capabilities of malware. It blends theoretical concepts with lots of real life examples and case studies to ensure practical exposure and through understanding all the digital forensics artifacts.

CSL546 Cloud and its Security

(2-0-4) 4 Credits

This course takes you on a tour of cloud computing systems and its security challenges. During this course, students will develop the necessary skills to identify possible security issues in the cloud environment. This course starts with basics of cloud, cloud security concepts covering encryption and presence of suspect in cloud, cloud security architecture and consequently discuss different ways to secure a

cloud. In this course, students will be able to: Understand important concepts of cloud computing such as types of cloud computing, deployment model, virtualization, etc. Design, implement and manage complete cloud computing systems. Identify security issues in cloud computing and different ways to store data safely on cloud.

CSL548 Network Hacking & Security (2-0-4) 4 Credits

This course delivers the technical knowledge, insight, and hands-on training students need to identify attacks on network with confidence. This course covers various aspects of network security including security issues in different layers of networks, intrusion detection, prevention and defense against cyber-attacks. Students will be guided through a series of laboratories and experiments in order to understand and analyze different attack/defend scenarios and determine the effectiveness of particular defense deployments against attacks.

CSL549 Secure coding vulnerabilities and mitigation (2-0-4) 4 Credits

This course deals with security architecture elements within modern object-oriented programming languages that create the framework for secure programming. This course would cover the design and implementation of secure systems. Coding Standards, best practices, guidelines and style will further enhance the ability to develop secure code. This course includes common software vulnerabilities and how to find them, as well as how the vulnerabilities can be exploited using reverse engineering & its tools. It also includes how buffer overflow attack happens and how attackers utilize it to gain access to the vulnerable system. Finally, at the end popular web SQL injection attack, and their common defense is implemented

CSL565 Web Application Security (2-0-4) 4 Credits

This course offers you the knowledge and skills to build better and more secure web and mobile applications. It starts with importance of web security, working of web, strengths and weakness of web, factors that makes web

vulnerable, and illustrates fundamental countermeasures that every web application should implement. Throughout the course, you will gain insights into the threats that modern web applications face and their countermeasures, not only in theory, but also in practice. Later, this course focuses on various mobile threats and exploits. Particularly, this course emphasize on android applications as these applications are the biggest surface of attacks.

CSL566 Blockchain and Cryptocurrency (2-0-4) 4 Credits

This course introduces blockchain, a revolutionary technology that enables peer-to-peer transfer of digital assets without any intermediaries. It is designed to provide students with an understanding of key concepts and developments around cryptocurrencies and distributed ledger systems. It develops a basic understanding of blockchain technology while covering basic properties of bitcoin, the mechanics behind it (e.g. including cryptographic hash functions, Bitcoin Script, privacy, and hash commitment schemes). It also demonstrates some of the blockchain use cases in technology, business and enterprise products. Other aspects of course include building a blockchain network and cryptocurrency and challenges in adoption of blockchain technology.

CSL567 Vulnerability Assessment and Penetration testing (2-0-4) 4 Credits

This course is focused on the practical side of penetration testing whilst including necessary theoretical details. It will make students learn how to protect users from cyber attackers by becoming an ethical hacker. It takes students from a beginner to a more advanced level, by the time course finishes students will be able to launch attacks and test the security of computers. It commences with different ways of gathering information about the target and consequently discusses various ways to discover and exploit large number of vulnerabilities to gain access. Thereafter, it includes what you can do with the access you gained from exploiting the above vulnerabilities and ways to maintain that access.

Data Science Electives

CSL454 Big Data

(2-0-4) 4 Credits

Characteristics of big data, Big Data and its importance, Challenges of big data, Big data applications, Hadoop Architecture, HDFS, Common Hadoop Shell commands, Anatomy of File Write and Read NameNode, Secondary NameNode and DataNode, Hadoop Technologies – Cassandra, Understanding Inputs and Outputs of MapReduce, Elastic MapReduce on Cloud, Hadoop MapReduce paradigm Map and Reduce tasks, Cluster Setup , Getting Started with Spark, Setting up Python with Spark, RDD, Functional Programming, Local Virtual Box Set-up, Amazon Web Service (AWS) EC2 PySpark Set-up, Databricks Setup (Optional), AWS EMR Cluster Setup, Running Spark on a Cluster, SparkSQL, Spark DataFrame Basics, Spark Graph X, Collaborative Filtering for Recommender Systems, Natural Language Processing in Spark, Real-time analytics with Spark Streaming

CSL551 Foundation of Data Science

(2-0-4) 4 Credits

Introduction to Computer Science, Computer Algorithms, Computer Hardware , Operating Systems—Bridging Software and Hardware , Limits of Integrated Circuits Technology: Moore's , Computer Software , Procedural vs. Object-Oriented Programming, Literals , Variables and Identifiers , Operators, Expressions and Data Types, What Is a Control Structure, Boolean Expressions (Conditions), Relational Operators, Membership Operators, Selection Control, Multi-Way Selection, Iterative Control, While Statement , Infinite loops, Definite vs. Indefinite Loops, Boolean Flags and Indefinite Loops, List Structures, Common List Operations, Tuples , Nested Lists, For Loops , While Loops and Lists (Sequences), Assigning and Copying Lists , Dictionary Type in Python, Set Data Type , Program Routines , Defining Functions, More on Functions , Calling Value-Returning Functions, Calling

Non-Value-Returning Functions, Parameter Passing, Arguments in Python Default Arguments in Python, Variable Scope, Recursive Function, Module Specification , Top-Down Design, Developing a Modular Design of the Calendar Year Program, Object-Oriented Programming concepts, Numpy - Creation on Array ,Array generation from Uniform distribution, Random array generation, reshaping, maximum and minimum, reshaping, Arithmetic operations, Mathematical functions, Bracket Indexing and Selection, Broadcasting, Indexing a 2D array (matrices); Pandas - Creating a Series - from lists, arrays and dictionaries, Storing data in series from intrinsic sources, Creating DataFrames, Imputation, Grouping and aggregation, Merging, Joining, Concatenation, Find Null Values or Check for Null Values, Reading data from csv, txt, excel, web, Visualization - Installing and setting up visualization libraries, Canvas and Axes, Subplots, Common plots – scatter, histogram, boxplot, Logarithmic scale, Placement of ticks and custom tick labels, Pandas Viz, Style Sheets, Plot type, Area, Barplots, Histograms, Line Plots, Scatter Plots, BoxPlots, Hexagonal Bin Plot, Kernel Density Estimation plot (KDE), Distribution Plots, Categorical Data Plots, Combining Categorical Plots, Matrix Plots, Regression Plots, Grids.

CSL555 Advanced Machine Learning

(2-0-4) 4 Credits

Overview to machine learning and pre-processing concepts, Model Selection, Model Selection, XGBoost. Feature Selection- Filter and Wrapper, Dimensionality Reduction, Principal Component Analysis PCA, Linear Discriminant Analysis LDA, Kernel PCA, Introduction to Self-Organizing Maps (SOM), Building a Self-Organizing Map. Overview of clustering in machine learning, Different categories of clustering algorithms, similarity/distance measures, K Means algorithm, Hierarchical, DBSCAN, Fuzzy C-Means , Agglomerative clustering algorithm, Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabeled data., Evaluation methods, A case study with clustering implementation, Eclat, Reinforcement

Learning, Upper Confidence Bound UCB, Thompson.

CSL558 Computer Vision

(2-0-4) 4 Credits

Elements of digital image processing, Image model, Sampling and quantization, Relationships between pixels, Image Transforms, Discrete Fourier Transform, Discrete Cosine Transform, Haar Transform, Hadamard Transform, Image Enhancement, Enhancement by point processing, Spatial filtering, Enhancement in the frequency domain, Color Image Processing, Image Segmentation, Discontinuity detection, Edge linking and boundary detection, Thresholding, Region oriented segmentation, Use of motion for segmentation Introduction to CV, Introduction to Face Detection, Face Detection with OpenCV, Object Detection Introduction, Object Detection with SSD, Generative Adversarial Networks (GANs) Introduction.

CSL559 Neural Networks and Deep Learning

(2-0-4) 4 Credits

Introduction to ANN, Building an ANN, Evaluating, Improving and Tuning the ANN, Restricted Boltzmann Machine, CNN Introduction-Building a CNN, Evaluating, Improving and Tuning the CNN RNN Introduction - Building a RNN Evaluating, Improving and Tuning the RNN, LSTM, Boltzmann Machine Intuition, Building a Boltzmann Machine, Auto Encoders Fundamentals Building an Auto Encoder, Types of Encoder, Deep Learning NLP Chat bots: Introduction to NLP (Natural Language Processing), Deep NLP Introduction, Building a ChatBot with Deep NLP.

CSL561 Business Intelligence and Data Visualization

(2-0-4) 4 Credits

Introduction to data analysis, Data processing, Fundamental of Data Visualization Compare and Contrast, Business Intelligence, User Interface –Tableau Desktop . Dashboards and Stories Building a Dashboard, Dashboard Layouts and Formatting , Exploratory vs. Explanatory, Statistical test, Preprocessing, Multidimensional Visualization, Infographics,

Level of Details, Building Gapminder in Tableau, Basic Geo-Coding for Tableau, Animations, Introduction to Knime Analytics Platform, Knime workbook, Data exploration, modeling and reporting in Knime, Database operation, web, date and time, loops in knime, advance reporting, Introduction to SQL, Joins, subqueries, store routine, SQL and Tableau problems.

CSL553 Statistics with Python

(2-0-4) 4 Credits

Types of Data (Quantitative, Qualitative, Logical), Exploratory Data Analysis (Histogram, Scatter plots, Box plot), Fundamentals of Descriptive Statistics (moments- Measures of Central Tendency, Measure of spread, Measure of Shape), Markov Chains, LATEX, Probability and Combinatorics: Sample Statistics and Population Parameters, Events (Mutually Exclusive, Disjoints, Independent), Counting Methods Permutations and Combinations), Joint, Conditional Probability, Bayes' Rule, Discrete Distributions Introduction, Probability Mass Function, Cumulative Distribution Function, Geometric Distribution, Binomial Distribution, Poisson Distribution, Continuous Distributions: ProbabilityDensity Functions, Cumulative Distribution Function, Inferential Statistics (Normal Distribution, Statistical Sampling, Central Limit Theorem), Estimations (Point and Intervals- Confidence intervals with means, sample, proportions), Hypothesis Testing :Introduction, Confidence Intervals, Critical Value based approach, P-value based approach, ZTests, TTests ,the χ^2 distribution, ANOVA/ANCOVA, Bayesian Statistics.

CSL556 Data Engineering

(2-0-4) 4 Credits

Introduction to Data Engineering (Definitions, Applications and examples) and Data Warehouse, Need of Data Warehouse, Types of Data Warehouse, functions of data warehouse tools and utilities, Process flow in Data Warehouse, Applications of Data Warehouse. Different views in Business Analysis framework, Three-tier Data Warehouse Architecture, Data Warehouse Models, Differentiate between OLAP and OLTP, Types of OLAP servers, OLAP operations , ETL,

Process of ETL, Need of ETL, Challenges in ETL systems, Data Wrangling, Goals of Data Wrangling, Importance, How different from ETL, Combining and Merging Data Sets, Bitmap Index and Join index, OLAP Server (ROLAP, MOLAP, HOLAP), Creation of Data Warehouse and Cubes, Regular Expressions (Regex), Data Aggregation, Association Rules. Introduction to Google Cloud Platform, GCP Setup, CloudSQL (RDMS) (OLTP), Cloud Spanner (RDMS) (OLTP), Big query (OLAP), Data Prep (UI for Dataflow) and Cloud Composer Airflow.