CENTRAL UNIVERSITY OF PUNJAB, BATHINDA

Ph.D. in Computer Science and Technology

Session – 2021-22(Onwards)

Department of Computer Science & Technology

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. 751	Research And Publication Ethics(RPE)	Core	2	0	0	**2**
CST.752	Teaching Assistantship		0	0	2	**1**
UNI.753	Curriculum, Pedagogy and Evaluation		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	Advanced Network Security					
CST.712	Big Data Analytics					
CST.713	Internet of Things					
CST.714	Data Mining					
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	Advanced Network Security-Lab					
CST.717	Big Data Analytics-Lab					

CST.718	Internet of Things-Lab					
CST.719	Data Mining-Lab					
Total Credits			**10**	**0**	**8**	**16**

Evaluation Criteria
As per UGC guidelines on adoption of CBCS.

L	T	P	Cr
4	0	0	4

Course Code: CST.701
Course Title: Research Methodology

Total Hours: 60

Course Outcomes:
Upon successful completion of this course, the student will be able:

- To formulate research plan, understand scientific literature, build hypothesis and test the results.
- To develop skills to prepare the research papers and PhD thesis.
- To Use tools like SPSS, Latex and MS office for research work.

UNIT I **Hours: 15**

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.

UNIT II **Hours: 15**

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.

UNIT III **Hours: 15**

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.

UNIT IV **Hours: 15**

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.

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.

L	T	P	Credits
4	0	0	4

Course Code: CST.703
Course Title: Advance Digital Image Processing

Total Hours: 60

Course Outcomes:

Upon successful completion of this course, the student will be able to:

- To Discuss the concepts of digital image processing
- To explain, analyse and implement algorithms for advanced image analysis.
- To Design solutions for complex image processing problems like image retrieval.

UNIT 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.

UNIT 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.

UNIT 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.

UNIT 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.

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.

	T	P	Credits
4	0	0	4

Course Code: CST.704
Course Title: Software Metrics and Measurements

Total Hours: 60

Course Outcomes:

Upon successful completion of this course, the student will be able:

- To apply software testing knowledge, verification & validation and engineering methods.
- To Design and conduct a software test process for a quality software test.
- To identify various software testing problems, and solve these problems by designing and selecting software metrics models, testing criteria, strategies, and methods.

UNIT 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.

UNIT 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.

UNIT 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.

UNIT IV **15 Hours**

Measuring software Reliability: Concepts and definitions, Software reliability models and metrics, Fundamentals of software reliability engineering (SRE), Reliability management model.

Transactional Modes:

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

Suggested Readings:

1. Norman E. Fenton, S. L. P fleeger. (1998).Software Metrics: A Rigorous and Practical Approach. International Thomson Computer Press.
2. Stephen H. Kan. (2002). Metrics and Models in Software Quality Engineering. New Delhi: Addison-Wesley Professional.
3. BasuAnirban. (2015). Software Quality Assurance, Testing and Metrics.New Delhi: Prentice Hall India Learning Private Limited.
4. Robert B. Grady. (1992). Practical Software Metrics for Project Management and Process Improvement. New Delhi: Prentice Hall.
5. Katrina D. M. (2002). Applied Statistics for Software Managers. New Delhi: Prentice Hall PTR.

L	T	P	Credits
4	0	0	4

Code: CST. 707

Course Title: Quantum Cryptography **Total Hours: 60**

Course Objectives:

The objective of this course is to:

- 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 Outcomes:

After completion of course, students would be able:

1. To understand the basic concepts and terminologies in quantum information processing and quantum cryptography.
2. To work in the field of quantum information processing and quantum cryptography, and to design efficient quantum algorithms to solve different computing problems.
3. To design new or modify existing quantum cryptographic algorithms for secure key distribution and communications.
4. To grasp the working principle of a quantum computer and understand the impact of noise in real world implementations.
5. To understand some of the long-standing issues in quantum computing, and way forward in Noise-Intermediate-Scale-Quantum and Post Quantum Cryptography era.
6. To understand the current scenario in Google, IBM, D-wave, IonQ etc.

UNIT 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

UNIT 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

UNIT 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.

UNIT 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.

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.

L	T	P	Cr
4	0	0	4

Course Code: CST.710

Course Title: Data Analysis with Machine Learning

Total Hours: 60

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 Outcomes:

After completion of course, students would be able to:

- Describe machine learning approaches.
- Discuss features that can be used for a particular machine learning approach in various applications.
- Compare and contrast pros and cons of various machine learning techniques.
- To mathematically analyze various machine learning approaches and paradigms.
- Formulate various machine learning and ensemble methods for use in IOT applications.

UNIT I **16 Hours**

Introduction to learning Techniques: Supervised Learning (Regression/Classification)

- Basic methods: Distance-based methods, Nearest-Neighbours, 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

Activities: Brainstorming, assignment based learning

UNIT 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)

Activities: Exercise based learning and practical hands on training

UNIT 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.

Activities: Exercise based learning and practical hands on training

UNIT 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.

Activities: Analysis of various case studies

Transactional Modes:

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

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.

L	T	P	Cr
4	0	0	4

Course Code: CST.711

Course Title: Advanced Network Security

Total Hours: 60

Course Objectives:

The outcome of this course is to:

- 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 Outcomes:

After completion of course, students would be able to:

- Identify the domain specific security issues.
- Apply Symmetric & Asymmetric Key Cryptography in various applications.
- Design Access Control Lists and Virtual Private Networks.

UNIT 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.

Activities: Assignment based and numerical exercise based learning, Case study based learning of different security mechanisms.

UNIT 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.

Activities: Assignment based and numerical exercise based learning, Implementation of various cryptographic algorithms using computer programming.

UNIT 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.

Activities: Implementation and web based simulation of various cryptographic algorithms.

UNIT 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.

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 indexed.

L	T	P	Cr
4	0	0	4

Course Code: CST.712

Course Title: Big Data Analytics

Total Hours: 60

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 Outcomes:

After completion of course, students would be able to:

- Illustrate the identification of Big Data problem
- Differentiate structured data from unstructured data.
- Use Hadoop related tools such as JAQL, Spark, Pig and Hive for structured and unstructured Big Data analytics

UNIT 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.

Activities: **Case Study and Group Discussion**

UNIT 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.

Activities: **Implementation above theory with Python code.**

UNIT 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.

Activities: **Implementation and designing with Spark/Mongo DB**

UNIT 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.

Activities: **Implementation and usage of tools over the cloud**

Transactional Modes:

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

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 Journals.

L	T	P	Cr
4	0	0	4

Course Code: CST.713

Course Title: Internet of Things

Total Hours: 60

Course Objectives:

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

Course Outcomes:

After completion of course, students would be able to:

- Describe IOT and its networking and communication aspects.
- Analyze the challenges in IoT Design
- Design IoT applications on different embedded platform.

UNIT 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.

Activities: Assignment and Exercise based learning

UNIT 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.

Activities: Flip Learning with simulation tools

UNIT 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

UNIT IV **16 Hours**

Developing IoTs: Developing applications through IoT tools including Python/Arduino/Raspberry pi, developing sensor based application through embedded system platform.

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.

L	T	P	Cr
4	0	0	4

Course Code: CST.714

Course Title: Data Mining

Total Hours: 60

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 Outcomes:

After completion of course, students would be able to:

- Discuss different sequential pattern algorithms.
- Apply the techniques to extract patterns from time series data and their applications in real world.
- Examine Graph mining algorithms to Web mining.
- Design the computing framework for Big Data.

UNIT 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;

Activities: Brainstorming for finding the Association rules, Case study to illustrate the data warehouse and data mining model design principles.

UNIT 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.

Activities: Assignment based learning, Exercise based learning.

UNIT 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.

Activities: Case based study and Group discussion for the prediction of solutions for real time problems.

UNIT 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.

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.

L	T	P	Cr
0	0	4	2

Course Code: CST.702

Course Title: Research Methodology - Lab

Course Outcomes:
Upon successful completion of this course, the student will be able to:

- To Use data analysis tools.
- 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

L	T	P	Cr
0	0	4	2

Course Code: CST.705

Course Title: Advance Image Processing Lab

Learning Outcomes:
Upon successful completion of this course, the student will be able to:

- To understand the concepts of image recognition and analysis.

- To Implement some techniques and analyze the result.
- 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

L	T	P	Cr
0	0	4	2

Course Code: CST.706

Course Title: Software Metrics and Measurements-Lab

Course Outcomes:

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

L	T	P	Cr
0	0	4	2

Code: CST. 709

Course Title: Quantum Cryptography Lab

Course Outcomes:

At the end of the course the student will be able to:

- To simulate qubits, multi-qubit pure and mixed quantum states, the celebrated Bell states and density matrices associated with entangled systems.
- To simulate quantum circuits composed of single and multi-qubit quantum gates.
- To simulate different measures of entanglement and nonlocality in pure and mixed two and three-qubit states.
- To simulate different noisy channels to analyse the effect of noise on entanglement and efficiency of a protocol.
- 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

L	T	P	Cr
0	0	2	1

Course Code: CST.715

Course Title: Data Analysis with Machine Learning Lab

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 Outcomes:

After completion of course, students would be able to:

- Review some common Machine Learning algorithms and their limitations.
- Apply common Machine Learning algorithms in practice and implementing the same.
- 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**

L	**T**	**P**	**Cr**
0	0	2	1

Course Code: CST.716

Course Title: Advanced Network Security Lab

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 Outcomes:

- Identify the domain specific security issues.
- Implement Symmetric & Asymmetric Key Cryptography algorithms.
- 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**

L	**T**	**P**	**Cr**

0	0	2	1

Course Code: CST.717

Course Title: Big Data Analysis Lab

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.

Learning outcome:

After completion of lab course, students would be able to:

- Pre-process the un-structured data by various cleaning activities.
- Convert the un-structured data to structured format.
- 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**

L	**T**	**P**	**Cr**

0	0	2	1

Course Code: CST.718

Course Title: Internet of Things-Lab

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 Outcomes:

After completion of course, students would be able to:

- Identify the different technology and develop IOT based applications.
- Analysis and evaluate protocols used in IOT.
- 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**

L	**T**	**P**	**Cr**

0	0	2	1

Course Code: CST.719

Course Title: Data Mining-Lab

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 Outcomes:

After completion of course, students would be able to:

- Design a data mart or data warehouse for any organization
- Extract knowledge using data mining techniques
- 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: BCH.751

Course Title: Research and Publication Ethics

L	T	P	Credits
2	0	0	2

Total Hours: 30

Unit I Philosophy and Ethics **3 hours**

- Introduction to Philosophy : definition, nature and scope, content, branches
- Ethics : definition, moral philosophy, nature of moral judgements and reactions

Unit II Scientific Conduct **5 hours**

- Ethics with respect to science and research
- Intellectual honesty and research integrity
- Scientific misconducts : Falsification, Fabrication, and Plagiarism (FFP)
- Redundant publications : duplicate and overlapping publications, salami slicing
- Selective reporting and misrepresentation of data

Unit III: Publication Ethics **7 hours**

- 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 behaviour and vice versa, types
- Violation of publication ethics, authorship and contributor ship
- Identification of publication misconduct, complaints and appeals
- Predatory publishers and journals

Unit IV Open Access publishing **4 hours**

- Open access publications and initiatives
- SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
- Software tool to identify predatory publication developed by SPPU

- Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer, Journal Suggester etc.

Unit V Publication Misconduct **4 hours**

- Group Discussions: Subject specific ethical issues, FFP, authorship; conflicts of interest; 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

Unit IV Databases and Research Metrics **7 hours**

- Databases: Indexing databases; Citation database: Web of Science, Scopus etc.
- Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score; Metrics : h-index, g-index, i10 index, almetrics

Course Code: BCH.752

Course Title: TEACHING ASSISTANTSHIP

L	T	P	Credit
0	0	2	1

Total Hours: 30

Learning Outcome:

At the end of this skill development course, the scholars shall be able to

1. familiarize themselves with the pedagogical practices of effective class room delivery and knowledge evaluation system
2. manage large and small classes using appropriate pedagogical techniques for different types of content

Activities and Evaluation:

- 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.
- 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).
- 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.

- 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:
- 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).
- 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 Code: UNI.753

Course Title: CURRICULUM, PEDAGOGY AND EVALUATION

L	T	P	Credit
1	0	0	1

Learning outcomes: **Total Hours: 15**

After completion of the course, scholars shall be able to:

- analyze the principles and bases of curriculum design and development
- examine the processes involved in curriculum development
- develop the skills of adopting innovative pedagogies and conducting students' assessment
- develop curriculum of a specific course/programme

Course Content

Unit I Bases and Principles of Curriculum **4 hours**

1. Curriculum: Concept and Principles of curriculum development, Foundations of Curriculum Development.
2. 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.

Unit II Curriculum Development **4 hours**

1. Process of Curriculum Development: Formulation of graduate attributes, course/learning outcomes, content selection, organization of content and learning experiences, transaction process.
2. Comparison among Interdisciplinary, multidisciplinary and trans-disciplinary approaches to curriculum.

Unit III Curriculum and Pedagogy **3 hours**

1. Conceptual understanding of Pedagogy.
2. Pedagogies: Peeragogy, Cybergogy and Heutagogy with special emphasis on Blended learning, Flipped learning, Dialogue, cooperative and collaborative learning
3. Three e- techniques: Moodle, Edmodo, Google classroom

Unit IV Learners' Assessment **4 hours**

1. Assessment Preparation: Concept, purpose, and principles of preparing objective and subjective questions.
2. Conducting Assessment: Modes of conducting assessment – offline and online; use of ICT in conducting assessments.
3. Evaluation: Formative and Summative assessments, Outcome based assessment, and scoring criteria.

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-learningexcellence/Pages/Principles-of-a-Flipped-Classroom.aspx
- http://leerwegdialoog.nl/wp-content/uploads/2018/06/180621-Article-The-BasicPrinciples-of-Dialogue-by-Renate-van-der-Veen-and-Olga-Plokhooij.pdf