CENTRAL UNIVERSITY OF PUNJAB BATHINDA

SYLLABUS

Ph.D in Computer Science & Technology

Session – 2025 Onwards

Department of Computer Science & Technology
Central University of Punjab, VPO-Ghudda, Bathinda, Punjab, India- 151401

Course Structure of the Programme

Semester-I

Course Code	Course Title	Course Type	Credit Hours			
			L	T	P	Cr
CST.701	Research Methodology	Core	4	0	0	**4**
CST.708	Research and Publication Ethics (RPE)	Core	2	0	0	**2**
CST.720	Teaching Assistantship	Core	0	0	2	**1**
UNI.XXX	Curriculum, Pedagogy and Evaluation	Core	1	0	0	**1**
CST.703	Advanced Image Processing	*Opt any one of the courses along with the corresponding Lab.	4	0	0	**4**
CST.704	Software Metrics and Measurements					
CST.707	Quantum Cryptography					
CST.710	Data Analysis with Machine Learning					
CST.711	Cryptography					
CST.712	Big Data Analytics					
CST.713	Internet of Things					
CST.714	Data Mining					
CST.715	Advanced Network Security					
CST.716	Affective Computing					
CST.702	Research Methodology-Lab	Core	0	0	4	**2**
CST.705	Advanced Image Processing-Lab		0	0	4	**2**
CST.706	Software Metrics and Measurements-Lab					
CST.709	Quantum Cryptography-Lab					
CST.715	Data Analysis with Machine Learning-Lab					
CST.716	Cryptography-Lab					
CST.717	Big Data Analytics-Lab					
CST.718	Internet of Things-Lab					
CST.719	Data Mining-Lab					
CST.720	Advanced Network Security-Lab					
CST.721	Affective Computing Lab					
Total Credits			**11**	**0**	**10**	**18**

Course Code: CST.701
Course Title: Research Methodology
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives

The objective of this course is to equip research scholars with the foundational knowledge and essential skills required for conducting rigorous and ethical research. It aims to develop a comprehensive understanding of the research process, including problem formulation, hypothesis development, literature review, research design, sampling techniques, data collection methods, and statistical analysis. The course emphasizes critical thinking, academic writing, and referencing standards, fostering the ability to prepare high-quality research proposals and scholarly articles. By the end of the course, students will be capable of selecting appropriate methodologies, analyzing data meaningfully, and presenting research findings in a structured and impactful manner, thereby laying a strong groundwork for their doctoral research journey.

Course Learning Outcomes:
After completion of the course, students would be able to:
CLO1: To formulate a research plan, understand scientific literature
CLO2: To build the hypothesis and test the results.
CLO3: To develop skills to prepare research papers and a PhD thesis.
CLO4: To use tools like SPSS, Latex, and MS Office for research work.

Units/Hours	Contents	Mapping with Course Learning Outcome
I **15 Hours**	**Research Aptitude:** Meaning of Research, Objectives of Research, and Motivation in Research, Types of Research, Research Approaches, and Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is done. **Research Process:** Reviewing the literature, Formulation of research problem, Nature and type of variables, Hypothesis - meaning, types, and development of hypothesis and its testing, Meaning & functions of Research Design.	**CLO1** **CLO 2**
II **15 Hours**	**Data Analysis:** Sources, acquisition and interpretation of data, Quantitative and qualitative data, Graphical representation and mapping of data, Sensitivity Analysis with Data Tables, Optimization with EXCEL Solver, Summarizing Data with Histograms and Descriptive Statistics, Pivot Tables, Summarizing Data with database statistical functions, using correlation, Multiple Regression, Using Sampling to Analyze Data.	**CLO1**

III **15 Hours**	**Scientific and Technical Writing:** Role and importance of communication, Effective oral and written communication, Scientific writing, Preparing Research papers for journals, Seminars and Conferences, Technical report writing, Making R&D proposals, Dissertation/Thesis writing, Oral and poster presentation in meetings, seminars, group discussions, Use of modern aids; Making technical presentations. **Research and academic integrity:** Plagiarism, copyright issues, ethics in research, and case studies.	**CLO3**
IV **15 Hours**	**Use of Computers in Education and Research**: Data analysis tools, e-Library, Search engines related to research, Research paper editing tools like Latex. **Transactional Modes:** Lecture, E-tutorial, Self-Learning, lecture and demonstration.	**CLO4**

Transactional Modes:

- Lecture
- E-tutorial
- Self-Learning
- Lecture
- Demonstration

Suggested Readings:

1. Kothari, C. R. (2014). Research methodology (s). New Age International (p) Limited. New Delhi.
2. Kauda J. (2012). Research Methodology: A Project Guide for University Students. Samfunds literature Publications.
3. Dharmapalan B. (2012). Scientific Research Methodology. Narosa Publishing House ISBN: 978-81-8487-180-7.

Course Code: CST.708
Course Title: Research and Publication Ethics (RPE)
Total Hours: 30

L	T	P	Cr
2	0	0	2

Course Objectives

The objective of this course is to develop an understanding of ethical principles and professional standards that govern research and scholarly publication. It aims to sensitize research scholars to issues related to academic integrity, plagiarism, data fabrication and falsification, authorship criteria, and peer review ethics. The course provides insights into the regulatory framework for research involving human and animal subjects and emphasizes responsible conduct in handling data, citations, and dissemination of results. Additionally, it familiarizes students with current publication guidelines, open access policies, predatory journals, and the use of plagiarism detection tools. By the end of the course, students will be equipped to conduct ethical research and contribute responsibly to the academic and scientific community.

Course Learning Outcomes:

After completion of course, students would be able to:
CLO1: To Gain a deep knowledge about research misconduct and predatory publications.
CLO2: To learn indexing and citation databases, open access publications, research metrics.
CLO3: To execute various plagiarism tools for plagiarism check.

Units/Hours	Contents	Mapping with Course Learning Outcome
I **7 Hours**	**Philosophy, Ethics and Scientific Conduct** Introduction to philosophy: definition, nature And scope, concept, branches. Ethics: definition, moral philosophy, Nature of moral judgments and reactions. Ethics with respect to science and research Intellectual honest and research integrity Scientific misconducts: falsification, fabrication, and plagiarism. Redundant publications: duplicate and overlapping publications, Salami slicing Selective reporting and misrepresentation of data.	**CLO1**

II **8 Hours**	**Publication Ethics** Publication ethics: definition, introduction and importance. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types. Violation of publication ethics, authorship and contributor ship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals.	**CLO1**
III **8 Hours**	**Open Access Publishing** Open access publications and initiatives SHERPA/RoME0 online resource to check publisher copyright and self-archiving policies. Software tool to identify predatory publications developed by SPPU Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. Group Discussions a) Subject specific ethical issues, FFP, authorship b) Conflicts of interest c) Complaints and appeals: examples and fraud from India and abroad Software tools Use of plagiarism software like Turnitin, Urkund and other open source software tools.	**CLO2** **CLO3**
IV **7 Hours**	**Databases and Research Metrics** A. Databases 1. Indexing databases 2. Citation databases: Web of Science, Scopus, etc. B. Research Metrics Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics.	**CLO2**

Transactional Modes:

- Lecture
- Case Studies
- E-tutorial
- Self-Learning

Suggested Readings:

1. Melville, S., and Goddard, W. (1996). Research methodology: An introduction for science & engineering students. South Africa: Juta Academic.

Course Title: TEACHING ASSISTANTSHIP
Course Code: XXXX
Total Hours: 30

L	T	P	Cr
2	0	0	2

Course Objectives

The objective of this course is to provide research scholars with practical exposure to teaching methodologies, academic communication, and classroom management. It aims to develop the pedagogical skills required to support faculty members in delivering undergraduate and postgraduate courses effectively. Through structured involvement in lesson planning, conducting tutorials, assisting in laboratory sessions, grading assignments, and providing academic support to students, scholars gain hands-on experience in academic instruction. The course also emphasizes the development of soft skills such as public speaking, use of educational technology, and professional conduct in academic settings. By the end of the course, scholars will be well-prepared to undertake teaching responsibilities and contribute meaningfully to the academic environment of their institutions.

Course Learning Outcomes:

After completion of course, scholar would be able to:

CLO1: familiarize themselves with the pedagogical practices of effective class room delivery and knowledge evaluation system

CLO2: manage large and small classes using appropriate pedagogical techniques for different types of content

Activities and Evaluation:

1. The scholars shall attend Master degree classes of his/her supervisor to observe the various transaction modes that the supervisor follows in the class room delivery or transaction process one period per week.
2. The scholars shall be assigned one period per week under the direct supervision of his/her supervisor to teach the Master degree students adopting appropriate teaching strategy(s).
3. The scholars shall be involved in examination and evaluation system of the Master degree students such as preparation of questions, conduct of examination and preparation of results under the direction of the supervisor.
4. At the end of the semester, the supervisor shall conduct an examination of teaching skills learned by the scholar as per the following **evaluation criteria**:
5. The scholars shall be given a topic relevant to the Master degree course of the current semester as his/her specialization to prepare lessons and deliver in the class room before the master degree students for one hour (45 minutes teaching + 15 minutes' interaction).
6. The scholars shall be evaluated for a total of 50 marks comprising *content knowledge* (10 marks), *explanation and demonstration skills* (10 marks), *communication skills* (10 marks), *teaching techniques employed* (10 marks), and classroom interactions (10).

Course Title: Curriculum, Pedagogy and Evaluation
Course Code: **XXXX**
Total Hours: 15

L	T	P	Cr
1	0	0	1

Course Objectives

The objective of this course is to provide research scholars with a comprehensive understanding of curriculum development, effective pedagogical practices, and diverse evaluation strategies in higher education. It aims to critically engage scholars with the theoretical foundations and practical aspects of curriculum design, including learner-centered approaches, interdisciplinary integration, and alignment with learning outcomes. The course emphasizes innovative pedagogies such as experiential learning, ICT-enabled teaching, and inclusive education to enhance student engagement and learning effectiveness. Additionally, it equips scholars with tools and techniques for formative and summative assessment, rubric-based evaluation, and feedback mechanisms. By the end of the course, students will be capable of designing outcome-based curricula, adopting reflective teaching practices, and applying appropriate assessment methods to ensure quality education and continuous improvement in teaching-learning processes.

Course Learning Outcomes:

After completion of course, scholar would be able to

CLO1: analyze the principles and bases of curriculum design and development

CLO2: examine the processes involved in curriculum development

CLO3: develop the skills of adopting innovative pedagogies and conducting students' assessment

CLO4: develop curriculum of a specific course/programme

Units/Hours	Contents	Mapping with Course Learning Outcome
I **15 Hours**	**Bases and Principles of Curriculum** Curriculum: Concept and Principles of curriculum development, Foundations of Curriculum Development. Types of Curriculum Designs- Subject centered, learner centered, experience centered and core curriculum. Designing local, national, regional and global specific curriculum. Choice Based Credit System and its implementation.	**CLO1**
II **15 Hours**	**Curriculum Development** Process of Curriculum Development: Formulation of graduate attributes, course/learning outcomes, content selection, organization of content and learning experiences, transaction process. Comparison among Interdisciplinary, multidisciplinary and trans-disciplinary approaches to curriculum.	**CLO2**

III **15 Hours**	**Curriculum and Pedagogy** Conceptual understanding of Pedagogy. Pedagogies: Peeragogy, Cybergogy and Heutagogy with special emphasis on Blended learning, Flipped learning, Dialogue, cooperative and collaborative learning Three e- techniques: Moodle, Edmodo, Google classroom	**CLO3**
IV **15 Hours**	**Learners' Assessment** Assessment Preparation: Concept, purpose, and principles of preparing objective and subjective questions. Conducting Assessment: Modes of conducting assessment – offline and online; use of ICT in conducting assessments. Evaluation: Formative and Summative assessments, Outcome based assessment, and scoring criteria.	**CLO4**

Transaction Mode

Lecture, dialogue, peer group discussion, workshop

Evaluation criteria

There shall be an end term evaluation of the course for 50 marks for duration of 2 hours. The course coordinator shall conduct the evaluation.

Suggested Readings

- Allyn, B., Beane, J. A., Conrad, E. P., & Samuel J. A., (1986). *Curriculum Planning and Development*. Boston: Allyn & Bacon.
- Brady, L. (1995). *Curriculum Development*. Prentice Hall: Delhi. National Council of Educational Research and Training.
- Deng, Z. (2007). Knowing the subject matter of science curriculum, *Journal of Curriculum Studies*, 39(5), 503-535. https://doi.org/10.1080/00220270701305362
- Gronlund, N. E. & Linn, R. L. (2003). *Measurement and Assessment in teaching*. Singapore: Pearson Education
- McNeil, J. D. (1990). *Curriculum: A Comprehensive Introduction*, London: Scott, Foreman/Little
- Nehru, R. S. S. (2015). *Principles of Curriculum*. New Delhi: APH Publishing Corporation.
- Oliva, P. F. (2001). *Developing the curriculum* (Fifth Ed.). New York, NY: Longman
- Stein, J. and Graham, C. (2014). *Essentials for Blended Learning: A Standards-Based Guide*. New York, NY: Routledge.

Web Resources

- https://www.westernsydney.edu.au/__data/assets/pdf_file/0004/467095/Fundamentals_of_Blended_Learning.pdf
- https://www.uhd.edu/academics/university-college/centers-offices/teaching-learning-excellence/Pages/Principles-of-a-Flipped-Classroom.aspx
- http://leerwegdialoog.nl/wp-content/uploads/2018/06/180621-Article-The-Basic-Principles-of-Dialogue-by-Renate-van-der-Veen-and-Olga-Plokhooij.pdf

Course Code: CST.703
Course Title: Advance Image Processing
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives

The objective of this course is to provide in-depth knowledge and advanced techniques in the field of digital image processing, enabling students to analyze, enhance, and interpret images effectively. Building upon fundamental concepts, the course introduces sophisticated image enhancement methods, multiresolution processing, color image processing, morphological operations, image segmentation, feature extraction, and object recognition techniques. Emphasis is placed on real-world applications such as medical imaging, satellite imagery, computer vision, biometrics, and surveillance systems. The course also familiarizes students with recent advances in machine learning-based image analysis and the use of popular tools and libraries (e.g., OpenCV, MATLAB, Python). By the end of the course, students will be equipped with the analytical and computational skills necessary to develop, evaluate, and apply advanced image processing algorithms in practical scenarios.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: To Discuss the concepts of digital image processing
CLO2: To explain, analyse and implement algorithms for advanced image analysis.
CLO3: To Design solutions for complex image processing problems like image retrieval.

Units/Hours	Contents	Mapping with Course Learning Outcome
I **15 Hours**	**Recognition of image patterns:** Introduction to pattern classification, supervised and unsupervised pattern classification, introduction to neural networks as pattern classifiers. Texture and shape analysis: primitives in textures, classification of textures, gray level co-occurrence matrix, texture spectrum.	**CLO1**
II **15 Hours**	**Introduction to shape analysis** (landmark points, polygon as shape descriptor, dominant points in shape description, curvature and its role in shape determination, polygonal approximation for shape analysis), active contour model, shape distortion and normalization, contour-based shape descriptor, region based shape descriptors.	**CLO2**

III **15 Hours**	**Fuzzy set theory in image processing**: introduction to fuzzy set theory (fuzzification, basic terms and operations, image as a fuzzy set , selection of the membership function), need for fuzzy image processing, fuzzy methods of contrast enhancement, fuzzy spatial filter for noise removal, smoothing algorithm.	**CLO1**
IV **15 Hours**	Fuzzy approaches to pixel classification (fuzzy c-means algorithm) **Content based image retrieval:** introduction, fundamental steps in image retrieval, image features for retrieval, fuzzy similarity measure in an image retrieval System. **Transactional Modes:** Lecture and demonstration, Flipped Learning, Peer Learning/Teaching.	**CLO3**

Transactional Modes:

- Lecture
- Demonstration
- Flipped Learning
- Peer Learning/Teaching.

Suggested Readings:

1. Acharya, T. and Ray A.K. (2005). Image processing principles and applications, 2005, United States: Wiley Blackwell.
2. Gonzalez, R.C. and Woods, R.E. (2009). Digital Image Processing. New Delhi: Person Education.

Course Code: CST.704
Course Title: Software Metrics and Measurements
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives

The objective of this course is to develop an in-depth understanding of software metrics and their role in the quantitative analysis of software systems, with a focus on supporting empirical research in software engineering. The course is designed to equip doctoral scholars with the theoretical foundation and practical skills required to design, validate, and apply meaningful software metrics across various software development paradigms. It explores advanced methods for measuring software size, complexity, quality, and performance, as well as process and people metrics. Scholars will engage in critical analysis of metric models, learn about measurement theory, and examine case studies involving real-world data to derive actionable insights. By the end of the course, students will be capable of formulating metric-based research hypotheses, applying statistical and analytical techniques for metric evaluation, and contributing to the development of reliable, scalable, and evidence-based software engineering practices.

Course Learning Outcomes:

After completion of course, scholar would be able to

CLO1: To apply software testing knowledge, verification & validation and engineering methods.

CLO2: To Design and conduct a software test process for a quality software test.

CLO3: To identify various software testing problems, and solve these problems by designing and selecting software metrics models, testing criteria, strategies, and methods.

Units/Hours	Contents	Mapping with Course Learning Outcome
I **15 Hours**	**Overview of Software Metrics:** Measurement in Software Engineering, Scope of Software Metrics, Measurement and Models Meaningfulness in measurement, Measurement quality, Measurement process, Scale, Measurement validation, Object-oriented measurements, **Goal based framework for software measurement:** Software measure classification, Goal-Question-Metrics (GQM) and Goal-Question-Indicator-Metrics (GQIM), Applications of GQM and GQIM.	**CLO1**
II **15 Hours**	**Empirical Investigation:** Software engineering investigation, Investigation principles, Investigation techniques, Planning Formal experiments, Case Studies for Empirical investigations. **Object–oriented metrics:** Object-Oriented measurement concepts, Basic metrics for OO systems, OO analysis and design metrics, Metrics for productivity measurement, Metrics for OO software quality.	**CLO1** **CLO2**

III **15 Hours**	**Measuring Internal Product attributes:** Software Size, Length, reuse, Functionality, Complexity, Software structural measurement, Control flow structure, Cyclomatic Complexity, Data flow and data structure attributes Architectural measurement. **Measuring External Product attributes:** Software Quality Measurements, Aspects of Quality Measurements, Maintainability Measurements, Usability and Security Measurements.	**CLO-2**
IV **15 Hours**	**Measuring software Reliability:** Concepts and definitions, Software reliability models and metrics, Fundamentals of software reliability engineering (SRE), Reliability management model.	**CLO-3**

Transactional Modes:

- Lecture cum Demonstration
- Peer Learning/Teaching
- E-tutorial
- Self-Learning

Text Book:

Norman E. Fenton, S. L. P fleeger. (1998).Software Metrics: A Rigorous and Practical Approach. International Thomson Computer Press.

Suggested Readings:

1. Stephen H. Kan. (2002). Metrics and Models in Software Quality Engineering. New Delhi: Addison-Wesley Professional.
2. BasuAnirban. (2015). Software Quality Assurance, Testing and Metrics.New Delhi: Prentice Hall India Learning Private Limited.
3. Robert B. Grady. (1992). Practical Software Metrics for Project Management and Process Improvement. New Delhi: Prentice Hall.
4. Katrina D. M. (2002). Applied Statistics for Software Managers. New Delhi: Prentice Hall

Code: CST. 707
Course Title: Quantum Cryptography
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives:
To provide fundamental concepts of quantum information processing and cryptography, and take the discussion forward to potentials offered technological bottlenecks and the way forward. To expose the participants to the state-of-the-art in quantum computing and cryptography with its possible impact on the society.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: To understand the basic concepts and terminologies in quantum information processing and quantum cryptography.
CLO2: To work in the field of quantum information processing and quantum cryptography, and to design efficient quantum algorithms to solve different computing problems.
CLO3: To design new or modify existing quantum cryptographic algorithms for secure key distribution and communications.
CLO4: To grasp the working principle of a quantum computer and understand the impact of noise in real world implementations.
CLO5: To understand some of the long-standing issues in quantum computing, and way forward in Noise-Intermediate-Scale-Quantum and Post Quantum Cryptography era.
CLO6: To understand the current scenario in Google, IBM, D-wave, IonQ etc.

Units/Hours	Contents	Mapping with Course Learning Outcome
I **12 Hours**	Basics of Quantum Information and Linear Algebra: Why Quantum Computing, Classical to quantum mechanics, Hilber space, bases and linear independence, operators and matrices, Hermitian and Unitary operators, measurements in quantum mechanics, Einstein-Podolsky-Rosen paradox.	**CLO-1**
II **14 Hours**	Introduction to quantum information: Qubits and quantum gates, quantum circuits, density operators, pure and mixed states, Bloch sphere, Bell states, information and entropy, von-Neumann entropy and trace distance, fidelity, No-cloning Theorem.	**CLO-1**
III **17 Hours**	Entanglement and Nonlocality: Quantum entanglement, bi-partite and multiqubit systems, Bell-type inequalities and nonlocality, entanglement classes and measures, quantum parallelism, Deutsch-Jozsa algorithm.	**CLO-2** **CLO-6**

IV **17 Hours**	Applications and Quantum Cryptography: Teleportation, dense coding, entanglement swapping, quantum key distribution, quantum cryptographic protocols. Quantum Noise and Operation: Environments and quantum operations, examples of noisy channels, effect of noise on entanglement and efficiency of communication protocols.	**CLO-3,** **CLO-4** **CLO-5**

Transactional Modes:

- Lecture cum Demonstration
- Peer Learning/Teaching
- E-tutorial
- Self-Learning

Suggested Readings:

1. Griffiths, D. J. (2016). Introduction to Quantum Mechanics, Reprint edition, United Sates: Pearson Prentice Hall.
2. Bouwmeester, D., Ekert, A., and Zeilinger, A. (2000). The Physics of Quantum Information. Reprint edition. Springer Berlin Heidelberg.
3. Nielsen, M. A., and Chuang, I. L., (2010). Quantum Computation and Quantum Information. New Delhi: Cambridge University Press.

Course Code: CST.710
Course Title: Data Analysis with Machine Learning
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives:
To help students explain the concept of how to learn patterns and concepts from data without being explicitly programmed to analyze various machine learning algorithms and techniques with a modern outlook focusing on recent advances.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Describe machine learning approaches.
CLO2: Discuss features that can be used for a particular machine learning approach in various applications.
CLO3: Compare and contrast pros and cons of various machine learning techniques.
CLO4: To mathematically analyze various machine learning approaches and paradigms.
CLO5: Formulate various machine learning and ensemble methods for use in IOT applications.

Units/Hours	Contents	Mapping with Course Learning Outcome
I **16 Hours**	Introduction to learning Techniques: Supervised Learning (Regression/Classification) Basic methods: Distance-based methods, Nearest-Neighbors, Decision Trees, Naive Bayes. Linear models: Linear Regression, Logistic Regression, Generalized Linear Models. Support Vector Machines, Nonlinearity and Kernel Methods. Beyond Binary Classification: Multi-class/Structured Outputs, Ranking.	**CLO-1**
	Activities: Brainstorming, assignment-based learning.	
II **14 Hours**	Unsupervised Learning Clustering: K-means/Kernel K-means Dimensionality Reduction: PCA and kernel PCA Matrix Factorization and Matrix Completion Generative Models (mixture models and latent factor models)	**CLO-2**
	Activities: Exercise based learning and practical hands on training.	
III **14 Hours**	Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests). Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning. Introduction to ANN and Deep learning.	**CLO3** **CLO4**
	Activities: Exercise based learning and practical hands on training.	

IV **16 Hours**	Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference. Simulation Tool for Machine Learning, Hands on with recent tools WEKA, R MATLAB. Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.	**CLO4** **CLO5**
	Activities: Analysis of various case studies.	

Transactional Modes:

- Lecture cum Demonstration
- Collaborative Learning
- Peer Learning/Teaching
- Experimentation
- Online Teaching Tools

Text Book

James, G., Witten, D., Hastie, T., & Tibshirani, R. (2023). *An introduction to statistical learning with applications in Python*. Springer.

Suggested Readings:

1. Murphy, K. (2012). Machine Learning: A Probabilistic Perspective. Cambridge: MIT Press.
2. Hastie, T., Tibshirani, R., and Friedman, J. (2009). The Elements of Statistical Learning. New York: Springer.
3. Bishop, C. (2007). Pattern Recognition and Machine Learning, New York: Springer.
4. Shalev-Shwartz, S., and Ben-David, S. (2014). Understanding Machine Learning: From Theory to Algorithms. New Delhi: Cambridge University Press.

Course Code: CST.711
Course Title: Cryptography
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives:
To introduce students to the concept of security, and types of attacks. Describe Symmetric & Asymmetric Key Cryptography**.** Define Network Perimeter Security, Access Control Lists and Virtual Private Networks.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Identify the domain specific security issues.
CLO2: Apply Symmetric & Asymmetric Key Cryptography in various applications.
CLO3: Design Access Control Lists and Virtual Private Networks.

Units/Hours	Contents	Mapping with Course Learning Outcome
I **14 Hours**	Mathematics of Cryptography- Prime and Composite Numbers, Greatest Common Divisor, Euclidean algorithm, Modulo arithmetic, Fermat's little theorem, Multiplicative Inverse, Euler's theorem and Totient function, Discrete logarithm. Introduction to Security: Need for security, Security Trends, Security Attacks, Security Services, Security Mechanisms. Security techniques: Plaintext, Cipher text, Encryption & Decryption, Cryptanalysis techniques.	**CLO1**
	Activities: Assignment based and numerical exercise based learning, Case study based learning of different security mechanisms.	
II **16 Hours**	Classical Cryptographic Algorithms: Substitutions techniques-Monoalphabetic ciphers, Polyalphabetic Ciphers, Transposition Techniques, Rotor Machines, and Cryptanalysis of classical cryptographic algorithms. Symmetric Key Cryptography: Algorithm types & Modes: - Electronic Codebook (ECB), Cipher Block Chaining (CBC), Cipher Feedback (CFB) Output Feedback (OPFB) Mode, Counter (CTR) Mode. Morden symmetric key Cryptographic Algorithms: Data Encryption Standard (DES), Triple DES, RC4, Blowfish IDEA, Advance Encryption Algorithm (AES), Cryptanalysis.	**CLO2**
	Activities: Assignment based and numerical exercise based learning, Implementation of various cryptographic algorithms using computer programming.	

III **16 Hours**	Asymmetric key Cryptographic Algorithms:- Public-Key Cryptography Principles, Diffie–Hellman key exchange algorithm, Knapsack algorithm, RSA, ElGamal, Elliptic-curve cryptography. Message Authentication: Approaches to Message Authentication, MD5, SHA-512, Digital Signature Standard (DSS). User Authentication Mechanism: Authentication basics, Passwords, Authentication tokens, Certificate based & Biometric authentication.	**CLO2**
	Activities: Implementation and web based simulation of various cryptographic algorithms.	
IV **14 Hours**	Network Security Protocol: Introduction, Security at the Application Layer: PGP and S/MIME, Secure Electronic Transaction, Security at the Transport Layer: Secure Socket Layer (SSL), Transport Layer Security (TLS), Security at the Network Layer: IPSec, Virtual Private Networks: VPN Basics, Types of VPN, Access Control Lists, Types of Access Control Lists Firewalls: Firewall Basics, Types of Firewalls. Security Concerns in Data Link Layer, Physical Layer Security: - Elements of hardware security, side-channel attacks, hardware Trojans.	**CLO3**
	Activities: Case study of various network security protocols, Brainstorming, Implementation and solution of real time cryptographic problems, live demonstration of firewall configuration and network security tools.	

Transactional Modes:

- Lecture
- Blended Learning
- Collaborative Learning
- Case Study
- Online Teaching Tools

Suggested Readings:

1. Forouzan, B. A. (2010). Cryptography & Network Security. New Delhi: Tata McGraw-Hill Education.
2. Kahate, A. (2009). Cryptography and Network Security. New Delhi: tata McGraw-Hill Higher Ed.
3. Godbole, N. (2008). Information Systems Security: Security Management, Metrics, Frameworks and Best Practices. United States: John Wiley & Sons India.
4. Riggs, C. (2009). Network Perimeter Security: Building Defence In-Depth, New Delhi: Auerbach Publications.
5. Northcutt, S. (2005). Inside Network Perimeter Security, New Delhi: Pearson Education.
6. Stallings, W. (2007). Network Security Essentials: applications and standards. New Delhi: Pearson Education India.
7. Stallings, W. (2004). Cryptography and Network Security: Principles and Practice. New Delhi: Pearson.
8. Kim. D., and Solution, M. G. (2010). Fundamentals of Information System Security. Massachusetts: Jones & Bartlett Learning.
9. Research Articles from SCI & Scopus i

Course Code: CST.712
Course Title: Big Data Analytics
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives:
The course will help students prepare the big data for analysis and extract the meaningful data from unstructured big data. Help student to develop data visualizations skill and to apply various tools for analysis of structured and unstructured big data.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Illustrate the identification of Big Data problem
CLO2: Learn the Behavior and Visualisation of Data
CLO3: Differentiate structured data from unstructured data.
CLO4: Use Hadoop related tools such as JAQL, Spark, Pig and Hive for structured and unstructured Big Data analytics

Units/Hours	Contents	Mapping with Course Learning Outcome
I **15 Hours**	Big Data Introduction: What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, big data and healthcare, big data in medicine, advertising and big data, big data technologies, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics. Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues.	**CLO1**
	Activities: Case Study and Group Discussion.	
II **15 Hours**	Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation. Visualization: Descriptive and comparative statistics, Designing visualizations, Time series, Geo-located data, Correlations and connections, Hierarchies and networks, interactivity.	**CLO2** **CLO3**
	Activities: Implementation above theory with Python code.	
III **15 Hours**	Big Data Technology: Big Data Architecture, Big Data Warehouse, Functional Vs. Procedural Programming Models for Big Data NoSQL: Introduction to NoSQL, aggregate data models, key-value and document data models.	**CLO3**

	Activities: Implementation and designing with Spark/Mongo DB.	
IV **15 Hours**	Big Data Tools: Hadoop: Introduction to Hadoop Ecosystem, HDFS, Map-Reduce programming, Spark, PIG, JAQL, Understanding Text Analytics and Big Data, Predictive Analysis of Big Data, Role of Data Analyst.	**CLO-4**
	Activities: Implementation and usage of tools over the cloud.	

Transactional Modes:

- Lecture cum Demonstration
- Peer Learning/Teaching
- E-tutorial
- Self-Learning
- Online Teaching Tools

Text Book:

Bahga, A., & Madisetti, V. (2019). *Big data analytics: A hands-on approach*. VPT.

Suggested Readings:

1. EMC Education Services. (2015). Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data. United States: John Wiley & Sons.
2. Maheshwari, A. (2019). Data Analytics Make Accesible. California: Orilley Publications.
3. Croll, A., and Yoskovitz, B. (2013). Lean Analytics: Use Data to Build a Better Startup Faster. California: Oreilley Publications.
4. Research Articles from SCI & Scopus indexed Journal

Course Code: CST.713
Course Title: Internet of Things
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives:
The objective of this course is to introduce the students to the concepts of IoT, its networking and communication. The course focused on use of IoT technology and its design constraints.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Describe IOT and its networking and communication aspects.
CLO2: Analyze the challenges in IoT Design
CLO3: Design IoT applications on different embedded platform.

Units/Hours	Contents	Mapping with Course Learning Outcome
I **14 Hours**	Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models and APIs IoT and M2M, Difference between IoT and M2M, Software define Network.	**CLO1**
	Activities: Assignment and Exercise based learning.	
II **14 Hours**	Network and Communication aspects: Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment, Node discovery, Data aggregation and Dissemination.	**CLO2**
	Activities: Flip Learning with simulation tools.	
III **16 Hours**	Challenges in IoT Design: challenges, Development challenges, Security challenges, Other Challenges Domain specific applications: IoT Home automation, Industry applications, Surveillance applications, Other IoT applications **Activities**: Group Discussion and IOT design simulation using simulation tools.	**CLO2**
	Activities: Group Discussion and IOT design simulation using simulation tools.	

IV **16 Hours**	Developing IoTs: Developing applications through IoT tools including Python/Arduino/Raspberry pi, developing sensor based application through embedded system platform.	**CLO3**
	Activities: Hands on experience with IOT kits.	

Transactional Modes:

- Lecture cum Demonstration
- Peer Learning/Teaching
- E-tutorial
- Self-Learning
- Online Teaching Tools

Suggested Readings:

1. Madisetti, V., and Bahga, A. (2015). Internet of Things: A Hands-On Approach, New Delhi: Orient Blackswan Pvt. Ltd.
2. Dargie, W., and Poellabauer, C. (2010). Fundamentals of Wireless Sensor Networks: Theory and Practice. Wiley-Blackwel.
3. DaCosta, F., and Henderson B. (2014). Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, New York: Apress Publications.
4. Holler, J., Tsiatsis V., Mulligan, C., Avesand, S., Karnouskos, S., & Boyle, D. (2014). From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence. Massachusetts: Academic Press.
5. Research Articles from SCI & Scopus indexed Journals.

Course Code: CST.714
Course Title: Data Mining
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives:
The objective of this course is to introduce data warehousing and mining techniques. Applications of data mining in web mining, pattern matching and cluster analysis are included to aware students of broad data mining areas.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Discuss different sequential pattern algorithms.
CLO2: Apply the techniques to extract patterns from time series data and their applications in real world.
CLO3: Examine Graph mining algorithms to Web mining.
CLO4: Design the computing framework for Big Data.

Units/Hours	Contents	Mapping with Course Learning Outcome
I **14 Hours**	Introduction to Data Warehousing: Data warehousing Architecture, OLAP Server, Data warehouse Implementation. Data Mining: Mining frequent patterns, association and correlations; Sequential Pattern Mining concepts, primitives, scalable methods.	**CLO4** **CLO1**
	Activities: Brainstorming for finding the Association rules, Case study to illustrate the data warehouse and data mining model design principles.	
II **15 Hours**	Classification and prediction: Cluster Analysis – Types of Data in Cluster Analysis, Partitioning methods, Hierarchical Methods; Transactional Patterns and other temporal based frequent patterns.	**CLO1**
	Activities: Assignment based learning, Exercise based learning.	
III **16 Hours**	Mining Time series Data, Periodicity Analysis for time related sequence data, Trend analysis, Similarity search in Time-series analysis; Mining Data Streams, Methodologies for stream data processing and stream data systems, Frequent pattern mining in stream data, Sequential Pattern Mining in Data Streams, Classification of dynamic data streams.	**CLO2**

	Activities: Case based study and Group discussion for the prediction of solutions for real time problems.	
IV **15 Hours**	Web Mining, Mining the web page layout structure, mining web link structure, mining multimedia data on the web, Automatic classification of web documents and web usage mining; Distributed Data Mining. Recent trends in Distributed Warehousing and Data Mining, Class Imbalance Problem; Graph Mining; Social Network Analysis.	**CLO-3** **and** **CLO-4**
	Activities: Student presentation, Class discussion on different types of mining for the solution of real world problem.	

Transactional Modes:

- Lecture cum Demonstration
- Peer Learning/Teaching
- E-tutorial
- Self-Learning
- Online Teaching Tools

Suggested Readings:

1. Han, J., and Kamber, M., (2011). Data Mining Concepts and Techniques. Elsevier Publication.
2. Tan, P., Kumar, V., & Steinbach M. (2016). Introduction to Data Minings. New Delhi: Pearson Education.
3. Dong, G., and Pei, J. (2007). Sequence Data Mining. New York: Springer.
4. Han, Jiawei, Kamber, Micheline, Pei, Jian. (2012). Data mining: Concepts and techniques, USA: Morgan Kaufman publishers.
5. Kantardzic, Mehmed. (2011). Data mining: concepts, models, methods and algorithms. New Jersey: John, Wiley & sons.
6. Research Articles from SCI & Scopus indexed Journals.

Course Code: CST. 715
Course Title: Advanced Network Security
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objectives

To understand the principles of computer networking and layered network models. To apply concepts of Ethernet LANs, VLANs, and IP addressing using Cisco devices. To analyze IPv4 and IPv6 addressing, routing, and subnetting for network implementation. To evaluate network security techniques including firewalls, ACLs, and wireless protections.

Course Learning Outcomes:

After completion of course, scholar would be able to

CLO1: Explain networking fundamentals and models such as OSI and TCP/IP.

CLO2: Configure LAN switches, VLANs, and IPv4/IPv6 addressing on Cisco devices.

CLO3: Analyze routing techniques and troubleshoot IP connectivity using network tools.

CLO4: Evaluate and implement network security mechanisms like firewalls, NAT, and ACLs.

Units/Hours	Contents	Mapping with Course Learning Outcome
Unit I **14 Hours**	Networking Fundamentals: Perspectives on Networking, TCP/IP Networking Model, OSI Networking Model. Ethernet LANs and Switches: Building Ethernet LANs with Switches, Installing and operating Cisco LAN Switches, Configuring Ethernet Switching.	**CLO1**
	Activities: Brainstorming, assignment-based learning	
Unit II **16Hours**	Virtual LAN: introduction to VLAN, VLAN Links, VLAN Tagging, VLAN Trunk Protocol (VTP). Fundamentals of IPv4 Addressing and Routing: Overview of Network layer Functions, IPv4 Addressing: Rules for IP Addresses, Class A, B, and C IP networks. Implementing IPv4: Operating Cisco Routers, Configuring IPv4 Addresses and Routes: IP Routing, Configuring Connected Routes, Configuring Static Routes. Configuring and Verifying Host Connectivity: Configuring Routers to Support DHCP, Verifying Host IPv4 Settings, Testing Connectivity with ping, traceroute and telent.	**CLO2** **CLO3**

	Activities: Exercise based learning and practical hands-on training	
Unit III **16 Hours**	IPv6 Addressing and Subnetting: Global Unicast Addressing Concepts, Public and Private IPv6 Addresses, The IPv6 Global Routing Prefix, Address Ranges for Global Unicast Addresses, IPv6 Subnetting Using Global Unicast Addresses, *The Mechanics of Subnetting IPv6 Global Unicast Addresses, Listing the IPv6 Subnet Identifier, List All IPv6 Subnets.* Implementing IPv6 Addressing on Routers: Implementing Unicast IPv6 Addresses on Routers.	**CLO3**
	Activities: Exercise based learning and practical hands-on training	
Unit IV **14 Hours**	Firewalls: Firewall Basics, Types of Firewalls: Packet Filter, State-full Filter, Application Filter, Proxy Firewalls, Network Address Translation: Basic concepts and NAT Configuration. Access Control Lists: Ingress and Egress Filtering, Types of Access Control Lists, ACL types: standard and extended, ACL commands. Wireless Network Security. implementation of Denial of service (DoS) attacks, Distributed DoS (DDoS) attack and various types of DoS attacks.	**CLO4**
	Activities: Exercise based learning and practical hands on training	

Transactional Modes:

- Lecture
- Case Studies
- Collaborative
- Self-Learning
- Online Teaching Tools

Suggested readings:

1. Riggs, C., & Group, T. &. F. (2019). *Network Perimeter Security: Building Defense In-Depth*. Auerbach Publications.
2. Northcutt S. 2005. Inside Network Perimeter Security, 2nd Ed., Pearson Education
3. Stallings, W. (2017). *Network Security Essentials: Applications and Standards*.
4. Daimi, K. (2018). Computer and Network Security Essentials. In *Springer eBooks*. https://doi.org/10.1007/978-3-319-58424-9
5. Ibe, O. C. (2017). *Fundamentals of Data Communication Networks*. John Wiley & Sons.
6. Forouzan,B.A, 2009, Data Communications and Networking, 4th Ed. Tata McGraw Hill Education

Course Code: CST.716
Course Title: Affective Computing
Total Hours: 60

L	T	P	Cr
4	0	0	4

Course Objective:
The main objective of this course is to prepare students interested in Emotional AI. The course will help students understand the concept behind affective computing and develop intelligent models equipped with emotions and affects. A machine without emotions or affects cannot be called intelligent. So, the course includes the emotion theory, computational modelling of emotions, analysis of emotions using different modalities (such as voice, facial expressions, physiological signals, etc.) and related machine learning and/or signal processing techniques. This course also discusses ethical, legal and social implications of affective computing, particularly concerning Human-Machine Interaction.

Course Learning Outcomes:
After completion of this course, students will be able to
CLO1: Understand the foundational concepts of affective computing and its real-world applications, and analyze psychological and theoretical models of emotion
CLO2: Apply techniques to elicit and recognize emotions using different modalities and implement multimodal emotion recognition systems
CLO3: Evaluate the role of emotional empathy in artificial agents and robotic systems and critically analyze challenges in real-time emotion recognition and adaptivity in systems
CLO4: Assess the ethical, legal, and social implications of affective computing.

Units/Hours	Content	Mapping with Course Learning Outcome
I **15 hrs**	**Affective Computing:** Fundamentals of Affective Computing and its Applications, Affect Sensing, Psychology of Emotion, Emotion Models, Limitations of Traditional Affective Computing, Specificity of the emotions, Emotion and Brain Asymmetry. Emotional design. Affect Elicitation, Experimental Methodology. Research and Development Tools for Affective Computing.	**CLO1** **CLO2**
II **15 hrs**	**Face Emotion Recognition (FER):** Emotions in Facial Expressions, Micro v/s Macro Expressions, Facial Feature Extraction, FER Databases, Group-level emotions, Applications of FER **Emotions in Voice:** Speech in Affective Computing, its applications, databases, and challenges, Acoustic feature extraction, Speech emotion recognition, Emotion Speech Synthesis, Research challenges in audio emotion recognition	**CLO2** **CLO3**

	Emotions in Text: Applications, Implicit and explicit emotions in text, Tools for text emotion recognition. Feature extraction for text: BOW, TF-IDF, Embeddings, Text emotion recognition using Machine Learning and Transformers.	
III **15 hrs**	**Emotions in Physiological Signals:** Heart rate and emotions, Skin conductance and Emotions: Emotional Sweating, Features, Emotions using EEG signal, **Multimodal Emotion Recognition:** Why Multimodal, Types of fusion, Multimodal affect recognition, Data collection, Feature extraction	**CLO2** **CLO3**
IV **15 hrs**	**Emotional Empathy in Agents/Machines/Robots**: Empathy and Empathic Agents, Development of Artificial Empathy, Evoking Empathy, Empathy in Robotics and Virtual Agents, Empathy beyond emotional states, Evaluation of empathetic response. **Online and Adaptive Recognition of Emotions**: Challenges and Opportunities **Ethical Issues**: Ethical, Legal and Social Implications of Affective Computing	**CLO3** **CLO4**

Recommended Books:

1. Affective Computing. MIT Press
2. The Oxford Handbook of Affective Computing. Oxford University Press
3. The Encyclopedia of Human-Computer Interaction, 2nd Ed.
4. Interaction Design: Beyond Human-Computer Interaction. 2019. (5th Edition) by Jenny Preece, Helen Sharp, Yvonne Rogers (Wiley)

Course Code: CST.702
Course Title: Research Methodology – Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives

The objective of this course is to provide research scholars with practical exposure to the tools, techniques, and methodologies essential for conducting high-quality research. It aims to bridge the gap between theoretical understanding and applied research by offering hands-on experience in data collection, analysis, visualization, and interpretation using modern statistical and analytical software. The course includes exercises in literature review using academic databases, plagiarism detection tools, citation management systems, and structured writing of research proposals and reports. Scholars will also engage with experimental design, hypothesis testing, and result validation using software tools such as SPSS, R, Python, or MATLAB. By the end of the course, students will be proficient in applying methodological rigor to their research work and will have the skills necessary to conduct reproducible, ethical, and impactful research in their respective fields.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: To Use data analysis tools.
CLO2: To analyze the research results using data analysis tools.

The Laboratory assignments for this lab will include the assignments from the paper CST-701: Based on MS office, Latex and SPSS.

Lab Assignments will be based on topics studied in CST.701

Suggested Readings:

1. Lab Manual

Course Code: CST.705
Course Title: Advance Image Processing Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives

The objective of this lab course is to provide hands-on experience in implementing advanced image processing algorithms using tools such as MATLAB or Python. Students will explore techniques like image enhancement, segmentation, feature extraction, and object recognition. The course emphasizes practical problem-solving and experimentation using real-world image datasets. It aims to enhance students' ability to design and evaluate image processing solutions for research and applications.

Course Learning Outcomes:

After completion of course, scholar would be able to

CLO1: To understand the concepts of image recognition and analysis.

CLO2: To Implement some techniques and analyze the result.

CLO3: To Use tools like Matlab and Python

Lab Assignments will be based on topics studied in Subject

The Laboratory assignments for this lab will include the assignments from the paper CST-703: Based on Image feature extraction, fuzzy image processing, and image classification.

Suggested Readings:

1. Lab Manual

Course Code: CST.706
Course Title: Software Metrics and Measurements-Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives

The objective of this lab course is to provide practical exposure to software measurement techniques and tools used for analyzing software quality, complexity, and productivity. Students will implement and evaluate software metrics such as LOC, cyclomatic complexity, cohesion, coupling, and defect density using real-world datasets. The course aims to develop hands-on skills in using metric tools and interpreting results for process improvement and decision-making in software projects.

Course Learning Outcomes:

After completion of course, scholar would be able to

CLO1: Apply software measurement techniques and tools to analyze software quality attributes such as complexity, cohesion, coupling, and defect density.

CLO2: Interpret and evaluate software metric results to support process improvement and informed decision-making in software development projects.

The Laboratory assignments for this lab will include the assignments from the paper CST-704

Lab Assignments will be based on topics studied in Subject

Suggested Readings:

1. Lab Manual

Code: CST. 709
Course Title: Quantum Cryptography Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives

The objective of this lab course is to provide hands-on experience in the principles and implementation of quantum cryptographic protocols. Students will simulate and analyze algorithms like BB84, quantum key distribution (QKD), and quantum teleportation using platforms such as Qiskit or other quantum simulators. The course aims to bridge theoretical understanding with practical skills in quantum-secure communication and cryptographic protocol evaluation.

Course Learning Outcomes:

After completion of course, scholar would be able to

CLO1: To simulate qubits, multi-qubit pure and mixed quantum states, the celebrated Bell states and density matrices associated with entangled systems.

CLO2: To simulate quantum circuits composed of single and multi-qubit quantum gates.

CLO3: To simulate different measures of entanglement and nonlocality in pure and mixed two and three-qubit states.

CLO4: To simulate different noisy channels to analyse the effect of noise on entanglement and efficiency of a protocol.

CLO5: To simulate different quantum information processing protocols such as teleportation, dense coding, and Secret Sharing.

The Laboratory assignments for this lab will include the assignments from the paper CST-708: Based on Qubit, Quantum Gates, Density Matrix, Entanglement, Quantum Algorithms, and Applications- Teleportation, dense coding, entanglement swapping, and quantum key distribution.

Suggested Readings:

1. Lab Manual

Course Code: CST.715
Course Title: Data Analysis with Machine Learning Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives:
The objectives of the Machine Learning Lab course are to introduce students to the basic concepts and techniques of Machine Learning. To develop skills of using recent machine learning software for solving practical problems.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Review some common Machine Learning algorithms and their limitations.
CLO2: Apply common Machine Learning algorithms in practice and implementing the same.
CLO3: Perform experiments in Machine Learning using real-world data.

Suggested Readings:

1. Lab Manual
2. Kumar, U.D., and Pradhan, M. (2019). Machine Learning using Python. Wiley.

Lab Evaluation:

The criteria for evaluation of lab will be based on following parameters:

Component	**Marks**
Continuous Evaluation	60
End Term (Implementation and Viva-Voce)	40
Total	**100**

Course Code: CST.716
Course Title: Cryptography-Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives:
To introduce students to the concept of security, and types of attacks. Describe Symmetric & Asymmetric Key Cryptography Define Network Perimeter Security, Access Control Lists and Virtual Private Networks.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Identify the domain specific security issues.
CLO2: Implement Symmetric & Asymmetric Key Cryptography algorithms.
CLO3: Design Access Control Lists and Virtual Private Networks.

Suggested Readings:

1. Lab Manual
2. Forouzan, B. A. (2010). Cryptography & Network Security. New Delhi: Tata McGraw-Hill Education.
3. Kahate, A. (2009). Cryptography and Network Security. New Delhi: tata McGraw-Hill Higher Ed.

Lab Evaluation:

The criteria for evaluation of lab will be based on following parameters:

Component	**Marks**
Continuous Evaluation	60
End Term (Implementation and Viva-Voce)	40
Total	**100**

Course Code: CST.717
Course Title: Big Data Analysis Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives:
The lab will help students prepare the big data with pre-procesing analysis and to extract the meaningful data from unstructured data. Help student to develop data visualizations skill and to apply various tools for analysis of structured and unstructured big data.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Pre-process the un-structured data by various cleaning activities.
CLO2: Convert the un-structured data to structured format.
CLO3: Use Python libraries for analysis and visualisation of data such as PySpark, PyMongo,pandas, numpy and beutifulsoap.

Students will implement the lab practical as per the syllabus of the subject.

Lab Evaluation:

The criteria for evaluation of lab will be based on following parameters:

Component	**Marks**
Continuous Evaluation	60
End Term (Implementation and Viva-Voce)	40
Total	**100**

Course Code: CST.718
Course Title: Internet of Things-Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives:
The outcome of IOT Lab is to introduce the students to the different IOT technologies. To develop skills that will help the students to develop different IOT applications. To help use different IOT protocols and analysis the data in IOT.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Identify the different technology and develop IOT based applications.
CLO2: Analysis and evaluate protocols used in IOT.
CLO3: Evaluate the data received through sensors in IOT.

Students will implement the lab practical as per the syllabus of the subject.

Lab Evaluation:

The criteria for evaluation of lab will be based on following parameters:

Component	**Marks**
Continuous Evaluation	60
End Term (Implementation and Viva-Voce)	40
Total	**100**

Course Code: CST.719
Course Title: Data Mining-Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives:
The outcome of Data Mining Lab is to introduce the students to the different technologies used for Data Mining. To develop skills that will help the students to develop different applications/technologies for data mining applications.

Course Learning Outcomes:
After completion of course, scholar would be able to
CLO1: Design a data mart or data warehouse for any organization
CLO2: Extract knowledge using data mining techniques
CLO3: Adapt to new data mining tools.

Students will implement the lab practical as per the syllabus of the subject.

Lab Evaluation:

The criteria for evaluation of lab will be based on following parameters:

Component	**Marks**
Continuous Evaluation	60
End Term (Implementation and Viva-Voce)	40
Total	**100**

Course Code: CST. 720
Course Title: Advanced Network Security Lab
Total Hours: 60

L	T	P	Cr
0	0	4	2

Course Objectives:

To develop practical skills in configuring switches, routers, and VLANs. To apply IP addressing and subnetting techniques in real-world scenarios. To configure and verify IPv4/IPv6 connectivity using Cisco devices. To implement basic network security features such as ACLs, NAT, and firewall settings.

Course Learning Outcomes:

After completion of course, scholar would be able to

CLO1: Configure Ethernet LANs and VLANs on Cisco switches using CLI commands.

CLO2: Implement IPv4 and IPv6 addressing, subnetting, and routing on routers.

CLO3: Verify end-to-end connectivity and troubleshoot network issues using tools like ping and traceroute.

CLO4: Apply security mechanisms including ACLs and NAT configurations in lab setups.

The Laboratory assignments for this lab will include the assignments from the paper CST-703: Based on LANs, VLANs, Implement IPv4 and IPv6 addressing, subnetting, and routing, Verify end-to-end connectivity, ACLs and NAT configurations etc.

Suggested Readings:

1. Lab Manual

Lab Evaluation:

The criteria for evaluation of lab will be based on following parameters:

Component	**Marks**
Continuous Evaluation	60
End Term (Implementation and Viva-Voce)	40
Total	**100**

Course Code: CST.721
Course Title: Affective Computing Lab
Total Hours: 30

L	T	P	Cr
0	0	2	1

Course Objectives:

The objective of IOT Lab is to introduce the students to the different IOT technologies. To develop skills that will help the students to develop different IOT applications. To help use different IOT protocols and analysis the data in IOT.

Course Learning Outcomes:

After completion of course, students would be able to:
CLO1: Identify the different technology and develop IoT based applications.
CLO2: Implement IoT applications on different embedded platform.
CLO3: Evaluate the data received through sensors in IOT

Lab Assignments

Practical will be based on as per the Teaching Learning in the Theory Class**.**

1. A study of various tools and libraries for Affective Computing
2. Real-Time Face emotion detection using OpenCV and pre-trained model (Detect faces, extract features and predict the emotions)
3. Build a Real-Time Voice Emotion Detector
4. Text Emotion Classification with ML models
5. EEG Signal Analysis for Emotions
6. GSR and Heart Rate Emotion Correlation
7. Combine text + audio + visual input (early or late fusion)
8. Training and testing of multi-modal sentiment or emotion analysis models
9. Develop a Rule-based or ML-based bot that responds with empathy
10. Stream-Based Emotion Recognition (Use WebSocket or real-time input to adapt emotion models, update predictions based on live data (audio, text).)

Lab Evaluation:

The criteria for evaluation of the lab will be based on the following parameters:

Component	**Marks**
Continuous Evaluation	60
End Term (Implementation and Viva-Voce)	40
Total	**100**

Suggested Readings

1. Lab Manuals