Tribhuvan University

**Faculty of Humanities and Social Sciences**

Office of the Dean

Balkhu, Kathmandu.

# Curriculum of Master in Computer Applications (MCA)

**(Third and Fourth Semester)**

**2025**

**Course Title: Cryptography and Network Security (3 Cr.)**

**Course Code: MCA 601**

**Year/Semester: II/III**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

This course introduces the basic principles and design of cryptosystems. It consists of basic cryptography concepts, including classical ciphers, block ciphers, stream ciphers, and symmetric and public key cryptographic algorithms. The course also includes the theory of hash functions, authentication systems, and network security protocols.

**Course Objectives:**

The main objective of this course is to provide students with knowledge of basic cryptography Theories, Algorithms, and Systems, secure messages over insecure channels by various means, and understand various protocols for network security to protect against network threats.

**Course Contents:**

**Unit-1 Introduction and Classical Cryptography** **[7 hrs.]**

**Security concept**: introduction, the need for security, security approaches, principles of security, types of security attacks, security services, security mechanism, A model for Network security, CIA Traid: Confidentiality, Integrity, and Availability.

**Classical Cryptosystem**: Introduction to cryptography, Cryptosystem, Crypto analysis, Shift Cipher, Affine Cipher, Vigenere Cipher, Hill Cipher, Playfair Cipher and Rail Fence Cipher

**Unit-2 Symmetric key cryptography** **[12 hrs.]**

**The mathematical background of Symmetric key Cryptography**: Modular arithmetic, GCD (Euclid's algorithm), Congruence, and matrices. Basic concept of Groups, Rings, and Finite Fields, set of residue($Z_n$), Residue classes, Quadratic residue, Operation on $Z_n$, Inverses: Additive Inverse, Multiplicative Inverse, Relatively Prime, Extended Euclidean Algorithm, Galois Fields (GF(p) & GF($2^n$)), Polynomial Arithmetic Addition, Multiplication and Division over Galois Field

**Symmetric key cipher**: Block Cipher vs. Stream Ciphers, DES (Data Encryption Standard): key generation, Encryption and decryption process. Strength of DES, linear and differential cryptanalysis

IDEA (International Data Encryption Algorithm): key generation, Encryption and decryption process.

Advanced Encryption Standards (AES): Key Generation, Encryption and Decryption Process

**Unit-3 Public key cryptography** **[12 hrs.]**

**The mathematical background of Asymmetric Key Cryptography**: prime numbers, Primality testing, Millar-Rabin Algorithm, Fermat's theorem, Euler's Totient function, and Euler's theorem, primitive root, discrete logarithms, Chinese Remainder theorem.

**Principles of public key cryptosystem**: RSA algorithm (Key Generation, Encryption and Decryption process), Security of RSA

Distribution of public key, Distribution of secret key by using public key cryptography, Diffie-Hellman Key Exchange, Man-in-the-Middle Attack

Elgamal Cryptographic System: Key Generation, Encryption, and Decryption Process

**Unit-4 Cryptographic Hash Functions and Message Authentication** **[6 hrs.]**

Hash Function, Properties of Hash Function, application of Hash Function, secure- hash algorithms: SHA-1 and SHA-2 algorithms, comparison of SHA parameters, SHA-512.

Message Authentication, Authentication requirement, HMAC, CMAC, Digital signatures, Digital Signature Standard: The DSS Approach, Digital Signature Algorithm (DSA), The RSA Approach, Elgamal digital signature scheme.

**Unit-5 Authentication and Key Management** **[6 hrs.]**

Authentication System, password-based authentication, one-way authentication, mutual authentication and Biometric system.

**Key management and distribution**: Symmetric key distribution and distribution of public key, Session key exchange: simple key exchange protocol, Needham-Schroeder Scheme, Denning–Sacco Protocol, Kerberos System.

**Unit-6 Network Security and System Security** **[5 hrs.]**

Overview of network security, Digital certificates, and x.509 certificates. PKI trust models.

Email Security: Pretty Good Privacy (PGP), Services provided by PGP, Secure Socket Layer (SSL) Protocol, Transport Layer Security (TLS) Protocol, IP Security (IPsec) Protocol

Firewalls, Firewall Characteristics, Types of Firewalls: Packet filtering firewall, Circuit-level gateway, Stateful inspection firewall, Proxy firewall, Next-generation firewall

**Laboratory Work:** **[32 hrs.]**

The laboratory work includes the implementation of the following cryptographic algorithms and protocols mentioned in each unit.

- Perform encryption and decryption using the following classical cryptography algorithm.
- Implement some base components of DES and AES like the functioning of S-Box and key generation.
- Implement modular arithmetic (Finding additive inverse and multiplicative inverse).
- Implement primality testing, Totien function, Chinese remainder Theorem
- Implement the RSA algorithm and Elgamal cryptographic system.
- Implement the Diffie-Hellman Key Exchange algorithm for a given problem.
- Calculate the Message digest of text using the SHA-1 algorithm.
- Implement the SIGNATURE SCHEME - Digital Signature Standard.

**References:**


Bishop, M. (2018). *Computer security: Art and science* (2nd ed.). Addison-Wesley Professional.

Forouzan, B. A. (2007). *Cryptography and network security*. Tata McGraw-Hill.

Stallings, W. (2016). *Network security essentials: Applications and standards* (6th ed.). Pearson Education.

Stallings, W. (2017). *Cryptography and network security: Principles and practice* (7th ed.). Pearson Education.

Stinson, D. R. (2018). *Cryptography: Theory and practice* (4th ed.). CRC Press.

**Course Title: Data Mining and Data Warehousing (3 Cr.)**

**Course Code: MCA 602**

**Year/Semester: II/III**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

This course introduces the foundation principles and techniques of data mining and data warehousing. It covers the basic concepts of data warehouse, data mining, data preprocessing, various association rule analysis algorithms, classification and prediction algorithms, and clustering analysis. It also introduces advanced data mining concepts. For each topic, in addition to in-depth coverage, one or more representative problems and their algorithms shall be discussed.

**Course Objectives:**

The primary goal of this course is to understand data warehouse concepts, architecture, business analysis and tools, data pre-processing, and data visualization techniques. Study algorithms for finding hidden and interesting patterns in data. Discuss classification algorithms and learn how data is grouped using clustering techniques and advanced data mining techniques.

**Course Contents:**

**Unit-1 Introduction to Data Warehousing and Business Analysis [8 hrs.]**

Introduction to data and data warehouse, Difference between Operational database system and data warehouse, Data warehouse characteristics, Data warehouse architecture and its component, fundamentals of ETL architecture, the taxonomy of Data warehouse tool, Data mart, Meta Data repository, Multidimensional Data model: star, snowflake, and fact constellation schemas, measures, concept hierarchy, Online Analytical Processing (OLAP) and Online Transaction Processing (OLTP), OLAP operation in Multidimensional data model, Data warehouse back end- tools and utilities, Types of OLAP servers, Data warehouse models, Trends in data warehouse.

**Unit-2 Data mining and Data preprocessing** **[8 hrs.]**

Definition of data mining, Knowledge discovery in Data (KDD) , Data objects and attribute type, kinds of database, data mining functionality, classification of data mining system, Data mining task primitives, issue and application of data mining.

Data preprocessing: Data cleaning, Data Integration and transformation, Data reduction, Data discrimination and concept hierarchy, Data visualization, Data similarity and dissimilarity measures.

**Unit-3 Association rule analysis** **[8 hrs.]**

Association rule: problem, definition, Market Basket analysis, Frequent item set generation, Efficient and scalable Frequent pattern mining methods, The APPRIORI principle, support and confidence measures, Association rule generation, APPRIORI Algorithm, The partition algorithm, FP-Growth Algorithm, Compact Representation of Frequent item set-Maximal Frequent Item set, closed frequent item set.

**Unit-4 Classification and Prediction** **[10 hrs.]**

Classification: problem definition, General approach to solve a classification problem, Evaluation of classifier, Classification by Decision tree induction, ID3 algorithm as attribute selection, Rule-based classifier, Bayesian classifier, Laplace smoothing, Artificial Neural Network Classifier, Evaluating Accuracy, Issue in Classification: Overfitting and Underfitting, validation and Model Comparison, Regression analysis.

**Unit-5 Clustering and Trend analysis** **[9 hrs.]**

Clustering Overview, Types of data in cluster analysis, A categorization of major clustering methods: partitioning clustering (K-means and PAM algorithm), Hierarchical (Agglomerative and Divisive method). Density-based (DBSCAN), Evaluation of clustering, Outlier analysis.

**Unit-6 Advance Data Mining Technique** **[5 hrs.]**

Mining Complex Types of Data: Multi-dimensional Analysis and Descriptive Mining of Complex, Data Objects, Mining Spatial Databases, Mining Multimedia Databases, text mining: extracting attributes (keywords), structural approaches (parsing, soft parsing) and Web-mining: Web content mining, web structure mining, web usage mining

**Laboratory Work** **[32 hrs.]**

The laboratory work includes the implementation and demonstration of various data warehouse and data mining techniques.

- Build a Data warehouse and explore the WEKA tool.
- Perform Data preprocessing tasks and implement various association rule mining algorithm on data set.
- Demonstrate and implement various classification algorithm (Decision Tree, Naïve Bayes, ANN) on data set.
- Demonstrate and implement Regression analysis on data set.
- Demonstrate and implement various clustering algorithms on data set.

**References:**


Berry, M. J., & Linoff, G. S. (2012). *Mastering data mining* (2nd ed.). Wiley.

Bhosale, V., & Vora, D. (2013). *Data warehousing & data mining*. Technical Publications.

J. Han, J., Kamber, M. & J Pei Jan. (2012). *Data Mining -Concepts and Techniques*, (3rd ed.). Morgan Kaufmann Publisher.

Tan, P.-N., Steinbach, M., & Kumar, V. (2014). *Introduction to data mining* (1st ed.). Pearson.

**Course Title: Project II (3 Cr.)**
**Course Code: MCA 603**
**Year/Semester: II/III**
**Class Load: 6 hrs./Week (Practical)**

**Course Description:**

This advanced project course is designed to build upon the foundations laid in Project I, pushing students to engage with cutting-edge trends and practices in software development technologies. The course emphasizes deep dives into complex system analysis and design, sophisticated software engineering practices, advanced project management strategies, and the application of the latest programming languages and platforms. Students are expected to showcase the skills and abilities they have developed in their studies and to give extensive supervised experience in designing a software solution to fulfil a real need. The expectation is that this experience will prepare the students to take on professional responsibilities post-graduation. Students are expected to deliver and test a working prototype by the end of the course.

**Course Objectives:**

The main goal of this course is to provide students with the advanced skills and comprehensive knowledge necessary to design, develop, and present sophisticated real-time projects. These projects should reflect the latest trends and best practices within the full system development life cycle and demonstrate proficiency in advanced software development techniques and methodologies.
Although the scope of each project will vary, the overall expectation is that by the end of the course the students will have gained experience in the following areas:

- Reflection on the design process and the student's professional development,
- Proper assessment of your user's needs,
- Derivation of appropriate project requirements and evaluation criteria,
- Development of conceptual solutions,
- Adequate analysis of the options and the selection of the most promising solution,
- Detailed design, including the necessary engineering analyses,
- Development of detailed engineering drawings of components that will be built,
- Selection of suitable development methods,
- Prototype and final product development,
- Prototype and final product testing and evaluation, and
- Technical communication of results (verbal and written).



**Course Content:**

**Nature of Project:**

Students are expected to undertake highly complex projects individually or in pairs. Projects should address sophisticated system software issues such as advanced operating systems, big data analytics, cloud computing, advanced computer networks, cyber security, and innovative system utilities. Application projects should focus on cutting-edge technologies in fields like e-commerce, e-governance, geographic information systems (GIS), enterprise resource planning (ERP) systems, management information systems (MIS), Blockchain, artificial

intelligence (AI), machine learning, deep learning, IoT, data science, and other emerging technologies. Students are encouraged to use the most recent programming languages, tools, and technologies.

**Phases of Project:**

The project should be developed and evaluated in the following advanced phases:

1. Project proposal submission:
   Students must submit and present their project proposal by the 2nd week of the semester in a specified format to the research committee formed by the department.
2. Project mid-term evaluation:
   A detailed mid-term progress report should be submitted by the 12th week of the semester. This report should be evaluated by a domain-specific expert assigned by the department.
3. Project final evaluation:
   The final project evaluation will be conducted by an external examiner assigned by the TU, FoHSS, Office of the Dean. It should occur before the final semester examination.

**Provision of Project Supervision:**

The department will assign a project supervisor to guide students throughout the development process. Continuous monitoring, evaluation, and feedback will be provided to ensure the project meets advanced standards.

**Project Evaluation:**

The project will be evaluated based on the following parameters:

i. Innovativeness of the project idea
ii. Significance and impact of the project
iii. Comprehensive literature review
iv. Sophistication in the selection of development methodology
v. Depth of project analysis and design
vi. Complexity in the implementation of theory and algorithms
vii. Advanced level of work accomplished
viii. Professionalism in report formatting
ix. Effectiveness of project presentation


Evaluation Marks distribution should be as follows:

| Project Proposal Evaluation (Research Committee) | Mid-term Evaluation (Project Domain Expert) | Final Evaluation (External Examiner) | Project Supervisor's Continuous Evaluation | Total |
|---|---|---|---|---|
| 10 Marks | 20 Marks | 20 Marks | 50 Marks | 100 Marks |

**Report Format:**

**Prescribed Project Proposal Format:**

1. Introduction
2. Problem of Statement
3. Objectives
4. Project Development Methodology
    a. Requirement Identification
        i. Study of the existing system
        ii. Review of advanced literature
        iii. Requirement Analysis
    b. Feasibility Study
    c. System Design: Methodology, Proposed System Architecture
    d. Algorithms (if any)
5. Project development schedule (Gantt Chart)
6. Expected Outcomes
7. References

**Prescribed Final Project Report format:**

1. Cover and Title Page
2. Certificate Page
    a. Declaration
    b. Supervisor's Recommendation
    c. External Examiner's Approval Sheet
3. Acknowledgement
4. Abstract
5. Table of Contents
6. List of Abbreviations
7. List of Figures
8. List of Tables
9. Main Report
10. References
11. Bibliography (if any)
12. Appendices (Screenshots, Source Code, Supervisor's log sheet)

**Prescribed Chapters in the Main Report:**

Chapter 1: Introduction

1.1 Introduction
1.2 Problem Statement
1.3 Objectives
1.4 Scope and Limitations
1.5 Project Development Methodology
1.6 Report Organization

Chapter 2: Background Study and Literature Review

- 2.1 Background Study
- 2.2 Literature Review

Chapter 3: System Analysis and Design

- 3.1 System Analysis
  - 3.1.1 Requirement Analysis
    - 3.1.1.1 Functional Requirements
    - 3.1.1.2 Non-Functional Requirements
  - 3.1.2 Feasibility Analysis
    - 3.1.2.1 Technical Feasibility
    - 3.1.2.2 Operational Feasibility
    - 3.1.2.3 Economic Feasibility
    - 3.1.2.4 Schedule Feasibility
  - 3.1.3 Data/Object Modeling
  - 3.1.4 Process Modeling
- 3.2 System Design
  - 3.2.1 System Architecture
  - 3.2.2 Database Design
  - 3.2.3 UI/UX Design
  - 3.2.4 Deployment Design
  - 3.2.5 Report Design (if any)
- 3.3 Algorithm detail (if any)

Chapter 4: Implementation and Advanced Testing

- 4.1 Implementation
  - 4.1.1 Tools and Technology
  - 4.1.2 Detailed Implementation
- 4.2 Testing
  - 4.2.1 Unit Testing
  - 4.2.2 System Testing
- 4.3 Result Analysis

Chapter 5: Conclusion and Future Recommendation

- 5.1 Conclusion
- 5.2 Future Recommendation

**Citation and References:**

The citation and reference standards should adhere to the IEEE format.

**Report Format Standards:**

1. **Page Number**
   The pages from the certificate page to the list of tables/figures should be numbered in Roman starting from i. The pages from Chapter 1 onwards should be numbered numerically, beginning with 1. The page number should be inserted at the bottom centre.

2. **Page Size and Margin**
   The paper size must correspond to A4. Margins: Top = 1, Bottom = 1, Right = 1, Left = 1.25 inches.

3. **Paragraph Style**
   All paragraphs must be justified with 1.5 line spacing.

4. **Text Font of Document**
   Contents should be in Times New Roman font, size 12 for paragraphs.

5. **Section Headings**
   Font size: Chapter titles = 16, Section headings = 14, Sub-section headings = 12. All headings should be bold-faced.

6. **Figures and Tables**
   Figures and tables should be center-aligned. Figure captions should be centered below the figure, and table captions should be centered above the table. All captions should be bold-faced, size 12.

**References:**


Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1994). *Design patterns: Elements of reusable object-oriented software*. Addison-Wesley.

Kothari, C. R., & Garg, G. (2019). *Research methodology: Methods and techniques*. New Age International.

Pressman, R. S., & Maxim, B. R. (2019). *Modern software engineering: A practitioner's approach*. McGraw-Hill.

Project Management Institute. (2017). *A guide to the project management body of knowledge (PMBOK guide)* (6th ed.). Project Management Institute.

Valacich, J. S., & George, J. F. (2017). *Modern system analysis and design*. Pearson.

Schwaber, K. (2004). *Agile project management with Scrum*. Microsoft Press.

**Course Title: Academic Writing (1 Cr.)**

**Course Code: MCA604**

**Year/Semester: II/III**

**Class Load: 2 hrs. / Week (Practical)**

## Course Description

This course, offered to MCA students of the faculty of Humanities and Social Sciences, intends to impart the basic components of writing research articles/papers to the students which is very significant in promoting and disseminating their research works that help them in their personal and professional setting. The course not only familiarizes students with essential components of research articles/papers but also equips them with advanced academic writing styles, strategies, and skills to produce well-written and well-argued research articles/papers to get them published in the peer-reviewed DOI-indexed scholarly journals of their specific discipline.

1. **Title**:
   - i. Make it intelligent, and telling (avoid wording that is vague, garrulous, and pretentious);
   - ii. Use keywords that relate to the subject area, and disciplinary practice, and foreshadow the major argument
   - iii. Must have Issue raised + study area/primary text
2. **Abstract**: An abstract is a brief summary of a research article, thesis, review, conference proceeding, or any in-depth analysis of a particular subject or discipline. It is often used to help readers quickly ascertain the paper's purpose. It must:
   - i. reflect the content of the paper
   - ii. let the reader know what is being researched, how it has been researched, the gist of the results and discussion and the crux of the conclusion
   - iii. It is followed by keywords: 4-8
3. **Introduction**: It must lay the foundation of the research paper. It must include:
   - i. Promise sentence: accurately describe what the researcher hoped to achieve.
   - ii. Introduce key variables and study area/primary text.
   - iii. Clearly state the problem to be investigated.
   - iv. Identify the research gap through the critical analysis and synthesis of the relevant literature.
   - v. Show the point of departure that differs from previous studies.
4. **Methods and Materials**: It must include
   - i. Research design
   - ii. Reasons for selecting study area/primary text
   - iii. Methods of collecting data
   - iv. Tools and processes of analyzing the data
5. **Results and Discussion**: This section must
   - i. Show the statistics/information/facts/texts are sufficiently analyzed.

ii. Demonstrate that the analysis and interpretation of the data has led to reasonable inference.
iii. Show that each claim must be supported by SAFER (Statistic, Anecdote, Fact, Example, Reason)
iv. Discussion should integrate findings/results + evidence from study ares + objective reflection over the evidence with the support of theoretical insights and previous studies.

6. **Conclusion**: A good conclusion must contain
   i. Restatement of the thesis statement
   ii. Synopsis of the results and discussion
   iii. Researcher's concluding remarks: addition of new knowledge to the existing scholarship
   iv. Suggest the further lines of research
7. Follow *APA 7th edition* for Research Format, Mechanics, Citation and preparing list of References.
8. **Language**
   i. Use appropriate transitional words to establish link between sentences and paragraphs.
   ii. Avoid the use of wordiness, redundancy, ambiguous expression, biased and discriminatory words and expression.
   iii. Judiciously use appropriate action verbs rather than using old tired disgusting verbs like say, tell, state, write, view, etc.

**Evaluation Criteria:**
Students' work is evaluated by HoD/Director/Program Coordinator, Supervisor, and Final Viva conducted by the department. There will not be any external examination conducted by FoHSS for this course, it is totally evaluated by the internal activities completed under the supervision of the supervisor and Viva.

| **Synopsis** | **HoD. /Director /Coordinator** | **Supervisor** | **Final Viva** |
|---|---|---|---|
| 10 - Marks | 10 - Marks | Language & Grammar – 10 marks<br>Tools used in Report Preparation (Data Collection & Processing, Report Formatting, Grammar Tool, Text Editor, Citation, Referencing) – 10 Marks<br>Peer Review/Feedback – 10 Marks<br>Research Work(Literature Review, Data Collection & Analysis, Finding) – 20 Marks | Report: 10 Marks<br>Presentation: 10 Marks<br>Viva: 10 Marks |
| **Total Marks: 100 Marks** | | | |

The Final Viva team will be formatted including the following members:

- HoD/Director/Program Coordinator - 1
- Supervisor - 1
- Domain Expert – 1(At least)

**References**


Booth, W. C., Colomb, G. G., & Williams, J. M. (2023). *The craft of research*, 5th edition. The University of Chicago Press.

Graff, G, Birkenstein, C., & Durst, R. (2018). *They say/I say with readings*. W. W. Norton and Company.

Green, S., & Lidinsky, A. (2017). *From Inquiry to Academic Writing: Practical Guide*, 4th edition. Bedford/St. Martin's.

Hartley, J. (2008). *Academic Writing and Publishing: A Practical Handbook.* Routledge.

**Course Title: Big Data Management (3 Cr.)**

**Course Code: MCA605**

**Year/Semester: II/III**

**Class Load: 5hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

This course covers both theoretical and practical concepts of big data and its application in the real world. It includes the map reduces framework, the concept of NoSQL, the Google file system, and case studies that can relate technologies to big data for solving big data problems in different domains.

**Course Objectives:**

The objective of this course is to introduce current scenarios of big data provide various aspects of big data and familiarize students with the technologies for solving big data problems in different domains.

**Course Content:**

**Unit-1 Introduction** **[8 hrs.]**

Introduction, Characteristics, Scope, and Challenges of Big Data; Types and Source of Big Data; Tools and Technologies Used in Big Data.; Role of Distributed System in Big Data; Role of data Scientist in Big Data; Current Trend and real-life applications of Big Data.

**Unit-2 Google File System** **[8 hrs.]**

Architecture; Availability; Fault tolerance; Optimization for large-scale data

**Unit-3 Map Framework for Big Data** **[16 hrs.]**

Basics of functional programming, Fundamentals of functional programming, Real-world problems modeling in functional style; Map reduce fundamentals; Data Flow Architecture; Real-world problems; Scalability goal; Fault tolerance; Optimization and data locality; Parallel Efficiency of Map-Reduce; Case Study on Hadoop(Introduction to Hadoop Environment, Data Flow, Hadoop I/O, Query Languages of Hadoop, Hadoop and amazon cloud, YARN )

**Unit-4 NoSQL Databases** **[10 hrs.]**

Introduction to NoSQL; Need of NoSQL; Types of NoSQL Databases; NoSQL vs Relational databases; Structured and Unstructured Data; Taxonomy and NoSQL Implementation; Discussion of the basic architecture of HBase, Cassandra and MongoDB

**Unit-5 Searching and Indexing Big Data** **[6 hrs.]**

Full-text indexing and searching; indexing with Lucene; Distributed Searching with Elastic search

**Laboratory Works** **[32 hrs.]**

Lab works should be done covering big data technologies using various dummy as well as real world problems that will cover all the aspects discussed in course and a small project work should be carried out using the concept learnt in this course. Project should be assigned on Individual Basis.

**References:**


Apache Hadoop. *Hadoop*. Retrieved from http://hadoop.apache.org/

Chang, F., Dean, J., Ghemawat, S., Hsieh, W. C., Wallach, D. A., Burrows, M., Chandra, T., Fikes, A., & Gruber, R. E. (2006). Bigtable: A distributed storage system for structured data. *ACM Transactions on Computer Systems, 26*(2), 4-13. https://doi.org/10.1145/1132983.1132986

Dean, J., & Ghemawat, S. (n.d.). *MapReduce: Simplified data processing on large clusters*. Retrieved from http://research.google.com/archive/mapreduce.html.

Elasticsearch. *Elasticsearch guide*. Retrieved from http://www.elasticsearch.org/guide/

George, L. (2011). *HBase: The definitive guide*. O'Reilly Media.

Ghemawat, S., Gobioff, H., & Leung, S.-T. (2003). The Google file system. *ACM SIGOPS Operating Systems Review, 37*(5), 29-43. https://doi.org/10.1145/945111.945115

Miner, D., & Shook, A. (2012). *Map reduce design pattern*. O'Reilly Media.

Rutherglen, J., Tabora, R., Krupansky, J. (2010). *Lucene and Solr: The definitive guide*. O'Reilly Media.

White, T. (2015). *Hadoop: The definitive guide* (4th ed.). O'Reilly Media.

**Course Title: Managerial Economics (3 Cr.)**

**Course Code: MCA606**

**Year/Semester: II/III**

**Class Load: 4Hrs. / Week (Theory: 3 hrs. Practical: 1 hrs.)**

**Course Objectives**

This course is intended to provide a foundation in Managerial Economics and aims to enable students to understand the economic analysis applicable to managerial decision-making.

This course will help students to familiarize themselves with the most significant tools of economic analysis. In particular, this course will tackle the fundamental principles of microeconomics, including demand and supply, production, market competition, strategic interactions and government policy.

Microeconomics should be understood as a specific logic, as a state of mind that can help decision-makers better understand their landscape and enrich their business decisions.

The course develops qualitative and quantitative approaches for problem-solving and decision-making in the field of MCA program. Students will learn how to use theoretical and analytical tools from the fields of economics and statistics to enhance their ability to understand real-world problems, and identify possible solutions.

**Learning Outcomes**

By the end of this course, students should be able to:

- Apply the fundamental concepts of managerial economics and evaluate business decisions.
- Enable to reach the optimal managerial decision in the face of various business constraints.
- Identify different types of markets and determine price output under different market structures.
- Enable to anticipate future market trends and dynamics, including competition policy.

**Course Contents**

**Unit - I: Introduction** **[8 hrs.]**

Meaning and nature of managerial economics: Concept and scope of managerial economics and its usefulness to IT sector. Basic concepts and principles: Production possibility curve, opportunity cost, concept of marginal analysis, discounting principles, risk and uncertainty, nature of profits,

**Unit -II: Demand Analysis and Forecasting** **[8 hrs.]**

The elasticity of demand: Concept of price, income, cross and promotional elasticity of demand. Measurement of different types of elasticity of demand. Demand Forecasting: Concept and purpose of demand forecasting, Techniques of demand forecasting: Qualitative and quantitative method of demand forecasting, limitations of forecasting.

*Numerical Assignment and Case Studies*

**Unit III: Theory of Production and Cost** **[10 hrs.]**

Production function and optimal combination of inputs: One variable input and two variable inputs. Economies of scale and economies of scope. Concept of cost and estimation, Concept of revenue and estimation, cost volume profit analysis. Linear Programming: Profit maximization and cost minimization, dual problem, and shadow price.

*Numerical Assignment and Case Studies*

**Unit IV: Market: Market Structures and Pricing Practices** **[16 hrs.]**

Market structure and degree of competition: Price output determination under perfect market, monopoly, monopolistic, and oligopoly markets: Pricing models in cartel, price leadership, kink demand curve model. Strategic behavior and game theory: Strategies behavior and pay off matrix, dominant strategy, Nash equilibrium, and prisoner's dilemma. Pricing practices: Cost plus pricing, incremental cost pricing, product life cycle-based pricing, multiple product pricing, peak load pricing, auction pricing, transfer pricing, bundling, prestige pricing, and price lining.

*Numerical Assignment and Case Studies*

**Unit V: Government Regulation and Capital Budgeting** **[6 hrs.]**

Role of government in the economy, Government response to market failure: Competition promotion (Antitrust) policy, price regulation (including public utility company), patent system, subsidy, operating controls, regulations of environment pollution. The capital budgeting and its process: The cost of capital benefit analysis, an overview of cost-benefit analysis.

*Numerical Assignment and Case Studies*

**Reference Books**


Dwivedi, D. N. (2014). *Managerial economics* (7th ed.). Vikash Publishing House Pvt. Ltd.

Mankiw, N. G. (1998). *Principles of economics*. The Dryden Press, Harcourt Brace College Publishers.

Mehta, P. L. (2011). *Managerial economics: Analysis, problems, and cases*. Sultan Chand & Sons Educational Publishers.

Rajkarnikar, R. (2021). *Managerial economics*. Kriti Publication Pvt. Ltd.

Salvatore, D. (2012). *Managerial economics in a global economy*. McGraw-Hill.

Peterson, H. C., & Lewis, W. C. (2002). *Managerial economics*. Prentice Hall of India.


**Evaluation Scheme**

| S.N. | Activities | Marks Allocation |
|---|---|---|
| A | Assignments | |
| A1. | Review of Articles/Research papers (no. 4 @ 3) | 12 |
| A2. | Assignments/project works (no. 3 @ 3) | 9 |
| A3. | Online Class test (no. 1) | 15 |
| A4. | Quiz (Question and answers during Class/class participation) | 4 |
| | **Sub-Total** | **40** |
| | | |
| B. | Final Examination | **60** |
| | | |
| | GRAND TOTAL (A+B) | **100** |

**Specification Grid (Question Plan)**

| S.N | Group | uestion pattern | No. of Questions | Answer only | Unit | FM |
|---|---|---|---|---|---|---|
| 1. | A | Case / Situation Analysis | 2 | 2 | III, IV | 2x15= 30 |
| 2 | B | Problem Solving/ Critical Analysis | 4 | 3 | II, III, IV, V | 3x15= 45 |
| 3 | C | Concept based Short Answer | 6 | 5 | All | 5x=5= 25 |
| | | | | | | Total =100 |

**Course Title: Virtualization and Cloud Computing (3 Cr.)**

**Course Code: MCA 607**

**Year/Semester: II/III**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

This course covers both theoretical and practical concepts of virtualization and cloud computing and its application in the real world. It includes Virtualization, the concept of cloud computing, cloud architecture, cloud security, and container technology case studies that can relate to Virtualization and cloud computing.

**Course Objectives:**

The objective of this course is to introduce current scenarios of cloud computing provide various aspects of virtualization and cloud computing and familiarize students with the technologies for solving virtualization and cloud computing problems in different domains.

**Course Content:**

**Unit-1 Introduction** **[6 hrs.]**

- Introduction, Characteristics, Scope, and Challenges of Cloud computing
- features of cloud computing
- Cloud services requirements
- Cloud and dynamic infrastructure

**Unit-2 Cloud Computing Architectures and Service models** **[8 hrs.]**

- Cloud computing Characteristics,
- Cloud reference model -platform as service,
- software as a service,
- infrastructure as service,
- Cloud deployment models -Public clouds, private clouds, Community cloud, hybrid clouds
- Cloud design and implementation using SOA, security, trust and privacy

**Unit-3 Cloud Virtualization technology** **[10 hrs.]**

- Virtualization defined, type of virtualization, benefits of virtualization,
- Server virtualization,
- Hypervisor management software,
- virtual infrastructure requirements
- VLAN, SLAN and VSAN and benefits
- Technology examples: XEN, VM ware, Microsoft Hyper-V

**Unit-4 Cloud security** **[8 hrs.]**

- Cloud Security challenges and Risks
- Software-as-a-Service Security
- Security Monitoring
- Security Architecture Design
- Data Security, Application Security, Virtual Machine Security
- Identity Management and Access Control
- VM security and challenges

**Unit-5 Container technology:** **[6 hrs.]**

- Introduction to containers
- container architectures
- Docker containers
- Kubernetes Cloud Platforms in Industry

**Unit-6 Cloud platforms, applications and Case Studies** **[10 hrs.]**

- Web services, App Engine
- azure Platform, Aneka
- open challenges
- scientific applications and business and consumer applications
- energy efficiency in cloud
- cloud mobility
- market-oriented cloud computing

**Laboratory Works** **[32 hrs.]**

Lab work should be done covering virtualization and cloud computing using various real-world problems that will cover all the aspects discussed in the course and a small project work should be carried out using the concept learned in this course. Projects should be assigned on an individual basis.

**References**


Buyya, R., Vecchiola, C., & Selvi, S. T. (2013). *Mastering cloud computing: Foundations and applications programming*. Newnes.

Linthicum, D. S. (2009). *Cloud computing and SOA convergence in your enterprise*. Addison-Wisely.

Saurabh, K. (2012). *Cloud computing*. Wiley.

Sosinsky, B. (2011). *Cloud computing bible*. Wiley.

**Course Title: Image Processing (3 Cr.)**

**Course Code: MCA 608**

**Year/Semester: II/III**

**Class Load: 5 hrs. Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

The course introduces students to various image processing techniques and their practical applications. It also includes an exploration of real-world uses of image processing.

**Course Objectives:**

The course's goal is to comprehend the concepts and analysis of image processing, grasp its techniques, become acquainted with its environment and applications, and recognize the diverse uses of image processing across various fields

**Course Contents:**

**Unit 1: Image Processing Fundamentals** **[9 hrs.]**

Introduction, Elements of visual perception, Steps in Image Processing Systems, Digital Imaging System, Image Acquisition, Sampling and Quantization, Pixel Relationships, File Formats, colour images and models, Image Operations, Arithmetic, logical, statistical and spatial operations, Different types of digital images, Relationship between pixels, Basic concepts of distance transform, Color Image fundamentals: RGB, CMY, HSI Models, Different color models conversion.

**Unit 2: Image Enhancement and Restoration** **[10 hrs.]**

Image Transforms, Discrete and Fast Fourier Transform and Discrete Cosine Transform, Walsh and PCA, Spatial Domain, Gray level Transformations Histogram Processing Spatial Filtering, Smoothing and Sharpening, Frequency Domain: Filtering in Frequency Domain, Smoothing and Sharpening filters, Homomorphic Filtering, Noise models, Constrained and Unconstrained restoration models.

**Unit 3: Image Segmentation and Morphology** **[10 hrs.]**

Detection of Discontinuities, Edge Operators, Edge Linking and Boundary Detection, Thresholding, Region Based Segmentation, Motion Segmentation, Image Morphology: Binary and Gray level morphology operations, Erosion, Dilation, Opening and Closing Operations Distance Transforms, Basic morphological Algorithms, Features, Textures, Boundary representations and Descriptions, Component Labeling, Regional descriptors and Feature Selection Techniques.

**Unit 4: Image Analysis and Classification** **[10 hrs.]**

Image segmentation, pixel-based, edge-based, region-based segmentation, Active contour models and Level sets for medical image segmentation, Image representation and analysis, Feature extraction and representation, and Statistical, Shape, Texture, feature, and statistical image classification.

**Unit 5: Image Registration and Visualization** **[9 hrs.]**

Rigid body visualization, Principal axis registration, Interactive principal axis registration, Feature-based registration, Elastic deformation-based registration, Image visualization, 2D display methods, 3D display methods, virtual reality-based interactive visualization.

**Laboratory Work:** **[32 hrs.]**

The laboratory work should cover the implementation of concepts covered in each syllabus unit.

**Reference Books:**

Gonzalez, R. C., & Woods, R. E. (2008). *Digital image processing* (3rd ed.). Pearson Education.

Jain, A. J. (2006). *Fundamentals of digital image processing*. PHI.

McAndrew, A. (2011). *Introduction to digital image processing with Matlab*. Cengage Learning.

Najarian, K., & Splerstor, R. (2006). *Biomedical signals and image processing*. CRC Press.

Sridhar, S. (2011). *Digital image processing*. Oxford University Press.

**Course Title: Artificial Intelligence (3 Cr.)**

**Course Code: MCA609**

**Year/Semester: II/ III**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

In this course, students will be introduced to the concept of intelligent systems and their applications in addressing real-world problems that are not easily solvable through traditional computing methods. The primary focus of the course will be on search techniques and logic, which are relevant to the development and design of intelligent systems.

**Course Objectives:**

This course aims to provide an introduction to intelligent systems for learners. The course is designed to lay the groundwork for designing intelligent systems by teaching the fundamental concepts of intelligent systems, including search techniques and logic implementations. Ultimately, the goal of the course is to enable learners to develop the necessary skills and knowledge to design effective intelligent systems.

**Course Contents:**

**Unit 1: Introduction** **[6 hrs.]**

Introduction to AI, Roots, Applications and subdomains, Agents, its structure and its Environments, Behavior and Performance Measures

**Unit 2: Problem Solving** **[10 hrs.]**

Well defined Problems and solutions, Problem Formulations, Uninformed search techniques first search, breadth-first search, depth limit search, iterative deepening search and search strategy comparison, Informed search techniques climbing, best first search, greedy search, A*search, Local search Algorithm and optimization- Hill climbing, simulated annealing, Genetic Algorithm, Adversarial search techniques procedure, alpha-beta procedure, Constraint Satisfaction Problem-Definition, Constraint Propagation, Backtracking search, local search

**Unit 3: Knowledge and Reasoning** **[15 hrs.]**

Types of Knowledge Representation Systems: Semantic Network, Frame, Conceptual Dependency, Script, Rule-Based System, Propositional Logic, Predicate Logic Propositional Logic (PL): Syntax and Semantics, Proof by Resolution, Conjunctive Normal Form, Resolution Algorithm, Predicate Logic: FOPL, Syntax and Semantics, Quantifiers, Unification and Lifting,

Inference using Resolution Algorithm, Uncertain Knowledge: Uncertain, Radom Variables, Probability, Prior and Posterior Probability, Probabilistic Reasoning, Bayes' Rule and its use, Bayesian Networks Fuzzy Logic and Fuzzy Rule Base System

**Unit 4 Concept of Machine Learning** **[6 hrs.]**

Introduction to Machine Learning, Supervised, Unsupervised and Reinforcement Learning, Learning with Neural Networks: Artificial Neural Networks (ANN), Mathematical Model of ANN, Types of ANN, ANN for simulation of gates, learning by ANN, Perceptron Learning, Back-propagation Algorithm, Deep Learning, Statistical-based Learning: Naive Bayes Model, Learning by Evolutionary Approach: Genetic Algorithm

**Unit 5: Applications** **[6 hrs.]**

Expert System, Natural Language Processing, Robotics, Machine Vision, AI in Data Science

**Unit 6: Case Study** **[5 hrs.]**

Predictive maintenance using AI in the manufacturing industry, AI-powered fraud detection in banking and finance, Chatbots in customer service: a case study of a specific company's implementation, AI for medical diagnosis: case studies in oncology and radiology, Smart home technology: a case study of AI-powered home automation systems, Autonomous vehicles: case studies of self-driving cars and their impact on transportation, AI in agriculture: case studies of precision farming and crop yield optimization, Natural language processing in healthcare: a case study of virtual medical assistants and patient care, AI in education: case studies of personalized learning and adaptive testing, AI-powered recommendation systems: case studies of Netflix, Amazon, and Spotify

**Laboratory Work:** **[32 hrs.]**

Students should implement intelligent agents, expert systems, various search techniques, knowledge representation systems and machine learning techniques using appropriate programming language.

**Reference Books:**


Jackson, P. C. (1985). *Introduction to artificial intelligence*. Dover Publications.

Luger, G. F. (2008). *Artificial intelligence: Structures and strategies for complex problem solving* (6th ed.). Addison-Wesley Publishing Company.

Rich, E., Knight, K., & Nair, S. B. (2008). *Artificial intelligence* (3rd ed.). Tata McGraw-Hill Education Pvt. Ltd.

Russell, S., & Norvig, P. (2010). *Artificial intelligence: A modern approach*. Prentice Hall.

Winston, P. H. (1992). *Artificial intelligence* (3rd ed.). Addison-Wesley.

**Course Title: Digital Forensics (3 Cr.)**
**Course Code: MCA610**
**Year: II/III**
**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Objective:**

This course provides a broad knowledge of computer crimes and forensics.

**Course Outcomes:**

- To help students understand how computer forensics is used as a powerful technique in digital investigation.
- To make it possible for students to learn the process, various steps, tools, and techniques involved in computer forensics.
- Comprehend steps involved in recovering data stored in various devices and various techniques used in Windows, Linux, Network, and Web application forensics.
- Justify the need for meticulous documentation in computer forensics.
- Articulate the rationale for having an adequate legal framework when dealing with computer forensics.

**Unit 1: Fundamentals of Digital Forensics Investigation** **[6 hrs.]**

1.1 Digital Forensics Overview
  1.1.1 Definition of Digital Forensics
  1.1.2 History of Computer Crimes
  1.1.3 Digital Forensic Terminologies
1.2 Goals of Forensic Analysis
1.3 The Digital Forensics Process
1.4 Challenges for Digital Forensics Investigation

**Unit 2: Electronic Data Acquisition – Legal Compliance and Requirements** **[7 hrs.]**

2.1 Understanding Storage Formats and Digital Evidence
2.2 Acquisition Methods
2.3 Computer Forensics Acquisition Tools
2.4 Validating Data Acquisitions

**Unit 3: Computer Processing Crime and Incident Scenes** **[8 hrs.]**

3.1 An Overview of Digital Evidence
3.2 Private-Sector Incident Scenes
3.3 Preparing for a Search
3.4 Securing a Crime Scene
3.5 Seizing Digital Evidence at the Scene
3.6 Storing Digital Evidence

**Course Title: Geographical Information System and Remote Sensing (3 Cr.)**

**Course Code: MCA611**

**Year/Semester: II/III**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

This course introduces basic principles and concepts of Geographical information systems and Remote Sensing, including remote sensing principles, GIS, image analysis, data interpretation, and advanced geospatial technologies. Students also delve into specialized areas like satellite image processing, spatial modeling, and environmental management and disaster monitoring applications. Practical training and projects are integral, allowing students to gain hands-on experience in GIS and remote sensing applications and technologies.

**Course Objectives:**

- To understand the basics of Geographical information systems and remote sensing.
- To be able to use the geospatial data processing and information retrieve
- To understand various concepts and use of GIS in disaster recovery and monitoring work.

**Course Contents:**

**Unit-1 Introduction to GIS.** **[8 hrs.]**

The nature of GIS: Some fundamental observations, Defining GIS, GI Systems, GI Science and GIS Applications, Spatial data, and Geoinformation. The real world and representations of it: Models and modeling, Maps, Databases, Spatial databases and spatial analysis, Geographic Information Systems: GIS Software, GIS Architecture and functionality, Spatial Data Infrastructure (SDI)

Remote Sensing Introduction; Distance and Definition of Remote Sensing; Remote Sensing: Art and/or Science; Data; Remote Sensing Process; Applications, Advantages, and Limitations of Remote Sensing; Ideal Remote Sensing System,

**Unit-2 Geographic Information and Spatial Database** **[10 hrs.]**

Models and Representations of the real-world Geographic Phenomena: Defining geographic phenomena, types of geographic phenomena, Geographic fields, Geographic objects, and

Boundaries, Computer Representations of Geographic Information: Regular tessellations, irregular tessellations, Vector representations, Topology and Spatial relationships, Scale and Resolution, Representation of Geographic fields, Representation of Geographic objects Organizing and Managing Spatial Data The Temporal Dimension

**Unit-3 Spatial Referencing and Positioning** **[12 hrs.]**

Spatial Referencing: Reference surfaces for mapping, Coordinate Systems, Map Projections, and Coordinate Transformations Satellite-based Positioning: Absolute positioning, Errors in absolute positioning, Relative positioning, Network positioning, code versus phase measurements, Positioning technology

**Data Entry and Preparation**

Spatial Data Input: Direct spatial data capture, Indirect spatial data capture, Obtaining spatial data elsewhere Data Quality: Accuracy and Positioning, Positional accuracy, Attribute accuracy, temporal accuracy, Lineage, Completeness, Logical consistency Data Preparation: Data checks and repairs, Combining data from multiple sources Point Data Transformation: Interpolating discrete data, Interpolating continuous data

**Unit-4 Spatial Data Analysis Classification of Analytical GIS Capabilities** **[6 hrs.]**

Retrieval, classification and measurement: Measurement, Spatial selection queries, Classification Overlay functions: Vector overlay operators, Raster overlay operators Neighbourhood functions: Proximity computations, Computation of diffusion, Flow computation, Raster based surface analysis Analysis: Network analysis, interpolation, terrain modeling GIS and Application models: GPS, Open GIS Standards, GIS Applications and Advances Error Propagation in spatial data processing: How Errors propagate, Quantifying error propagation

**Unit-5 Data Visualization** **[6 hrs.]**

GIS and Maps, The Visualization Process Visualization Strategies: Present or explore? The cartographic toolbox: What kind of data do I have? How can I map my data? How to map? How to map qualitative data, How to map quantitative data, How to map the terrain elevation, How to map time series Map Cosmetics, Map Dissemination

**Unit-6 Visual Image Interpretationof Remote Sensing** **[6 hrs.]**

Introduction; Information Extraction by Human and Computer; Remote Sensing Data Products; Border or Marginal Information; Image Interpretation; Elements of Visual Image Interpretation; Interpretation Keys; Generation of Thematic Maps; Thermal Image Interpretation; Radar Image Interpretation

Multi-approach of Remote Sensing; Integration with Ground Truth and Other Ancillary Data; Integration of Transformed Data; Integration with GIS; Process of Remote Sensing Data Analysis;

**Laboratory Work:** **[32 hrs.]**

The laboratory work includes implementing the above topics in any GIS application and map creation and manipulation of maps and their properties. The lab task must include data Visualization and analysis as per the requirement

**References:**


de By, R. A. et al. (2001). *Principles of geographic information systems*. ICT Enschede, The Netherlands

Laurini, R., & Thompson, D. (1992). *Fundamentals of spatial information systems*. Academic Press.

Weng, Q. (2009) *Remote sensing and GIS integration: Theories, methods, and applications*. McGraw-Hill.

**Course Title: Data Science (3 Cr.)**

**Course Code: MCA612**

**Year/Semester: II/III**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description**

The course provides the fundamental building blocks of data science. This course is designed to introduce key ideas and methodologies used in the domain of data science.

**Course Objectives**

The general objectives of this course are:

- To provide fundamental concepts of data science.
- To understand data analysis techniques for applications handling large data.
- To understand supervised and unsupervised learning.
- To understand the working model of the recommender system.

**Unit-1 Introduction to Data Science** **[8 hrs.]**

Introduction, Toolboxes: Python, fundamental libraries for data Scientists, Integrated development environment (IDE), Data operations: Reading, selecting, filtering, manipulating, sorting, grouping, rearranging, ranking, and plotting.

**Unit-2 Descriptive Statistics** **[9 hrs.]**

Introduction, data preparation, Exploratory Data Analysis data summarization, data distribution, measuring asymmetry, Sample and estimated mean, variance and standard score, Statistical Inference frequency approach, variability of estimates, hypothesis testing using confidence intervals, using p-values.

**Unit-3 Supervised Learning** **[7 hrs.]**

Introduction, First step, learning curves, training-validation and test, Learning models generalities, support vector machines, random forest.

**Unit-4 Regression Analysis** **[8 hrs.]**

Introduction, Regression: linear regression simple linear regression, multiple & Polynomial regression, Sparse model, Unsupervised learning, clustering, similarity and distances, quality measures of clustering, case study.

**Unit-5 Network Analysis** **[6 hrs.]**

Network Analysis, Graphs, Social Networks, centrality, drawing centrality of Graphs, PageRank, Ego-Networks, Community Detection.

**Unit-6 Recommender System** **[7 hrs.]**

Introduction, Working of Recommender system: Content-based filtering, Collaborative filtering, Hybrid Recommenders, Modelling user preferences.

**Unit-7 Statistical Natural Language Processing for Sentiment Analysis** **[3 hrs.]**

Introduction, Data Cleaning, Text Representation: Bi-Grams and n-Grams

**Laboratory Works** **[32 hrs.]**

Laboratory work should be done covering all the topics listed above and a small project work should be carried out using the concept learned in this course.

**Recommended Books**


Blum, A., Hopcroft, J., & Kannan, R. (2020). *Foundations of Data Science*.

Igual, L., & Seguí, S. (2017). *Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications*. Springer International Publishing.

Schutt, R., O'Neil, C., Loukides, M., Nash, C., & Demarest, R. (2014). *Doing Data Science*. O'Reilly Media, Inc.


**Course Title: Dissertation (9 Cr.)**

**Course Code: MCA651**

**Year/Semester: II/IV**

**Class Load: 15 hrs. / Week (Practical: 15 hrs.)**

**Course Description**

This course, offered to MCA students, intends to impart research work skills required in both personal and professional settings. It focuses on the practical implementation of research problem identification, setting objectives, reviewing related literature, selecting appropriate research methodology, and interpreting and discussing research findings systematically. In addition, the course also provides research writing and publishing standards to the students.

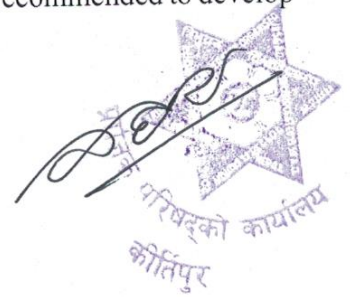
**Course Objectives:**

The objective of the course is to make students able to:

- Identify Research Problem
- Set the objectives of the research
- Identify research questions and set the hypothesis
- Perform a literature review and identify the research gap
- Select and implement appropriate research methodology
- Analyze and discuss the research findings
- Write and publish research work
- To develop a product based on the suggested solution architecture


**Nature of Course:**

In this course, students should conduct research work. The research domain should be in the field of Computer Applications like Software Engineering, Programming Languages, Software Development Frameworks, Automation, Cloud Computing, Security, Artificial Intelligence, Computer Vision, Data Science, Quantum Computing, E-Governance, E-Commerce, Digital Marketing and any other core field of computing. The research work should be conducted by students individually. Apart from providing solution architecture, it is recommended to develop a product that demonstrates solutions to the problem.



**Evaluation:**

| Particulars | Proposal Defence | Mid-Term Defence | Final – Viva, Presentation and Demonstration | Supervisor's Continuous Evaluation | Total Marks |
|---|---|---|---|---|---|
| When to Conduct | With in 3rd week of the semester | With in 12th week of semester | With in 16th week of the semester | Over the duration of semester. | |
| Evaluator | Research Committee of the respective department | Subject matter or Domain Expert | External Examiner | Supervisor | |
| Marks | 10 | 20 | 20 | 50 | 100 |

**Research Committee:** Committee which evaluates research work in respective departments.

The formation of the research committee should be as follows:

1. Head of Department/Program Director - 1
2. Subject Experts - 2 (Persons)

**Proposal Format:**

1. Introduction
2. Problem Statement
3. Objectives
4. Review of Literature
5. Research Methodology
6. Outcome
7. References

**Report Format:**

1. Cover Page
2. Blank Page
3. Inner Cover Page
4. Declaration
5. Recommendation Letter
6. Certification Page
7. Acknowledgements
8. Abstract
9. Table of Contents
10. List of Acronyms and Abbreviations

11. List of Symbols (if any)
12. List of Tables
13. List of Figures
14. Main Report
15. References
16. Appendices

**Structure of Main Report:**

**Chapter 1: Introduction**

1.1 Introduction
1.2 Problem Statement
1.3 Objectives
1.4 Scope(s)
1.5 Delimitations and Limitations of the Study
    1.5.1 Delimitations
    1.5.2 Limitations
1.6 Report Organization

**Chapter 2: Review of Literature**

2.1 Background Study
2.2 Review of Related Literature

**Chapter 3: Research Methodology**

3.1 Research Design
3.2 Data Description and Collection
3.3 Description of model/algorithm
3.4 Performance Evaluation Tools and Techniques

**Chapter 4: Implementation and Results Analysis**

4.1 Implementation Details
4.2 Result Analysis and Discussion
    4.2.1 Findings
    4.2.2 Outcome Analysis and Discussion

**Chapter 5: Conclusions and Future Recommendations**

5.1 Conclusions
5.2 Future Recommendations



**Referencing/Citation:** IEEE format for Research Format, Mechanics, Citation and preparing a list of References.

**Report Format Standards:** Use LaTeX as a documentation tool.

**1. Page Number**

The pages from the declaration page to the list of figures should be numbered in Roman starting from i. The pages from Chapter 1 onwards should be numbered numerically beginning from 1. The page number should be inserted at the bottom, aligned centre.

**2. Page Size and Margin**

The paper size must be a page size corresponding to A4. The margins must be set as Top = 1, Bottom = 1, Right = 1, Left = 1.25.

**3. Paragraph Style**

All paragraphs must be justified and have a spacing of 1.5.

**4. Text Font of Document**

The contents of the document should be in Times New Roman font. The font size in the paragraphs of the document should be 12.

**5. Section Headings**

The font size of the headings should be 16 for the chapter title, 14 for section headings, and 12 for the sub-section headings. All the headings should be bold-faced.

**6. Figures and Tables**

The position of figures and tables should be aligned center. The figure caption should be centered below the figure and table captions should be centered above the table. All the captions should be in boldface with 12 font size.

**Final Report Binding and Submission:**

**Number of Copies:** 3 (College Library, Self, and Dean Office)
**Look and Feel:** Golden Embracing with Black Binding
A final approved signed copy of the report should be submitted to the Dean's Office, Exam Section, FOHSS.

**References:**


Bairagi, V., & Munot, M. V. (Eds.). (2019). *Research methodology: A practical and scientific approach.* CRC Press.

Kothari, C. R., & Garg, G. (2019). Research methodology: Methods and techniques (4th ed.). New Age International.

Lazar, J., Feng, J. H., & Hochheiser, H. (2017). *Research methods in human-computer interaction* (2nd ed.). Elsevier, Morgan Kaufmann Publishers.

Nallaperumal, K. Engineering research methodology: A computer science and engineering and information and communication technologies perspective.

Wang, G. T., & Park, K. (2016). From topic selection to the complete paper. Wiley Blackwell.

**Course Title: Project III (9 Cr.)**

**Course Code: MCA652**

**Year/Semester: II/IV**

**Class Load: 15 hrs. / Week (Practical: 15 hrs.)**

**Course Description:**

This course is designed to engage students with cutting-edge trends and practices in software development technologies. Emphasizing complex system analysis and design, the course requires students to conduct in-depth analyses and develop comprehensive system architectures. It introduces sophisticated software engineering practices, promoting best practices in coding, testing, and maintenance using the latest methodologies and tools. The course also covers advanced project management strategies, teaching students to efficiently manage large-scale projects through advanced planning, execution, monitoring, and closure techniques. Additionally, students will learn and apply the latest programming languages and development platforms, ensuring proficiency in current technologies.

**Course Objectives:**

The main goal of this course is to provide students with the advanced skills and comprehensive knowledge necessary to design, develop, and present sophisticated real-time projects. These projects should reflect the latest trends and best practices within the full system development life cycle, demonstrating proficiency in advanced software development techniques and methodologies.

Although the scope of each project will vary, the overall expectation is that by the end of the course, the students will have gained experience in the following areas:

- Reflection on the design process and the student's professional development,
- Proper assessment of your user's needs,
- Derivation of appropriate project requirements and evaluation criteria,
- Development of conceptual solutions,
- Adequate analysis of the options and the selection of the most promising solution,
- Detailed design, including the necessary engineering analyses,
- Development of detailed engineering drawings of components that will be built,
- Selection of suitable development methods,
- Prototype and final product development,
- Prototype and final product testing and evaluation, and

- Technical communication of results (verbal and written).

**Nature of Project:**

The course emphasises complex system analysis and design, sophisticated software engineering practices, advanced project management strategies, and the latest programming languages and platforms. Students are expected to undertake highly complex projects individually or in pairs, addressing issues such as advanced operating systems, big data analytics, cloud computing, advanced computer networks, cyber security, and innovative system utilities. Application projects should focus on cutting-edge technologies in fields like e-commerce, e-governance, GIS, ERP systems, MIS, blockchain, artificial intelligence (AI), machine learning, deep learning, IoT, data science, and federated learning. Students will showcase their skills through practical applications, receiving supervised experience in designing software solutions that meet real-world needs, culminating in the delivery and testing of a functional prototype by the end of the course. This experience aims to prepare students for professional responsibilities post-graduation, ensuring they are ready to tackle complex projects and responsibilities in the professional software development environment.

**Phases of Project:**

The project should be developed and evaluated in the following advanced phases:

1. Project proposal submission:

   Students must submit and present their project proposal by the 2nd week of the semester in a specified format to the research committee formed by the department.
2. Project mid-term evaluation:

   A detailed mid-term progress report should be submitted by the 12th week of the semester. This report should be evaluated by a domain-specific expert assigned by the department.
3. Project final evaluation:

   The final project evaluation will be conducted by an external examiner assigned by the TU, FoHSS, Office of the Dean. It should occur before the final semester examination.

**Provision of Project Supervision:**

The department will assign a project supervisor to guide students throughout the development process. Continuous monitoring, evaluation, and feedback will be provided to ensure the

project meets advanced standards. The course includes weekly meetings with the project supervisor, periodic seminars on project management, advanced technical topics and research methods, peer-to-peer collaboration sessions, and independent research and development work. This comprehensive approach ensures that students receive ongoing guidance, stay updated on the latest industry practices, collaborate effectively with peers, and engage in self-directed learning to enhance their skills and knowledge.

**Learning Outcomes:**

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

- Design a project that addresses a complex problem or research question in IT.
- Manage the lifecycle of a project, including planning, execution, and closure.
- Employ advanced technical skills and tools to achieve project objectives.
- Demonstrate the ability to work independently and make informed decisions.
- Communicate project progress and results effectively to an audience of peers and superiors.

**Project Evaluation:**

The project will be evaluated based on the following parameters:

i. Innovativeness of the project idea
ii. Significance and impact of the project
iii. Comprehensive literature review
iv. Sophistication in the selection of development methodology
v. Depth of project analysis and design
vi. Complexity in the implementation of theory and algorithms
vii. Advanced level of work accomplished
viii. Professionalism in report formatting
ix. Effectiveness of project presentation

Evaluation Marks distribution should be as follows:

| Particulars | Proposal Defence | Mid-Term Defence | Final – Viva, Presentation and Demonstration | Project Supervisor's Continuous Evaluation | Total Marks |
|---|---|---|---|---|---|
| When to Conduct | Within 3rd week of the semester | Within 12th week of semester | Within 16th week of the semester | Over the duration of semester. | |
| Evaluator | Research Committee of the respective department | Subject matter or Domain Expert | External Examiner | Supervisor | |
| Marks | 10 | 20 | 20 | 50 | 100 |

**Course Content:**

**1. Introduction (Week 1)**

- Course Overview
- Project selection criteria
- Team formation guidelines

**2. Project Planning (Weeks 2-3)**

- Defining project scope and objectives
- Creating a project timeline
- Resource planning
- Introduction to project management tools (JIRA, Asana, Trello, etc.)
- Proposal submission.

**3. Research and Design (Weeks 4-6)**

- Conducting a literature review
- Finalising project design
- Ethical considerations
- UI/UX design considerations

**4. Project Implementation (Weeks 7-11)**

- Development of the project components

- Application of theoretical knowledge and technical skills
- Regular progress updates and feedback sessions
- Version control and code documentation (Git, SVN, etc.)

**5. Project Evaluation (Weeks 12-13)**

- Testing and validation of project outputs
- Analysis of findings and results
- Preparation of the final report

**6. Presentation and Completion (Weeks 14-15)**

- Preparation for the final presentation
- Submission of the final project report
- Project defense and evaluation

**Resources:**

- Access to lab equipment and software as required by the project.
- Library and online/offline resources for research.
- Documentation preparation tools LaTeX
- Referencing techniques like Zotero, EndNote Mandalay, etc.

**References:**


Cohn, M. (2005). *Agile estimating and planning* (latest ed.). Prentice Hall.

Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (2009). *Design patterns: Elements of reusable object-oriented software*. Addison-Wesley Professional.

Hunt, A., & Thomas, D. (2019). *The pragmatic programmer: Your journey to mastery* (latest ed.). Addison-Wesley Professional.

Martin, R. C. (2008). *Clean code: A handbook of agile software craftsmanship*.

Pressman, R. S., & Maxim, B. (2010). *Software engineering: A practitioner's approach* (latest ed.). McGraw-Hill Education.

**Report Format:**

**Prescribed Project Proposal Format:**

1. Introduction
2. Problem of Statement
3. Objectives
4. Project Development Methodology
    a. Requirement Identification
        i. Study of the existing system
        ii. Review of advanced literature
        iii. Requirement Analysis
    b. Feasibility Study
    c. System Design: Methodology, Proposed System Architecture
    d. Algorithms (if any)
5. Project development schedule (Gantt Chart)
6. Expected Outcomes
7. References

**Prescribed Final Project Report format:**

1. Cover and Title Page
2. Certificate Page
    a. Declaration
    b. Supervisor's Recommendation
    c. External Examiner's Approval Sheet
3. Acknowledgement
4. Abstract
5. Table of Contents
6. List of Abbreviations
7. List of Figures
8. List of Tables
9. Main Report
10. References
11. Bibliography (if any)
12. Appendices (Screenshots, Source Code, Supervisor's log sheet)

**Prescribed Chapters in the Main Report:**

Chapter 1: Introduction

- 1.1 Introduction
- 1.2 Problem Statement
- 1.3 Objectives
- 1.4 Scope and Limitations
- 1.5 Project Development Methodology
- 1.6 Report Organization

Chapter 2: Background Study and Literature Review

- 2.1 Background Study
- 2.2 Literature Review

Chapter 3: System Analysis and Design

- 3.1 System Analysis (what the system should do?)
  - 3.1.1 Requirement Analysis
    - 3.1.1.1 Functional Requirements
    - 3.1.1.2 Non-Functional Requirements
  - 3.1.2 Feasibility Analysis
    - 3.1.2.1 Technical Feasibility
    - 3.1.2.2 Operational Feasibility
    - 3.1.2.3 Economic Feasibility
    - 3.1.2.4 Schedule Feasibility
  - 3.1.3 Data/Object Modeling
  - 3.1.4 Process Modeling
- 3.2 System Design (how to accomplish the objective of the system?)
  - 3.2.1 System Architecture
  - 3.2.2 Database Design
  - 3.2.3 UI/UX Design
  - 3.2.4 Deployment Design
  - 3.2.5 Report Design (if any)
- 3.3 Algorithm details

Chapter 4: Implementation and Advanced Testing

4.1 Implementation

4.1.1 Tools and Technology

4.1.2 Detailed Implementation

4.2 Testing

4.2.1 Unit Testing

4.2.2 System Testing

4.3 Result Analysis

Chapter 5: Conclusion and Future Recommendation

5.1 Conclusion

5.2 Future Recommendation

**Citation and References:**

The citation and reference standards should adhere to the IEEE format.

**Report Format Standards:**

7. **Page Number**

   The pages from the certificate page to the list of tables/figures should be numbered in Roman starting from i. The pages from Chapter 1 onwards should be numbered numerically, beginning with 1. The page number should be inserted at the bottom centre.

8. **Page Size and Margin**

   The paper size must correspond to A4. Margins: Top = 1, Bottom = 1, Right = 1, Left = 1.25 inches.

9. **Paragraph Style**

   All paragraphs must be justified with 1.5 line spacing.

10. **Text Font of Document**

    Contents should be in Times New Roman font, size 12 for paragraphs.

11. **Section Headings**

    Font size: Chapter titles = 16, Section headings = 14, Sub-section headings = 12. All headings should be bold-faced.

### 12. Figures and Tables

Figures and tables should be center-aligned. Figure captions should be centred below the figure, and table captions should be centred above the table. All captions should be bold-faced, size 12.

**References:**


Valacich, J. S., & George, J. F. (2017). *Modern system analysis and design* (8th ed.). Pearson.

Pressman, R. S., & Maxim, B. R. (2019). *Modern software engineering: A practitioner's approach* (9th ed.). McGraw Hill.

Kothari, C. R., & Garg, G. (2019). *Research methodology: Methods and techniques* (4th ed.). New Age International.

Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1994). *Design patterns: Elements of reusable object-oriented software*. Addison-Wesley.

Schwaber, K. (2004). *Agile project management with Scrum*. Microsoft Press.

Project Management Institute. (2017). *A guide to the project management body of knowledge (PMBOK guide)* (6th ed.). Project Management Institute.

**Course Title: Machine Learning (3 Cr.)**

**Course Code: MCA653**

**Year/Semester: II/IV**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

This course covers both theoretical and practical concept of machine learning and its application in real world tasks. It includes supervised, unsupervised and reinforcement learning algorithm, overview of learning theory and evaluation metrics

**Course Objectives:**

This course is designed to familiarize students about the concept of different machine learning techniques and their applications in real world.

**Course Content:**

**Unit 1: Introduction** **[6 hrs.]**

The Definition of Machine Learning and its application, The Overview of Supervised Learning Unsupervised Learning and Reinforcement Learning. Overview of Learning Theory, Bias/variance Tradeoff, Cross-Validation, Bagging, Boosting and Stacking.

**Unit 2: Supervised Learning** **[10 hrs.]**

Supervised Learning, Linear Regression, Gradient Descent, Batch Gradient Descent, Stochastic Gradient Descent (Incremental Descent), The Concept of Underfitting and Overfitting, The Concept of Parametric Algorithms and Non-parametric Algorithms, Locally Weighted Regression, Supervised learning setup, Least Mean squares, Logistic Regression, Perceptron Learning Algorithm, Naive Bayes classifier, Laplace Smoothing, Support Vector Machine (SVM), Notation for SVM, Functional and Geometric Margins, Optimal Margin Classifier, Lagrange Duality, K-Nearest Neighbours.

**Unit 3: Unsupervised Learning** **[10 hrs.]**

The Concept of Unsupervised Learning, K-means Clustering Algorithm, K-means Algorithm, The EM Algorithm, Factor Analysis, Restrictions on a Covariance Matrix, The Factor Analysis Model, EM for Factor Analysis, The Factor Analysis Model, EM for Factor Analysis, Principal Component Analysis (PCA), PCA as a Dimensionality Reduction Algorithm, Applications of PCA, Face Recognition by Using PCA.

**Unit 4: Model Evaluation and Selection** **[7 hrs.]**

Model Evaluation & Selection, Confusion Matrices & Basic Evaluation Metrics, Precision-recall and ROC curves, Multi-Class Evaluation, Regression Evaluation, Model Selection: Optimizing Classifiers for Different Evaluation Metrics.

**Unit 5: Reinforcement Learning** **[7 hrs.]**

Applications of Reinforcement Learning, Markov Decision Process (MDP), Defining Value & Policy Functions, Value Function, Optimal Value Function, Value Iteration, Policy Iteration, Generalization to Continuous States, Discretization & Curse of Dimensionality

**Unit 6: Neural Network and Deep Learning** **[8 hrs.]**

Neural Networks, Perceptron, Activation functions, learning rules, Back-propagation, Multi-layer Neural Networks, Feed Forward Neural Networks, Recurrent Neural Networks Convolution Neural Network, Vanishing gradient and Dropout

**Laboratory Works** **[32 Hrs.]**

Lab works should be done covering supervised, and unsupervised machine learning algorithm using any high-level programming language (Python preferred) and a small project work should be carried out using the concept learned in this course. Projects should be assigned on an Individual Basis.

**References:**


Bishop, C. M. (2006). *Pattern Recognition and Machine Learning*. Springer.

Forsyth, D. A. (2019). *Applied Machine Learning* (1st ed.). Springer Verlag.

Mitchell, T. M. (1997). *Machine Learning*. McGraw-Hill.

Sattari, H. (2017). *Applied Machine Learning with Python*. Packt Publishing.

Sutton, R. S., & Barto, A. G. (1998). *Reinforcement Learning: An Introduction*. MIT Press.

**Course Title: Internet Of Things (3 Cr.)**

**Course Code: MCA 654**

**Year/Semester: II/IV**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

The course is designed to equip learners with a deep understanding of IoT concepts, working models, protocols, physical devices, endpoints, security, privacy issues, and practical applications. In addition to theoretical concepts, the course also emphasizes hands-on learning experiences with various IoT physical devices and endpoints. By exploring the diverse range of sensors, actuators, microcontrollers, and other hardware components used in IoT systems, students gain practical skills in configuring, deploying, and troubleshooting IoT devices in real-world scenarios

**Course Objectives:**

The course aims to educate students on various aspects of IoT, including understanding its concepts and working models, knowledge of different IoT protocols, familiarity with IoT physical devices and endpoints, awareness of security and privacy issues related to IoT, and practical application of IoT concepts in real-world scenarios.

**Course Contents:**

**Unit 1: Fundamentals of IoT** **[9 hrs.]**

Definition and Characteristics of IoT, Sensors, Actuators, Physical Design of IoT, IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies, Wireless Sensor Networks, Cloud Computing, Embedded Systems, IoT Levels andTemplates, Domain Specific IoTs, Home, City, Environment, Energy, Agriculture and Industry

**Unit 2: IoT Protocols** **[10 hrs.]**

Protocol Standardization for IoT, Efforts, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards, Protocols, IEEE802.15.4, BACnet Protocol, Modbus, KNX, Zigbee, Network layer, APS layer, Security

**Unit 3: Physical Devices and Endpoints** **[9 hrs.]**

Introduction to Arduino and Raspberry Pi, Installation, Interfaces (serial, SPI, I2C), Programming, Python program with Raspberry PI with a focus on interfacing external gadgets, controlling output, and reading input from pins.

**Unit 4: Internet of Things Privacy, Security adn Governance** **[11 hrs.]**

Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security

**Unit 5: IoT Applications** **[9 hrs.]**

IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc.

**Laboratory Work:** **[32 hrs.]**

1. To study various IoT protocols – 6LowPAN, IPv4/IPv6, Wifi, Bluetooth, MQTT.
2. IoT Application Development Using sensors and actuators (temperature sensor, light sensor, infrared sensor)
3. To study Raspberry Pi development board and to implement LED blinking applications.
4. To develop an application to send and receive data with Arduino using HTTP request
5. To develop an application that measures the room temperature and posts the temperature value on the cloud platform.
6. To develop an application that measures the moisture of soil and post the sensed data over Google Firebase cloud platform.
7. To develop an application for measuring the distance using ultrasonic sensor and post distance value on Google Cloud IoT platform
8. Develop a simple application based on sensors.
9. Develop IoT applications using Django Framework and Firebase/ Bluemix platform.
10. Develop a commercial IoT application

**Reference Books:**


Bahga, A., & Madisetti, V. (2015). *Internet of Things: A Hands-on Approach*. Universities Press. ISBN: 9788173719547.

Hanes, D., Salgueiro, G., Grossetete, P., Barton, R., & Henry, J. (2017). *IoT fundamentals: Networking technologies, protocols, and use cases for the Internet of Things* (1st ed.). Cisco Press.

Hersent, O., Boswarthick, D., & Elloumi, O. (2012). *The Internet of Things: Key applications and protocols*. Wiley.

Uckelmann, D., Harrison, M., Michahelles, F. (Eds.). (2011). *Architecting the Internet of Things*. Springer.

Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895

Peter Friess,'Internet of Things – From Research and Innovation to Market Deployment', River Publishers, 2014.

**Course Title: Information Security Audit (3 Cr.)**

**Course Code: MCA655**

**Year/Semester: II/IV**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

The syllabus should emphasize on practical aspects of auditing such as tools and techniques used in auditing IT infrastructure and applications, auditing cloud computing, and auditing incident response and business continuity plans.

**Course Objectives:**

The objectives of an information security audit are to evaluate and assess the effectiveness of an organization's information security policies, procedures, and controls, identify vulnerabilities and risks, ensure compliance with regulatory and industry standards, assess the adequacy of security controls against cyber threats, review incident response plans, identify areas for improvement and provide recommendations, verify the effectiveness of security controls, provide assurance to stakeholders, prioritize investments in information security, and develop a comprehensive and proactive information security strategy that aligns with the organization's business objectives.

**UNIT-1. Introduction to Information Security Audit** **[4 hrs.]**

- Overview of information security audit and its role in information security management
- Understanding the regulatory and compliance requirements for information security audit
- Introduction to different audit standards and frameworks (COBIT, ITIL, ISO 27001/2, NIST)
- Understanding the audit process and methodologies

**UNIT-2. Risk Assessment and Management** **[5 hrs.]**

- Understanding risk assessment and management
- Developing a risk assessment methodology (FAIR, ISO 31000, NIST)
- Risk assessment and management techniques
- Risk assessment and management case studies

**UNIT-3. Information Security Controls** **[5 hrs.]**

- Introduction to information security controls
- Understanding different types of security controls
- Designing and implementing security controls
- Evaluating the effectiveness of security controls
- IT security frameworks and standards (ISO 27001/2, NIST Cybersecurity Framework)
- Privacy regulations and standards (GDPR, CCPA)

**UNIT-4. Auditing IT Infrastructure** **[8 hrs.]**

- Understanding IT infrastructure
- Auditing different IT infrastructures such as networks, databases, servers, and cloud infrastructure
- Auditing access controls, network security, and encryption
- Auditing IT infrastructure case studies

**UNIT-5. Auditing Applications** **[6 hrs.]**

- Understanding application security
- Auditing web applications, mobile applications, and other types of applications
- Auditing application security controls, coding practices, and vulnerability management
- Auditing application case studies

**UNIT-6. Auditing Cloud Computing** **[6 hrs.]**

- Understanding cloud computing
- Auditing cloud infrastructure and services
- Auditing cloud security controls and compliance
- Auditing cloud computing case studies

**UNIT-7. Incident Response and Business Continuity** **[7 hrs.]**

- Understanding incident response and business continuity planning
- Developing an incident response plan
- Developing a business continuity plan
- Auditing incident response and business continuity plans

**UNIT-8. Emerging Trends in Information Security Audit** **[7 hrs.]**

- Emerging technologies and their impact on information security audit
- Emerging threats and challenges in information security audit
- The future of information security audit

**Laboratory Works** **[32 hrs.]**

1. **Vulnerability scanning tools**: Examples include Nessus, OpenVAS, and QualysGuard. These tools scan IT systems and applications for known vulnerabilities, and generate reports that highlight potential security risks.
2. **Penetration testing tools**: Examples include Metasploit, Burp Suite, and Nmap. These tools simulate attacks on IT systems and applications, in order to identify weaknesses and vulnerabilities that could be exploited by real-world attackers.
3. **Log analysis tools**: Examples include LogRhythm, Splunk, and ELK Stack. These tools analyze log files generated by IT systems and applications, in order to identify potential security incidents or policy violations.
4. **Configuration management tools**: Examples include Chef, Puppet, and Ansible. These tools track and manage configuration changes to IT systems and applications, in order to ensure that they remain in compliance with security policies and best practices.
5. **Network mapping tools**: Examples include Zenmap, NetBrain, and SolarWinds Network Topology Mapper. These tools map out the network topology of IT systems and applications, in order to identify potential security risks and vulnerabilities.
6. **Access control testing tools**: Examples include Aclight, ABE, and SecurIT. These tools test the effectiveness of access controls in IT systems and applications, in order to ensure that only authorized users have access to sensitive data and resources.
7. **Compliance auditing tools**: Examples include Qualys Compliance, McAfee Security Compliance, and Tripwire Enterprise. These tools automate the process of auditing IT systems and applications for compliance with industry and regulatory standards, such as PCI-DSS, HIPAA, and GDPR.
8. **Risk assessment methodologies**: Examples include ISO/IEC 27005, NIST SP 800-30, and FAIR (Factor Analysis of Information Risk). These are systematic approaches for

identifying and evaluating potential security risks to IT systems and applications, and developing strategies to mitigate those risks.

9. **Code review tools**: Examples include Veracode, Checkmarx, and Fortify. These tools analyze the source code of software applications, in order to identify potential security vulnerabilities and code-level flaws.
10. **Social engineering testing techniques**: Examples include phishing simulations, pretexting scenarios, and physical security testing. These techniques simulate attacks that attempt to exploit human vulnerabilities, in order to assess the effectiveness of security awareness training programs and policies.

**References :**


Alexander, D., & Finch, A. (2014). *Information security management principles*. BCS Learning & Development.

Andress, J., & Winterfeld, S. (2013). *The basics of information security: Understanding the fundamentals of InfoSec in theory and practice* (2nd ed.). Elsevier.

Debreceny, R., & Gray, P. (). *Information technology control and audit*. Pearson.

Lindgren, M., & Olofsson, T. (2014). *IT infrastructure audit: A practical handbook*. Wiley.

Mather, T., Kumaraswamy, S., & Latif, S. (2009). *Cloud security and privacy: An enterprise perspective on risks and compliance*. O'Reilly Media.

National Institute of Standards and Technology. (2002). *Risk management guide for information technology systems* (Special Publication 800-30). U.S. Department of Commerce. https://doi.org/10.6028/NIST.SP.800-30

Snedaker, S. (2013). *Business continuity and disaster recovery planning for IT professionals* (2nd ed.). Syngress.

Venkataramanan, N., & Yue, C. (Eds.). (2020). *The future of cybersecurity and privacy: A view from the inside*. Springer.

**Course Title: Natural Language Processing (3 Cr.)**

**Course Code: MCA656**

**Year/Semester: II/IV**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

The course aims to familiarize students with fundamental concepts of Natural Language Processing or Computational Linguistics, such as Morphology, Syntax, Semantics, and Discourse. Furthermore, the course will cover advanced concepts, applications, and the latest advancements in this field.

**Course Objectives:**

Provides students with an introduction to the basics and advanced concepts of natural language processing (NLP). Upon completion of the course, students will be able to apply various concepts of her NLP both theoretically and practically.

**Course Contents:**

**Unit 1: Introduction to NLP** **[2 hrs.]**

Background, challenges in NLP, Computational Linguistics, Machine learning, Text mining, Language and Knowledge (Syntax, Semantics, Pragmatics and Discourse), A multi-disciplinary field (Psychology, Information Retrieval),

**Unit 2: Words and Morphology** **[8 hrs.]**

Morphology fundamentals; Isolating, Inflectional, Agglutinative morphology; Infix, Prefix and Postfix Morphemes, Morphology Paradigms; Rule-Based Morphological Analysis: Finite State Machine Based Morphology; Automatic Morphology Learning; Deep Learning based morphology analysis.

**Unit 3: Part of Speech Tagging** **[5 hrs.]**

Parts of Speech (PoS) Tagging and Hidden Markov Models (HMM) ,PoS Tagsets ,Rule-based PoS Tagging, Stochastic PoS Tagging, Maximum Entropy Models and POS; Random Fields and POS, DNN for POS.

**Unit 4 Syntax** **[5 hrs.]**

Syntactic Analysis, Context Free Grammar (CFG) & Probabilistic CFG ,Word's Constituency (Phrase level, Sentence level), Parsing (Top-Down and Bottom-Up), CYK Parser, Probabilistic Parsing

**Unit 5: Lexical Semantics** **[6 hrs.]**

Lexical Semantics, Lexeme, Lexicon, Senses, Lexical relations, WordNet (Lexical Database), Word Sense Disambiguation (WSD), Word Similarity, Vector Semantics, Distributional Models, Word Embedding, Topic Modeling

**Unit 6: Discourse** **[5 hrs.]**

Pragmatic & Discourse Analysis, Monologue and Dialogue ,Reference Resolution ,Coherence and Cohesion , Discourse Structure

**Unit 7: Advanced NLP** **[6 hrs.]**

Deep Learning for NLP, Text Sequence Modeling and Deep Learning, Statistical Language Models , Kernel Methods ,Neural Language Models ,Recurrent Neural Network and its variants ,Attention Mechanism ,Reinforcement Learning

**Unit 8: Applications** **[6 hrs.]**

Classification, Clustering, Machine Translation; Sentiment and Emotion Analysis; Text Entailment; Question Answering; Code Mixing; Analytics and Social Networks, Information Retrieval and Cross Lingual Information Retrieval, Transformers

**Unit 9: Case study** **[5 hrs.]**

Sentiment analysis: a case study of using NLP to analyze customer reviews and feedback

Named entity recognition: a case study of using NLP to identify and extract information from unstructured text data

Text classification: a case study of using NLP to classify news articles, emails, or social media posts into different categories or topics

Machine translation: a case study of using NLP to translate text from one language to another

Question-answering systems: a case study of using NLP to build intelligent chatbots or virtual assistants that can answer user questions in real-time

Topic modeling: a case study of using NLP to identify topics and patterns in large collections of unstructured text data

Natural language generation: a case study of using NLP to generate human-like text, such as product descriptions or news articles

Language detection: a case study of using NLP to detect the language of a given text or speech sample

Speech recognition: a case study of using NLP to transcribe spoken words into text, such as in automated transcription services

Text summarization: a case study of using NLP to summarize large volumes of text data, such as news articles or research papers.

**Laboratory Work:** **[32 hrs.]**

The laboratory works should be included in all above chapters using Python Programming language.

**Reference Books:**


Jurafsky, D., & Martin, J. H. (2019). *Speech and language processing* (3rd ed., draft). Retrieved from [URL or location of the draft if available].

Allen, J. (1995). *Natural language understanding* (2nd ed.). Benjamin/Cummings.

Charniak, E. (1993). *Statistical language learning*. MIT Press.

Manning, C., & Schütze, H. (1999). *Foundations of statistical natural language processing*. MIT Press.

Eisenstein, J. (2019). *Introduction to natural language processing*. MIT Press.

Goodfellow, I., Bengio, Y., & Courville, A. (2016). *Deep learning*. MIT Press.

Radford, A., et al. (1999). *Linguistics: An introduction*. Cambridge University Press.

**Course Title: IT Infrastructure Management (3 Cr.)**

**Course Code: MCA657**

**Year/Semester: II/IV**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description**

The IT Infrastructure Management course aims to provide students with comprehensive knowledge and practical skills to manage and maintain an organization's IT infrastructure. The course covers hardware, software, networks, data centers, cloud services, and IT security.

**Course Objectives**

- Understand the fundamental concepts of IT infrastructure management.
- Learn to manage and optimize IT resources.
- Gain insights into network, server, storage, and Data Center management.
- Develop skills for monitoring, troubleshooting, and maintaining IT infrastructure.

**Unit-1 Introduction to IT Infrastructure** **[4 hrs.]**

Overview of IT Infrastructure, Key Components of IT Infrastructure, Importance of IT Infrastructure Management, Challenges in IT Infrastructure.

**Unit-2 Network Management** **[6 hrs.]**

Network fundamentals, Network topologies and architectures, Network protocols and standards, Basics of network security, Network performance monitoring, Network optimization techniques, and Troubleshooting network issues.

**Unit-3 Server Management** **[9 hrs.]**

Introduction, Types of Servers (Web, Database, Application), Server Operating System (Windows, Linux), Server Virtualization and Cloud Computing, Server Configuration and Management, Backup and Recovery, Security and Patch Management.

**Unit-4 Storage Management** **[7 hrs.]**

Types of storage (DAS, NAS, SAN), Storage Devices and Technologies (HDD, SSD, RAID), Data Management and Backup Strategies, Storage virtualization, Disaster Recovery and Business Continuity.

**Unit-5 Data Center Management** **[7 hrs.]**

Data Center Infrastructure and Design, Power and Cooling Systems, Data Center Virtualization, Cloud Data Centers, Monitoring and Maintenance, Data Center Security.

**Unit-6 IT Infrastructure Monitoring and Tools** **[6 hrs.]**

Importance of IT Monitoring, Monitoring Tools and Software (Nagios, Zabbix, SolarWinds), Performance Metrics and KPIs, Incident Management, Reporting and Documentation.

**Unit-7 IT Service Management** **[6 hrs.]**

Introduction, ITIL Framework, Service Desk and Incident Management, Problem and Change Management, Service Level Agreements (SLAs), Configuration Management Database (CMDB).

**Unit-8 Emerging Technologies and Trends** **[3 hrs.]**

Internet of Things (IoT), Artificial Intelligence and Machine Learning in IT, Edge Computing, Blockchain Technology

**Laboratory Works** **[32 hrs.]**

Laboratory work should be done covering all the topics listed above.

**Recommended Books**


Schiesser, R. (2010). *IT Systems Management*. Pearson Education.

Laan, S. (2017). *IT Infrastructure Architecture - Infrastructure Building Blocks and Concepts Third Edition*.

Gupta, P. (2010). *It Infrastructure & Its Management*. Tata McGraw-Hill Education.


**Course Title: Quantum Computing (3 Cr.)**

**Course Code: MCA 658**

**Year/Semester: II/IV**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

The course introduces the building blocks of quantum computers and highlights the differences between conventional and quantum computing. It also includes several basic quantum computing algorithms.

**Course Objectives:**

The objective of the course is to Simulate and analyze the characteristics of Quantum Computing Systems, understand quantum state transformations and algorithms, Comprehend entangled quantum subsystems and properties of entangled states, and explore the applications of quantum computing.

**Course Contents:**

**Unit 1: Introduction** **[6 hrs.]**

Overview of traditional computing, Church-Turing thesis, circuit model of computation, reversible computation, quantum physics, quantum physics and computation, Dirac notation and Hilbert Spaces, dual vectors, operators, the spectral theorem, functions of operators, tensor products, Schmidt decomposition theorem

**Unit 2: Quantum Building Blocks** **[9 hrs.]**

The Quantum Mechanics of Photon Polarization, Single-Qubit Quantum Systems, Quantum State Spaces, Entangled States, Multiple-Qubit Systems, Measurement of Multiple-Qubit States, quantum circuit model, quantum gates, universal sets of quantum gates, unitary transformations, quantum circuits, Reversible Classical Computations to Quantum Computations, Language for Quantum Implementations, EPR Paradox and Bell's Theorem, Bloch sphere

**Unit 3: Quantum Algorithms** **[10 hrs.]**

Superdense coding, probabilistic versus quantum algorithms, phase kick-back, the Deutsch algorithm, the Deutsch- Jozsa algorithm, Simon's algorithm, Quantum phase estimation, and

quantum Fourier Transform, eigenvalue estimation Computing with Superpositions, Quantum Subroutines, Shor's Algorithm, and Generalizations, Grover's Algorithm and Generalizations

**Unit 4: Quantum Computational Complexity and Error Correction** **[9 hrs.]**

Computational complexity, black-box model, lower bounds for searching, general black-box lower bounds, polynomial method, block sensitivity, adversary methods, classical error correction, classical three-bit code, fault tolerance, quantum error correction, three- and nine, qubit quantum codes, fault-tolerant quantum computation

**Unit 5: Quantum Cryptography** **[6 hrs.]**

Classical cryptography basic concepts – Private key cryptography – Shors Factoring Algorithm -Quantum Key Distribution – BB84 – Ekart 91

**Unit 6: Quantum Information Processing** **[8 hrs.]**

Limitations of Quantum Computing, Alternatives to the Circuit Model of Quantum Computation, Quantum Protocols, Building Quantum, Computers, Simulating Quantum Systems, Bell states. Quantum teleportation. Quantum Cryptography, no-cloning theorem

**Laboratory Work:** **[32 hrs.]**

The laboratory work should cover the implementation of concepts covered in each unit of the syllabus.

**References**


Benenti, G., Casati, G., & Strini, G. (2004). *Principles of quantum computation and information, Vol. I: Basic concepts, Vol. II: Basic tools and special topics*. World Scientific.

Easttom, W. (2021). *Quantum computing fundamentals*. Addison-Wesley Professional.

Gribbin, J. (2021). *Computing with quantum cats: From Colossus to qubits*. Bantam Press.

Lala, P. (2019). *Quantum computing*. McGraw Hill.

Nielsen, M. A. (2002). *Quantum computation and quantum information*. Cambridge University Press.

Pittenger, A. O. (2000). *An introduction to quantum computing algorithms*. Springer.

Rieffel, E., & Polak, W. (2011). *Quantum computing: A gentle introduction*.

**Course Title: Business Intelligence (3 Cr.)**

**Course Code: MCA659**

**Year/Semester: II/IV**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

This course presents different concepts of business intelligence including business analytics, data mining, data visualization, and data tools to help organizations make better data-driven decisions. These concepts allow businesses to make informed decisions. Students are introduced to the basic concepts of business intelligence. It also includes the latest concepts and techniques used by marketers for business intelligence.

**Course Objectives:**

The primary objective of this course is to introduce different concepts and aspects of business intelligence to make better business decisions. At the end of the course, students should be able to understand and implement the concepts of Data mining, Business reporting and visual analysis, Text and web analysis, Big data and analytics from the business perspectives, DSS and its relation with business, and the current trends in the Business Intelligence required for making effective decisions.

**Course Contents:**

**Unit 1: Introduction to Business Intelligence** **[5 hrs.]**

A framework for BI, brief history of BI, architecture of BI, Application of BI, types of BI users, BI tools

**Unit 2: Data Warehousing and Data Mining** **[10 hrs.]**

Data warehousing process, Data warehousing architecture, Data warehouse development approaches, OALP vs OLTP, Real-time Data warehousing, Data mining process, Data mining methods: classification, clustering, association rule mining, Data mining software tools

**Unit 3: Business reporting, visual analytics, and business performance management** **[6hrs.]**

Data and information Visualization, Emergence of data visualization and visual analytics, Business performance management, Performance measurement: Key Performance Indicator (KPI), Performance measurement system

**Unit 4 Text and web analytics** **[7 hrs.]**

Text analytics and Text mining, NLP, Text mining process, sentiment analysis, web mining, web usage mining (web analytics), search engines, social analytics

**Unit 5: Big data and analytics** **[6 hrs.]**

Fundamentals, Big data technologies: Map Reduce, Hadoop, Big data and stream analytics, application of stream analytics

**Unit 6: DSS and BI** **[8 hrs.]**

DSS and its structure, Decision-making process, Types of Decisions, Decision Support Systems modeling,
Structure of mathematical models for decision support, Certainty, Uncertainty, and Risk, Decision Analysis with Decision Tables and Decision Trees

**Unit 7: Business analytics** **[3 hrs.]**

Emerging trends and future impacts, location-based analytics for organizations, analytics applications for consumers, Recommendation engines, Cloud computing, and BI

**Unit 8: Trends in BI** **[3 hrs.]**

Mobile BI, BI through NLP, Data governance, Self-service BI

**Laboratory Works:** **[32 hrs.]**

Laboratory work should be done covering all the topics listed above and a small work should be carried out using the concept learned in each unit.

**Teaching Methods:**

The general teaching pedagogy includes class lectures, group discussions, case studies, guest lectures, research work, project work, assignments (theoretical and practical), and examinations (written and verbal), depending on the topics. The teaching faculty will determine the choice of teaching pedagogy according to the needs of the topics.

**References:**


Grossmann, W., & Rinderle-Ma, S. (2015). *Fundamentals of business intelligence*. Springer.

Maheswari, A. K. (2015). *Business intelligence and data mining*. Business Expert Press.

Sharda, R., Delen, D., & Turban, E. (2018). *Business intelligence, analytics, and data science: A managerial perspective* (4th ed.). Pearson.

Vercellis, C. (2009). *Business intelligence: Data mining and optimization for decision making*. Wiley.

**Course Title: UI/UX Design (3 Cr.)**

**Course Code: MCA660**

**Year/Semester: II/IV**

**Class Load: 5 hrs. / Week (Theory: 3 hrs. Practical: 2 hrs.)**

**Course Description:**

This course presents different design principles, techniques, and concepts of UI and UX designs focusing on making products easy to use, efficient, and user-friendly. Students are introduced to the basic concepts, design techniques, and evaluation of UI and UX. It also includes the latest concepts used by the designers to design the UI/UX and also trends in the UI/UX design.

**Course Objectives:**

The primary objective of this course is to introduce different principles, techniques, and aspects of UI/UX design. At the end of the course, students should be able to design user-friendly UI and UX using different models and techniques and then evaluate the designs using different evaluation techniques.

**Course Contents:**

**Unit 1: Introduction** **[6 hrs.]**

Fundamentals of UI and UX, User interfaces: GUI, VUI, Menu-driven, NLP based, UI/UX tools

**Unit 2: UI** **[14 hrs.]**

Graphical and web user interfaces: interaction styles, UI design process, System menus, and navigation models, Global selection of Windows and its components, choosing screen-based controls

Understanding web and mobile screens, visual design and hierarchy, typography and working with text, color theory, layouts, visual hierarchy, shapes/grids, UI components, accessibility, interaction design

**Unit 3 VUI and NLP-based UI** **[12 hrs.]**

Command and control vs Conversational UI, Personas, Avatars, Actors and Video games, speech recognition technology, Dialog management, disambiguation, sentiment, and emotion analysis

**Unit 4: UX design and evaluations** **[16 hrs.]**

Models and paradigms for interaction, interaction designs, Competitive analysis, briefing questionnaires, generating user personas, user interviews, affinity mapping, card sorting, paper-sketching, wireframing, prototyping: Low fidelity and high fidelity prototyping, Evaluation through expert analysis and user participation, iterative evaluation and evaluation paradigms, DECIDE evaluation framework

**Laboratory Works:** **[32 hrs.]**

Laboratory work should cover all the topics listed above, and small work should be carried out using the concepts learned in each unit and UI/UX design tools.

**Teaching Methods:**

The general teaching pedagogy includes class lectures, group discussions, case studies, guest lectures, research work, project work, assignments (theoretical and practical), and examinations (written and verbal), depending on the topics. The teaching faculty will determine the choice of teaching pedagogy according to the needs of the topics.

**References:**


Cabrera, J. (2017). *Modular design frameworks: A project-based guide for UI/UX designers*. Apress.

Galitz, W. O. (2017). *The essential guide to user interface design* (3rd ed.). Wiley Publishing.

Tidwell, J., Brewer, C., & Valencia, A. (2019). *Designing interfaces: Patterns for effective interaction design* (3rd ed.). O'Reilly Media.

Pearl, C. (2017). *Designing voice user interfaces: Principles of conversational experiences*. O'Reilly Media.

Wood, D. (2014). *Interface design: An introduction to visual communication in UI design*. Bloomsbury Publishing.