# CENTRAL UNIVERSITY OF PUNJAB BATHINDA


## SYLLABUS

## M. Tech Computer Science & Engineering

## Session - 2025-27


## Department of Computer Science & Technology

**Central University of Punjab, VPO-Ghudda, Bathinda, Punjab, India- 151401**

# Programme Educational Learning Outcomes

**PELO1:** To build a rich intellectual potential embedded with inter-disciplinary knowledge, human values and professional ethics among the youth, aspirant of becoming technologists, so that they contribute to society and create a niche for a successful career.
**PELO2:** To enable students to gain research and development competence to sustain in academia as well as industry.
**PELO3:** To Produce "Creators of Innovative Technology".

**Graduate Attributes:**

After the Completion of Graduate Program student will be able:

1. To demonstrate competence in engineering mathematics, engineering fundamentals, and specialized engineering knowledge appropriate to the program.
2. To acquire appropriate knowledge and skills to identify, formulate, analyze, and solve computer engineering problems in order to reach a substantiated conclusion.
3. To conduct investigations of problems by appropriate experiments, analysis and interpretation of data and synthesis of information in order to reach valid conclusions.
4. To design solutions for open-ended engineering problems for designing systems, components or processes that meet specified needs of the program.
5. To create, select, apply, adapt, and extend appropriate techniques, resources, and modern engineering tools for a range of engineering activities.
6. To work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.
7. To understand the role of engineers with professional and ethical responsibilities in the society for public interest.
8. To analyze social and environmental aspects of engineering activities.
9. To communicate complex engineering concepts within the profession and with society at large.
10. To appropriately incorporate economics and business practices including project, risk, and change management into the practice of engineering and to understand their limitations.
11. To identify and address their own educational needs in a changing world in ways sufficient to maintain their competence and advancements in future.
12. To apply professional ethics, accountability and equity.

**Program Outcomes**

After the completion of degree program student will be able:

1. To apply mathematical foundations, algorithmic principles, and computer science theory in the modelling and design of computer based systems.
2. To apply the engineering knowledge in all domains, viz., health care, banking and finance, other professions such as medical, law, etc.
3. To design and conduct experiments as well as to analyze and interpret data.
4. To analyze the problem, subdivide into smaller tasks with well-defined interface for interaction among components, and complete within the specified time frame and financial constraints.
5. To propose original ideas and solutions, culminating into a modern, easy to use tool, by a larger section of the society with longevity.

# Course Structure of M. Tech Computer Science & Technology

## SEMESTER-I

| Course Code | Course Title | Course Type | Credit Hours | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | Cr |
| CST-606 | Research Methodology and IPR | Core | 4 | 0 | 0 | **4** |
| CBS-513 | Mathematical and Statistical foundation of Computer science | Core | 4 | 0 | 0 | **4** |
| **Elective I (opt any one)** | | | | | | |
| CST-608 | Advance computer networks | Any one Discipline Elective | 4 | 0 | 0 | **4** |
| CST-509 | Wireless Sensor Networks | | | | | |
| CST-609 | Data science with R | | | | | |
| CST-510 | Compiler for HPC | | | | | |
| CBS 608 | Linux OS and Scripting | | | | | |
| **Elective II (opt any one)** | | | | | | |
| CST-511 | Distributed database system | Any one Discipline Elective/MOOC | 4 | 0 | 0 | **4** |
| CST-512 | Information security | | | | | |
| CST-513 | Software testing and maintenance | | | | | |
| CST-506 | Advanced data structures | Compulsory Foundation | 4 | 0 | 0 | **4** |
| XXX.YYY | Any IDC course offered by other department in University or from the list of MOOC courses approved by the department/University | IDC | 2 | 0 | 0 | **2** |
| CST.515 | Advanced data structures – Lab | Skill Development | 0 | 0 | 2 | **1** |
| **Elective Lab I (opt any one)** | | | | | | |
| CST.611 | Advance computer networks– Lab | Skill Development | 0 | 0 | 2 | **1** |
| CST.516 | Wireless Sensor Networks Lab | | | | | |
| CST.612 | Data science with R/Python – Lab | | | | | |
| CST.518 | Compiler for HPC– Lab | | | | | |
| CST.611 | Linux OS and Scripting-lab | | | | | |
| **Elective Lab II (opt any one)** | | Skill Development | 0 | 0 | 2 | **1** |
| CST.514 | Distributed database system– Lab | | | | | |
| CST.519 | Information security– Lab | | | | | |
| CST.520 | Software testing and maintenance – Lab | | | | | |
| **Total Credits** | | | **22** | **0** | **6** | **25** |

# List of IDC for other departments (Semester-I)

| Course Code | Course Title | Course Type | Credit Hours | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | Cr |
| CBS.518 | IT Fundamentals | Interdisciplinary courses offered by CST Faculty (For students of other Departments) | 2 | 0 | 0 | **2** |
| CBS.519 | Programming in C | | | | | |
| CST.530 | Introduction to Digital Logic | | | | | |
| CST.531 | Multimedia and its Applications | | | | | |
| CST.532 | Introduction to MatLab | | | | | |
| CST.607 | Basics of Python Programming | | | | | |
| **Total Credits** | | | **2** | **0** | **0** | **2** |

# Course Structure of M.Tech Computer Science & Technology

## SEMESTER- II

| Course Code | Course Title | Course Type | Credit Hours | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | Cr |
| CST.508 | Machine learning | Core | 4 | 0 | 0 | **4** |
| CST.522 | Soft computing | Core | 4 | 0 | 0 | **4** |
| **Elective III (opt any one)** | | | | | | |
| CST.523 | Computer vision | Any one Discipline Elective | 4 | 0 | 0 | **4** |
| CBS.523 | Secure software design | | | | | |
| CST.524 | Internet of Things | | | | | |
| CST. XXX | Affective Computing | | | | | |
| **Elective IV (opt any one)** | | | | | | |
| CST.525 | GPU computing | | 4 | 0 | 0 | 4 |
| CST.539 | Natural Language Processing | | | | | |
| CBS.525 | Secure coding | | | | | |
| CBS.623 | Network security | | | | | |
| CST.529 | Blockchain technology | | | | | |
| CBS.626 | Quantum computing and machine learning | | | | | |
| CBS.524 | Big data Analytics and visualization | Skill Development | 4 | 0 | 0 | 4 |
| XXX.YYY | Any VAC course offered by other department in University or from the list of MOOC courses approved by the department/University | Value aided either as Theory* or practical** | 2 | 0 | 0 | **2** |
| CST.527 | Soft computing– Lab | Skill Development | 0 | 0 | 2 | **1** |
| CST.517 | Machine learning lab | Skill development | **0** | **0** | **2** | **1** |
| **Elective Lab III (opt any one)** | | | | | | |
| CST.533 | Computer vision – Lab | Skill Development | 0 | 0 | 2 | **1** |
| CBS.539 | Secure software design– Lab | | | | | |
| CST.534 | Internet of Things – Lab | | | | | |
| CST.XXX | Affective Computing -Lab | | | | | |
| **Elective Lab IV (opt any one)** | | Skill Development | 0 | 0 | 2 | **1** |
| CST.625 | Network security – Lab | | | | | |
| CST.535 | GPU computing – Lab | | | | | |
| CST.626 | Natural Language Processing– Lab | | | | | |
| CST.536 | Blockchain technology – Lab | | | | | |
| CBS.538 | Quantum computing and machine learning – Lab | | | | | |
| CBS.534 | Big Data Analytics and Visualization lab | Skill development | 0 | 0 | 2 | 1 |
| **Total Credits** | | | **22** | **0** | **8** | **27** |

# List of Value Added Courses (Semester II)

| Course Code | Course Title | Course Type | Credit Hours | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | Cr |
| CST.504 | Basics of Machine Learning* | Value added Course | 2 | 0 | 0 | **2** |
| CBS.504 | Report Writing using LaTeX | Value added Course | 2 | 0 | 0 | **2** |
| CST.XXX | AI for Education | Value added Course | 2 | 0 | 0 | **2** |

*** For other departments only**

# Course Structure of M.Tech Computer Science & Technology

## SEMESTER- III

| Course Code | Course Title | Course Type | Credit Hours | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | Cr |
| CST.551 | Optimization techniques | Opt any one Discipline Elective/MOOC course list approved by the department | 3 | 0 | 2 | **4** |
| CST.631 | Intelligent Systems | | | | | |
| CST.554 | Mobile application and services | | | | | |
| CST. 632 | Deep Learning | | | | | |
| CST.556 | Cost management of engineering projects | Opt any one Discipline Elective/MOOC course list approved by the department | 4 | 0 | 0 | **4** |
| CST.553 | Cyber law | | | | | |
| CST.557 | Software metrics | | | | | |
| CST.633 | Ethics in Data Science | | | | | |
| CST.600 | *Dissertation part -I | Core | 0 | 0 | 20 | **10** |
| **Total Credits** | | | **8** | **0** | **22** | **19** |

*Students will have an option to go for an Industrial Project. Students going for Industrial Project will complete the theory courses of the semester through MOOCs/Swayam/NPTEL Portal

**L: Lectures T: Tutorial P: Practical Cr: Credits**

# Course Structure of M. Tech Computer Science & Technology

## SEMESTER-IV

| Course Code | Course Title | Course Type | Credit Hours | | | |
|---|---|---|---|---|---|---|
| | | | L | T | P | Cr |
| CST.600 | Dissertation Part-II | Core | 0 | 0 | 32 | **16** |
| **Total Credits** | | | **0** | **0** | **32** | **16** |

**Mode of Transaction:** Lecture, Laboratory based Practical, Seminar, Group discussion, Team teaching, Self-learning.

## Evaluation Criteria for Theory Courses/or as per University Pattern

A. Continuous Assessment/Internal Assessment: [25 Marks]
B. Mid Semester Test-1: Based on Subjective Type Test [25 Marks]
C. End Semester Test: Based on Subjective Type Test (70%) and Objective (30%) [50 Marks]

*Every student has to take up one ID courses of 02 credits from other disciplines in semester I of the program and Value Added Course of 2 credits in Semester II.

## SEMESTER – I

**Course Code: CST.606**
**Course Title: Research Methodology and IPR**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To develop a research orientation among the students and help them understand fundamentals of research methods. The course will help the students to identify various sources of information for literature review, data collection and effective paper/ dissertation writing. Familiarize students with the concept of patents and copyright

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Explain effective methods to formulate a research problem.
**CLO2:** Analyze research related information and follow research ethics.
**CLO3:** Apply intellectual property law principles (including copyright, patents, designs and trademarks) to practical problems and be able to analyse the social impact of IPR.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**14 Hours** | Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations. | **CLO1** |
| | **Learning Activities**: Assignment based learning | |
| **II**<br>**15 Hours** | Effective literature studies approaches, analysis Plagiarism, Research ethics,<br>Effective technical writing, how to write report, Paper<br>Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee. | **CLO2** |
| | **Learning Activities**: Analysis of various tools and Case Studies | |
| **III**<br>**14 Hours** | Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.<br>International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. | **CLO3** |
| | **Learning Activities**: Case Studies | |

| | | |
|---|---|---|
| **IV**<br>**16 Hours** | Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.<br>New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software, Integrated Circuits, etc. | **CLO4** |
| | **Learning Activities**: Group discussion | |

**Transactional Modes:**

- Lecture
- Case Studies
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Melville, S., and Goddard, W. (1996). Research methodology: An introduction for science & engineering students. South Africa: Juta Academic.
2. Goddard, W., and Melville, S. (2001). Research Methodology: An Introduction. South Africa: Juta Academic.
3. Kumar, R. (2019). Research Methodology: A Step by Step Guide for beginners. New Delhi: SAGE Publications Ltd.
4. Halbert, (2006). Resisting Intellectual Property. New Delhi: Taylor & Francis Ltd.
5. Mayall, (2011). Industrial Design. New Delhi: McGraw Hill.
6. Niebel, (1974). Product Design. New Delhi: McGraw Hill.
7. Asimov, M. (1976). Introduction to Design. United States: Prentice Hall.
8. Merges, R. P., Menell, P. S., & Lemley, M. A. (2003). Intellectual Property in New Technological Age. United States: Aspen Law & Business.
9. Flick, U. (2011). Introducing research methodology: A beginner's guide to doing a research project. New Delhi: Sage Publications India.
10. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CBS.513**
**Course Title: Mathematical and Statistical Foundation of Computer Science**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To make students understand the mathematical fundamentals that is prerequisites for a variety of courses like Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Bioinformatics, Machine learning. To develop the understanding of the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Describe the basic notions of discrete and continuous probability.
**CLO2:** Explain the methods of statistical inference, and the role that sampling distributions play in those methods.
**CLO3:** Employ correct and meaningful statistical analyses of simple to moderate complexity problems.
**CLO4:** Categorize the domain specific mathematical models for different analysis.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | **Fundamentals of Probability and Distributions:**<br>Probability Mass and Density Functions<br>Cumulative Distribution Functions (CDF)<br>Common Probability Distributions: Binomial, Poisson, and Normal, Expected Value, Variance, and Probabilistic Inequalities<br>Kurtosis and Skewness | **CLO1, CLO2** |
| | **Activities:** Exercise-based learning with practical examples. | |
| **II**<br>**15 Hours** | **Sampling Distributions, Point Estimation, and Statistical Inference**<br><br>Unbiased Estimators, Variance of Estimators, and Standard Error, Methods of Point Estimation: Method of Moments, Method of Maximum Likelihood, Bayesian Estimation, Tests on the Mean of Single and Two Sample Normal Distributions (Known and Unknown Variance), Non-parametric Tests for Difference in Two Means. | **CLO2, CLO3** |
| | **Activities:** Analysis of live data from dataworld.org/Kaggle.com.Application of statistical methods to sample data. | |

| | | |
|---|---|---|
| **III**<br>**15 Hours** | **Statistical Methods and Graph Theory**<br><br>Basic Statistics: Measures of Central Tendency (Mean, Median, Mode) and Dispersion (Variance, Standard Deviation, Standard Error), Parametric vs Non-parametric Statistics, One-Way and Two-Way Analysis of Variance (ANOVA), Introduction to Fuzzy Set Theory, Graph Theory: Isomorphism, Planar Graphs, Graph Coloring, Hamilton Circuits, Euler Cycles | **CLO3, CLO4** |
| | **Activities:** Simulation based learning from web resources, Statistical analysis of real-world datasets (e.g., Kaggle) and graph theory exercises. | |
| **IV**<br>**15 Hours** | **R Programming and Applications in Computer Science**<br><br>Introduction to R Programming, Functions, Control Flow, and Loops, Working with Vectors, Matrices, and Data Files, Statistical and Mathematical Operations in R, Applications in Data Mining, Machine Learning, Computer Security, Software Engineering, and Bioinformatics, Recent Trends in Mathematical Models and Distribution Functions in Computer Science (e.g., Soft Computing, Computer Vision) | **CLO4** |
| | **Activities:** Hands-on exercises using R for statistical analysis and problem-solving in computer science domains. | |

**Transactional Modes:**

- Lecture
- Blended Learning
- Collaborative Learning
- Peer Learning/Teaching
- Online Teaching Tools

**Suggested Readings:**


1. Vince, J. (2015). Foundation Mathematics for Computer Science. New York: Springer International Publishing.
2. Trivedi, K. S. (2008). Probability and Statistics with Reliability, Queuing, and Computer Science Applications. United states: Wiley.
3. Mitzenmacher, M., & Upfal, E. (2017). Probability and Computing: Randomized Algorithms and Probabilistic Analysis. New Delhi: Cambridge University Press.
4. Tucker, A. (2016). Applied Combinatorics, United State: Wiley.

Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.608**
**Course Title: Advance computer networks**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
This module aims provides in depth knowledge of the layered communication architecture, routing algorithms, congestion control algorithms in the computer network field. Additionally, it provides a broad coverage of some new advanced topics in the field of computer networks (wireless networks, mobile networks, VPN networks, Mobile IP, etc.) so that students should be able to provide the necessary understanding of the subject.

**Course Learning Outcomes:**
After completion of course, students would be able:
**CLO1:** To describe various types of data structures and list their strengths and weaknesses.
**CLO2:** To classify non-randomized and randomized algorithms.
**CLO3:** To use data structures for various applications.
**CLO4**: To summarize suitable data structure for computational geometry problems.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | Network layer and protocol<br>Network Management: What Is Network Management? The Infrastructure for Network Management, The Internet-Standard Management Framework, IP Addressing: Address Space, Notations, Classfull addressing, Classless addressing, Network Address Translation (NAT). Internet Protocol (IP): Datagram Format, Fragmentation, Options. ICMPv4: Messages, Debugging Tools, ICMP Checksum. Mobile IP: Addressing, Agents, Three Phases, Inefficiency in Mobile IP. Virtual Private Network: VPN Technology. | **CLO1, CLO2** |
| | **Activities: Exercise-based learning with practical examples.** | |
| **II**<br>**15 Hours** | Data forwarding and Routing<br>Introduction, Forwarding and Routing, Network Service Models, Virtual Circuit and Datagram Networks, Virtual-Circuit Networks, Datagram Networks, Origins of VC and Datagram Networks, What's Inside a Router?, Input Processing, Switching , Output Processing, Where Does Queuing Occur?, The Routing Control Plane, The Internet Protocol (IP): Forwarding and Addressing in the Internet, Datagram Format, IPv4, Addressing, Internet Control Message Protocol (ICMP), IPv6, A Brief Foray into IP Security, Routing Algorithms: The Link-State (LS) Routing Algorithm, The Distance-Vector (DV) Routing Algorithm, Hierarchical Routing, Routing in the Internet: Intra-AS Routing in the Internet: RIP, Intra-AS Routing in the Internet: OSPF, Inter-AS | **CLO2, CLO3** |

| | | |
|---|---|---|
| | Routing: BGP, Broadcast and Multicast Routing: Broadcast Routing Algorithms.<br>**Activities:** Assignment based learning | |
| **III**<br>**15 Hours** | Unicast and Multicast routing protocols<br>Inter domain and intra domain routing, routing algorithms: Distance vector routing, Bellman-ford algorithm, link state routing, path vector routing. Unicast routing protocols: internet structure, routing information protocol (RIP), open shortest path first (OSPF), border gateway protocol version 4 (BGP4). Introduction to unicast, multicast and broadcast. Intra domain multicast protocols: multicast distance vector (DVMRP), multicast link state (MOSPF), protocol independent multicast (PIM).<br>**Activities:** Simulation based learning from web resources. | **CLO3, CLO4** |
| **IV**<br>**15 Hours** | Transport and application layer protocol<br>Introduction and Transport-Layer Services, Relationship Between Transport and Network Layers, Overview of the Transport Layer in the Internet, Multiplexing and Demultiplexing, Connectionless Transport: UDP, UDP Segment Structure, UDP Checksum, Principles of Reliable Data Transfer, Building a Reliable Data Transfer Protocol, Pipelined Reliable Data Transfer Protocols, Go-Back-N (GBN), Selective Repeat (SR), Connection-Oriented Transport: TCP, The TCP Connection, TCP Segment Structure, RoundTrip Time Estimation and Timeout, Reliable Data Transfer, Flow Control, TCP Connection Management, Principles of Congestion Control, The Causes and the Costs of Congestion, Approaches to Congestion Control, Network-Assisted Congestion-Control Example: ATM ABR Congestion Control, TCP Congestion Control.<br>**Activities:** Hands-on exercises | **CLO4** |

**Transactional Modes:**

- Lecture
- Blended Learning
- Collaborative Learning
- Peer Learning/Teaching

**Suggested Readings:**


1. Data Communication and Networking 5E Forouzan Behrouz A. McGraw Hill Education (India), New Delhi, 2005, ISBN-13:978-1-25-906475-3
2. Internetworking with TCP/IP, Volume I, Fourth Edition. Comer Douglas E, Prentice Flail of India Private Limited, New Delhi, 2014 ISBN-81-203-2065-4
3. Computer Networks, Fourth Edition Tanenbaum Andrew S. PHI Learning, New Delhi- 2014 ISBN-81 -203 -2175-8
4. Advanced Computer Network B.M. Harwani and DT Editorial Services Dreamtech New Delhi- 2014 ISBN 978-93-5004-013-3
5. Computer Networks Principles, Technologies And Protocols For Network Design Natalia Olifer, Victor Olifer Wiley ISBN

**Code: CST.509**
**Course Title: Wireless Sensors Networks**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
The Outcome of this course is to introduce students to the concepts of wireless sensor networks. That will help them to explain various MAC and routing protocols. The course will conclude with discussion on the security for possible attacks.

**Course Learning Outcomes:**
After completion of course, students would be able to:
CLO1: Describe and discuss various MAC and routing protocols.
CLO2: Employ and compare various MAC and routing protocols.
CLO3: Design wireless sensor networks in simulator.
CLO4: Evaluate the performance of various protocols using simulator.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**16 Hours** | Introduction to Wireless Sensor Networks: Course Information, Introduction to Wireless Sensor Networks: Motivations, Applications, Performance metrics, History and Design factors.<br>Network Architecture: Traditional layered stack, Cross-layer designs, Sensor Network Architecture. | **CLO3** |
| | **Learning Activities**: | |
| **II**<br>**14 Hours** | Medium Access Control Protocol design: Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled.<br>Introduction to Markov Chain: Discrete time Markov Chain definition, properties, classification and analysis.<br>MAC Protocol Analysis: Asynchronous duty-cycled. X-MAC Analysis (Markov Chain). | **CLO1**<br>**CLO2** |
| | **Learning Activities**: | |
| **III**<br>**13 Hours** | Routing protocols for WSN: Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast<br>Opportunistic Routing Analysis: Analysis of opportunistic routing (Markov Chain). | **CLO3**<br>**CLO4** |
| | **Learning Activities**: | |
| **IV**<br>**17 Hours** | Security: Possible attacks, countermeasures, SPINS, Static and dynamic key Distribution.<br>Introduction to Network Simulations: Introduction to Network Simulator, Description of the module and simulation example.<br>Advanced Topics: Recent development in WSN standards, software applications. | |
| | **Learning Activities**: | |

**Transactional Modes:**

- Lecture cum Demonstration
- Collaborative Learning
- E-tutorial
- Experimentation
- Online Teaching Tools

**Suggested Readings:**


1. Dargie, W., and Poellabauer, C. (2010). Fundamentals of Wireless Sensor Networks – Theory and Practice. United States: Wiley.
2. Sohraby, K., Minoli, D., and TaiebZnati. (2010). Wireless sensor networks –Technology: Protocols and Applications. United States: Wiley.
3. Hara, T., Vladimir, I.Z., and Buchmann, E., (2010). Wireless Sensor Network Technologies for the Information Explosion Era. New York: Springer.
4. Murthy, C.S. R. and Manoj B.S. (2004). Ad-hoc Wireless Networks Architectures and protocols. New Delhi: Pearson Education.
5. Obaidat M.S. and Misra, S. (2014). Principles of Wireless Sensor Networks. New Delhi: Cambridge University Press.
6. Misra, S., Woungang, I. and Misra S. C. (2009). Guide to Wireless Sensor Networks: Computer Communications and Networks Series. London: Springer.
7. He, J., Shouling, J., Pan, Y., and Yingshu, L. (2014). Wireless Adhoc and sensor networks. London: CRC press Taylor & Francis group.
8. Hu, F., Xiaojun, C. (2010). Wireless sensor networks. London: CRC press.
9. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.609**
**Course Title: Data Science with R**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
This course will introduce students to the collection. Preparation, analysis, modeling and visualization of data, covering both conceptual and practical issues. Examples and case studies from diverse fields will be presented, and hands-on use of statistical and data manipulation software will be included.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Develop and appreciate various techniques for data modeling and mining.
**CLO2:** Able to use basic R data structures in loading, cleaning the data and preprocessing the data.
**CLO3:** Able to do the exploratory data analysis on real time datasets.
**CLO4:** Able to explore and implement Linear Regression.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | Introduction to R, Features of R, Basics of R,Assignment, Modes, Operators, Special numbers, Logical values , Basic Functions, R Data<br>Data Structures, Control Structures. Vectors: Definition, Declaration, Generating Indexing,<br>Naming , Adding & Removing elements , Operations on Vectors , Recycling , Special<br>Operators , Vectorized if, then else,Vector Equality – Functions for vectors , Missing values ,<br>NULL values , Filtering & Subsetting. | **CLO1** |
| | **Learning Activities**: Implementation and solution of real time problem | |
| **II**<br>**15 Hours** | Matrices , Creating Matrices , Adding or Removing rows/columns , Reshaping , Operations Special functions on Matrices. Lists , Creating List, General List Operations , Special Functions , Recursive Lists. Data Frames , Creating Data Frames, Naming, Accessing, Adding, Removing, Applying Special functions to Data Frames, Merging Data Frames,<br>Factors and Tables. | **CLO2** |
| | **Learning Activities**: Assignment based Learning of real time problem | |

| | | |
|---|---|---|
| **III**<br>**15 Hours** | Input / Output – Reading and Writing datasets in various formats, Functions , Creating User defined functions , Functions on Function Object , Scope of Variables , Accessing Global, Environment, Closures, Recursion. Exploratory Data Analysis, Data Pre-processing, Descriptive Statistics, Central Tendency, Variability, Mean, Median, Range, Variance, Handling Missing values and Outliers, Normalization | **CLO3** |
| | **Learning Activities**: Analysis of real world data from kaggle.com/dataworld.org website | |
| **IV**<br>**15 Hours** | Inferential Statistics with R , Types of Learning , Linear Regression, Simple Linear Regression , Implementation in R , functions on lm() , predict() , plotting and fitting regression line. Multiple Linear Regression , Introduction ,comparison with simple linear regression , Correlation Matrix , F-Statistic , Target variables Vs Predictors , Identification of significant features , Implementation of Multiple Linear Regression in R. | **CLO4** |
| | **Learning Activities**: Statistical Modelling of various problems with R | |

**Transactional Modes:**

- Lecture cum Demonstration
- Programme Learning
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Nina Zumel, John Mount, “Practical Data Science with R”, Manning Publications, 2014. 2.Jure Leskovec, Anand Rajaraman, Jeffrey D.Ullman,
   “Mining of Massive Datasets”, Cambridge University Press, 2020.
2. Mark Gardener, “Beginning R - The Statistical Programming Language”, John Wiley & Sons, Inc., 2020.
3. W. N. Venables, D. M. Smith and the R Core Team, “An Introduction to R”, 2013.
4. Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, Abhijit Dasgupta, “Practical Data Science Cookbook”, Packt Publishing Ltd., 2014.
5. Nathan Yau, “Visualize This: The Flowing Data Guide to Design, Visualization, and Statistics”, Wiley, 2018.

**Course Code: CST.510**
**Course Title: Compiler for HPC**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**

To introduce the structure of compilers and high performance compiler design for students. Concepts of cache coherence and parallel loops in compilers are included.

**Course Learning Outcomes:**

After completion of course, students would be able to:

**CLO1:** Describe compiler structure.

**CLO2:** Discuss regarding parallel loops, data dependency and exception handling and debugging in compiler.

**CLO3:** Outline scalar, array region and concurrency analysis.

**CLO4:** Categorize and compare message passing machines

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | High Performance Systems, Structure of a Compiler, Programming Language Features, Languages for High Performance.<br>Data Dependence: Data Dependence in Loops, Data Dependence in Conditionals, Data Dependence in Parallel Loops, Program Dependence Graph.<br>Scalar Analysis with Factored Use-Def Chains: Constructing Factored Use-Def Chains, FUD Chains for Arrays, Induction Variables Using FUD Chains, Constant Propagation with FUD Chains, Data Dependence for Scalars. Data Dependence Analysis for Arrays. | **CLO1** |
| | **Learning Activities**: High performance Matrix Multiplication example , Discussion of various high performance computing systems | |
| **II**<br>**15 Hours** | Array Region Analysis, Pointer Analysis, I/O Dependence, Procedure Calls, Inter-procedural Analysis.<br>Loop Restructuring: Simple Transformations, Loop Fusion, Loop Fission, Loop Reversal, Loop Interchanging, Loop Skewing, Linear Loop. Transformations, Strip-Mining, Loop Tiling, Other Loop Transformations, and Inter-Procedural Transformations.<br>Optimizing for Locality: Single Reference to Each Array, Multiple References, General Tiling, Fission and Fusion for Locality. | **CLO2** |
| | **Learning Activities**: Performing transformations such loop reversal, loop interchanging on Simple programs such as matrix multiplication | |

| | | |
|---|---|---|
| **III**<br>**15 Hours** | Concurrency Analysis: Concurrency from Sequential Loops, Concurrency from Parallel Loops, Nested Loops, Round off Error, Exceptions and Debuggers.<br>Vector Analysis: Vector Code, Vector Code from Sequential Loops, Vector Code from for all Loops, Nested Loops, Round off Error, Exceptions, and Debuggers, Multi-vector Computers. | **CLO3** |
| | **Learning Activities**: Group discussion and presentation by the students | |
| **IV**<br>**15 Hours** | Message-Passing Machines: SIMD Machines, MIMD Machines, Data Layout, Parallel Code for Array Assignment, Remote Data Access, Automatic Data Layout, Multiple Array Assignments, Other Topics.<br>Scalable Shared-Memory Machines: Global Cache Coherence, Local Cache Coherence, Latency Tolerant Machines.<br>Recent trends in compiler design for high performance computing and message passing machines and scalable shared memory machine. | **CLO4** |
| | **Learning Activities**: Group Discussion of Survey papers on SIMD, MIMD architectures | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Wolfe, M. (1995). High-Performance Compilers for Parallel Computing. New Delhi: Pearson Education.
2. Muchnick, S. (1997). Advanced Compiler Design and Implementation. Elsevier.
3. Allen. (2001). Optimizing Compilers for Modern Architectures. California: Morgan Kaufmann.
4. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CBS. 608**
**Course Title: Linux OS and Scripting**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
Familiarize students with the Linux environment, and able to run commands on a standard Linux operating system. Provide the skills needed to develop and customize Linux shell programs and to make effective use of a wide range of standard Linux programming and development tools. Develop the skills necessary for system programming and inter and intra process communication programming.

**Course Learning Outcomes:**
**CLO1:** Understand effective use of linux utilities
**CLO2:** Describe the basics of shell scripting language.
**CLO3:** Apply the concepts of control structure, loops, case and functions in shell programming.
**CLO4:** Design the Real Life Scripting

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **1**<br>**16 Hours** | **Linux basics**: Creating First Virtual Machine, Linux Installation, basics of linux, basic commands, variables, aliases, advanced commands, using help/wildcards, soft/hard links, backup/restore using tar, mounting/unmounting, stdin/stdout/stderr.<br>**Activities:** Assignments and Group Discussion. | **CLO1** |
| **II**<br>**14 Hours** | **Shell Scripting Basics:** Shell Scripting Basics, Kernel, Shell, Shell Scripting, Types of Shells, starting a Shell, Run a Shell Script.<br>**Scripting Standards:** Scripting Standards, Scripts Naming Convention, Script File Permissions, Shell Script Format, Sequence of Script Execution.<br>**Activities:** Brainstorming, assignment-based learning | **CLO2** |
| **III**<br>**14Hours** | **Shell Scripting:** First Script - Hello World, Run Basic Tasks - Script, Run Basic Administration Tasks, Defining Variables, Input/Output Script, Conditions/If Else Statements Scripts, Case Statements Script, For-Loop Script, do-while Scripts.<br>**Activities:** Hands on experience and Brainstorming. | **CLO3** |
| **IV**<br>**16 Hours** | **Real Life Scripting**: Real Life Scripting, Accessing Data from a File, Check Remote Servers' Connectivity, Script to Delete Old Files, Copy Files to Remote Hosts,<br>User Directory Assignment, Exploitation scripting:<br>Building exploits with Python, Creating Metasploit Exploits.<br>**Activities:** Hands on experience and Brainstorming. | **CLO4** |

**Transactional Modes:**

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

**Suggested Readings:**


1. Naik, G. S. (2018). *Learning Linux Shell Scripting: Leverage the power of shell scripts to solve real-world problems, 2nd Edition*. Packt Publishing Ltd.
2. Robbins, A., Beebe, N. H. F. (2005). Classic Shell Scripting: Hidden Commands that Unlock the Power of Unix. Germany: O'Reilly Media, Incorporated.
3. Shotts, W. (2012). The Linux command line: a complete introduction. In *No Starch Press eBooks*. http://ci.nii.ac.jp/ncid/BB11395808
4. Cannon, J. (2015). *Shell Scripting: How to Automate Command Line Tasks Using Bash Scripting and Shell Programming*. CreateSpace.

**Code: CST. 511**
**Course Title: Distributed Database System**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To introduce the fundamental concepts and issues of managing large volume of shared data in a parallel and distributed environment. Provide insight into related research problems.

**Course Learning Outcomes:**
After completion of course, students would be able to:
CLO1: Explain trends in distributed systems.
CLO2: Demonstrate distributed query optimization.
CLO3: Examine distributed system design and query processing issues.
CLO4: Categorize and assess reliability issues in distributed systems.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | Introduction: Distributed data processing; what is a DDBS; Advantages and disadvantages of DDBS; Problem areas; Overview of database and computer network concepts.<br>Distributed Database Management System Architecture: Transparencies in a distributed DBMS; Distributed DBMS architecture; Global directory issues. | **CLO1** |
| | **Learning Activities**: Example based study of Distributed Database Systems | |
| **II**<br>**15 Hours** | Distributed Database Design: Alternative design strategies; Distributed design issues; Fragmentation; Data allocation.<br>Semantics Data Control: View management; Data security; Semantic Integrity Control.<br>Query Processing Issues: Objectives of query processing; Characterization of query processors; Layers of query processing; Query decomposition; Localization of distributed data. | **CLO3** |
| | **Learning Activities**: Discussion of Distributed Database Design using Case Studies from good journal papers. | |
| **III**<br>**15 Hours** | Distributed Query Optimization: Factors governing query optimization; Centralized query optimization; ordering of fragment queries; Distributed query optimization algorithms.<br>Transaction Management: The transaction concept; Goals of transaction management; Characteristics of transactions; Taxonomy of transaction models.<br>Concurrency Control: Concurrency control in centralized database systems; Concurrency control in DDBSs; Distributed concurrency control algorithms; Deadlock management. | **CLO2** |

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|---|---|---|
| | **Learning Activities**: Discussion of Survey papers on Concurrency control techniques (optimistic vs pessimistic) in centralized database systems and Distributed systems, Example based study of query optimisation techniques | |
| **IV**<br>**15 Hours** | Reliability: Reliability issues in DDBSs; Types of failures; Reliability techniques; Commit Protocols; Recovery protocols.<br>Parallel Database Systems: Parallel architectures; parallel query processing and optimization; load balancing.<br>Introduction to cloud computing, Advanced Topics: Mobile Databases, Distributed Object Management, Multi-databases. | **CLO4** |
| | **Learning Activities**: PowerPoint presentations by students | |

**Transactional Modes:**

- Lecture cum Demonstration
- Case study
- E-tutorial
- Collaborative Learning
- Online Teaching Tools

**Suggested Readings:**


1. Ozsu, M.T., and Valduriez, P. (2011). Principles of Distributed Database Systems, United States: Prentice-Hall.
2. Bell D., and Grimson, J., (1992). Distributed Database Systems. United States: Addison-Wesley.
3. Deshpande, S., (2014). Distributed Databases. New Delhi: Dreamtech Press.
4. Saeed, K. R., Frank, S. H. (2010). Distributed Database Management Systems: A Practical Approach. New Delhi: Wiley.
5. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.512**
**Course Title: Information Security**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To introduce students to the concept of security, and types of attack. Help students to understand Symmetric & Asymmetric Key Cryptography. The course will also give exposure on Internet Security Protocol.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Explain the information system, and need, trends, services and techniques of security.
**CLO2:** Describe the Mathematics of Cryptography and Classical Cryptographic Algorithms.
**CLO3:** Discuss the various Symmetric & Asymmetric Key Cryptography algorithms with key distribution techniques.
**CLO4:** Learn the various Hash function algorithms.
**CLO5:** Compare the various internet security protocols

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | History of Information Systems: Importance of Information Systems, Basics of Information Systems, Changing Nature of Information Systems, Global Information Systems. Introduction to Security: Need for security, Security Trends, Security Attacks, Security Services, and Security Mechanisms. Security techniques. | **CLO1** |
| | **Learning Activities:** Group Discussion, Case study based learning of different information system and cybercrimes. | |
| **II**<br>**15 Hours** | Mathematics of Cryptography- Prime and Composite Numbers, Greatest Common Divisor, Euclidean algorithm, Modulo arithmetic, Fermat's little theorem, Multiplicative Inverse, Euler's theorem and Totient function, Discrete logarithm. Classical Cryptographic Algorithms: Substitutions techniques- Monoalphabetic ciphers, Polyalphabetic Ciphers, Transposition Techniques, Rotor Machines, Cryptanalysis of classical cryptographic algorithms. | **CLO2** |
| | **Learning Activities:** Assignment based and numerical exercise based learning, Implementation of various cryptographic algorithms using computer programming. | |

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|---|---|---|
| **III**<br>**15 Hours** | Key Management: Symmetric-Key Distribution, Public-Key Distribution.<br>Morden symmetric key Cryptographic Algorithms: Data Encryption Standard (DES), Triple DES, IDEA, Advance Encryption Algorithm (AES).<br>Asymmetric key Cryptographic Algorithms: - Public-Key Cryptography Principles, Diffie–Hellman key exchange algorithm, Knapsack algorithm, RSA.<br>Message Integrity and Message Authentication: Message Integrity, Approaches to Message Authentication, MD5, SHA-512, Digital Signature: Basics and Digital Signature Scheme. | **CLO3, CLO4** |
| | **Learning Activities:** Implementation and web based simulation of various cryptographic algorithms. | |
| **IV**<br>**15 Hours** | Internet Security Protocols: Introduction, Basic Concepts, Secure Electronic Transaction, 3-D Secure Protocol, Secure Socket Layer (SSL), Transport Layer Security (TLS), Wireless Application Protocol (WAP) Security. | **CLO5** |
| | **Learning Activities:** Brainstorming, assignment based learning | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Kahate, A. (2011). *Cryptography and Network Security*. New Delhi: tata McGraw-Hill Higher Ed.
2. Forouzan, B. A. (2010). Cryptography & Network Security. New Delhi: Tata McGraw-Hill Education.
3. Stallings, W. (2022). *Cryptography and Network Security: Principles and Practice, Global Edition*. Pearson Higher Ed.
4. Nielson, S. J., & Monson, C. K. (2019). *Practical Cryptography in Python: Learning Correct Cryptography by Example*. Apress.
5. Stallings, W. (2014). *Cryptography and Network Security: Principles and Practice, International Edition: Principles and Practice*. Pearson Higher Ed.
6. Kim, D., & Solomon, M. G. (2016). *Fundamentals of Information Systems Security*. Jones & Bartlett
7. Stallings, W. (2017b). *Network Security Essentials: Applications and Standards*.

**Course Code: CST.513**
**Course Title: Software Testing & Maintenance**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To enable a clear understanding and knowledge of the foundations, techniques, and tools in the area of software testing and its practice in the industry. To identify the software testing process for software quality checking. The help students design metrics models for predicting software testing and maintenance requirements.

**Course Learning Outcomes:**
After completion of course, students would be able to:
CLO1: Apply software testing knowledge, verification & validation and engineering methods.
CLO2: Design and conduct a software test process for a quality software test.
CLO3: Identify various software testing problems, and solve these problems by designing and selecting software metrics models, testing criteria, strategies, and methods.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**14 Hours** | Overview of Software Engineering: Phases in development of Software, Software Engineering Ethics, Life cycle Revisited (Incremental Development, Agile Methods, RAD), Model-Driven Architecture, Software Product Line, Process Modelling**.**<br>Project Management: Project Planning, Project Control (Work Break Down Structure, GANTT Charts, PERT Charts) Project Team Organization, Risk Management, CMM. | **CLO1** |
| | **Learning Activities**: Assignment base learning and Group Discussion | |
| **II**<br>**15 Hours** | Testing of OO systems: Objects and Classes, OO Testing, Class Testing, Regression Testing, Non-Functional Testing, Acceptance Testing, Mutation Testing.<br>Software Testing: Levels of testing, Module, Integration, System, Regression, Testing techniques and their Applicability, Functional testing and Analysis Structural testing and Analysis, Error Oriented testing and Analysis, Hybrid Approaches, Integration Strategies, Transaction Flow Analysis, Stress Analysis, Failure Analysis, Concurrency Analysis. | **CLO1**<br>**CLO2** |
| | **Learning Activities**: Case study of various organisation projects | |

| | | |
|---|---|---|
| **III**<br>**15 Hours** | Overview of Software Metrics: Measurement in Software Engineering, Scope of Software Metrics, Measurement and Models Meaningfulness in measurement, Measurement quality, Measurement process, Scale, Measurement validation, Object-oriented measurements.<br>Measuring Internal External Product Attributes: Measuring size, aspects of software size, length, functionality and complexity, measuring structure, types of structural measures, Modeling software quality, measuring aspects of software quality, software reliability, basics of software reliability. | **CLO2** |
| | **Learning Activities**: Case study of various organisation projects | |
| **IV**<br>**16 Hours** | Software Maintenance: Maintenance Categories, Major causes of Maintenance Problems, Reverse Engineering, Software Evolutions, Organizational and Managerial Issues of Maintenance activities, Maintenance Measurements Software Refactoring: Principles of Refactoring, Bad Smells in code, Composing Methods of Refactoring, Moving features between objects. | **CLO3** |
| | **Learning Activities**: Statistical Modelling of maintenance and Refactoring | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Pressman, R. S. (2017). Software Engineering a Practitioners Approach. New Delhi: McGraw Hill Education India Private Limited.
2. Peters, J. S., and Pedrycz, W. (2007). Software engineering an engineering approach. New Delhi: Wiley India.
3. Basu A. (2015). Software Quality Assurance, Testing and Metrics. New Delhi: PHI India.
4. Vliet, H.V. (2008). Software Engineering Principles and Practice. United States: John Wiley & Sons.
5. Ghezzi, C., Jazayeri, M., and Mandriolo, D. (2012). Fundamental of Software Engineering, New Delhi: PHI Private limited.
6. Mall, R. (2011). Fundamentals of Software Engineering. New Delhi: PHI learning.
7. Singh, Y., Aggarwal, K.K. (2014). Software engineering, New Delhi: New age international publishers.
8. Sommerville, I. (2014). Software engineering. New Delhi: Pearson education.
9. Research Articles from SCI & Scopus indexed Journals

**Course Code: CST.506**
**Course Title: Advanced Data Structures**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
The objective of this course is to provide the in-depth knowledge of different advance data structures. Students should be able to understand the necessary mathematical abstraction to solve problems. To familiarize students with advanced paradigms and data structure used to solve algorithmic problems.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Describe various types of Advance data structures and list their strengths and weaknesses.
**CLO2:** Classify non-randomized and randomized data structures.
**CLO3:** Design and analyse algorithms using appropriate data structures for real-world problems, i.e., pattern matching and security.
**CLO4:** Summarize suitable data structure for computational geometry problems.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **Unit-I 15 Hours** | **Introduction to Basic Data Structures**: Importance and need of suitable data structures and algorithms.<br><br>Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries.<br><br>Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, and Extendible Hashing. | **CLO 1** |
| | **Learning Activities**: Web based simulation | |
| **Unit-II 15 Hours** | **Skip Lists:** Need for Randomizing Data Structures and Algorithms, Search and Update Operations on Skip Lists, Probabilistic Analysis of Skip Lists, Deterministic Skip Lists.<br><br>Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, Splay Trees.<br><br>Binary Heaps, Fibonacci heaps, Data Structures for Disjoint Sets. | **CLO 2** |
| | **Learning Activities**: Visual Modelling of data structure | |
| | | **CLO 3** |

| | | |
|---|---|---|
| **Unit-III**<br>**15 Hours** | String Operations, Brute-Force Pattern Matching, The Boyer-Moore Algorithm, The Knuth-Morris-Pratt Algorithm, Standard Tries, Compressed Tries, Suffix Tries, The Huffman Coding Algorithm, The Longest Common Subsequence Problem (LCS).<br><br>Non-linear Data structure: Graph, Dynamic graph, Graph travels. | |
| | **Learning Activities**: Web based Training via simulation modelling | |
| **Unit-IV**<br>**16 Hours** | Computational Geometry: One-Dimensional Range Searching, Two-Dimensional Range Searching, constructing a Priority Search Tree, Searching a Priority Search Tree, Priority Range Trees, Quadtrees, k-D Trees.<br><br>One or more of the following topics are based on time and Recent Interest Trends in Hashing, Trees, and various computational geometry methods for efficiently solving the new evolving problem. | **CLO 4** |
| | **Learning Activities**: Implementation and solution of algorithms, case study of recent trends in algorithms. | |

**Transactional Modes:**

- Lecture
- Blended Learning
- Collaborative Learning
- Peer Learning/Teaching
- Online Teaching Tools

**Suggested Readings:**


1. Cormen, T.H., Leiserson, C. E., Rivest, R.L., and Stein, C. (2022). Introduction to Algorithms. New Delhi: PHI Learning Private Limited.
2. Sridhar, S. (2014). Design and Analysis of Algorithms. New Delhi: Oxford University Press India.
3. Allen Weiss M. (2014). Data Structures and Algorithm Analysis in C++. New Delhi: Pearson Education.
4. Goodrich M.T., Tamassia, R. (2014). Algorithm Design. United States: Wiley.
5. Aho, A.V., Hopcroft, J.E. and Ullman, J.D. (2013). Data Structures and Algorithms. New Delhi: Pearson Education.
6. Horowitz, E., Sahni, S. and Rajasekaran, S. (2017). Fundamentals of Computer Algorithms. New Delhi: Galgotia Publications.
7. Benoit, Anne, Robert, Yves, Vivien and Frederic. (2014). A guide to algorithm design: Paradigms, methods and complexity analysis. London: CRC Press Taylor & Francis group.
8. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.515**
**Course Title: Advanced Data Structures – Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**
The lab is designed to help students develop skills to design and analyse advanced data structures. To help students identify and apply the suitable data structure for a given problem.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Design and analyse different data structures.
**CLO2:** Choose the appropriate data structure for a given problem.

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

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

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

**Suggested Readings:**


1. Lab Manual
2. Allen Weiss M. (2014). Data Structures and Algorithm Analysis in C++. New Delhi: Pearson Education.

**Course Code: CST.611**
**Course Title: Advance computer networks Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**

The objective of this course is to introduce students to the difference between wired and wireless networks. Help them to differentiate between various protocols. Describe the various security loopholes and their countermeasures in wireless sensor networks.

**Course Learning Outcomes:**

After completion of course, students would be able to:

**CLO1:** Design the Wired and Wireless networks using suitable tools.

**CLO2:** Analyze the wireless sensor networks using various protocols.

**CLO3:** Evaluate the performance of sensor networks.

**Lab Assignments**

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

**Lab Evaluation:**

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

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

**Suggested Readings:**


1. Lab Manual
2. Sohraby, K., Minoli, D., and TaiebZnati. (2010). Wireless sensor networks –Technology: Protocols and Applications. United States: Wiley.

**Course Code: CST.516**
**Course Title: Wireless Sensors Networks Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**

The objective of this course is to introduce students to the difference between wired and wireless networks. Help them to differentiate between various protocols. Describe the various security loopholes and their countermeasures in wireless sensor networks.

**Course Learning Outcomes:**

After completion of course, students would be able to:

**CLO1:** Design the Wired and Wireless networks using suitable tools.

**CLO2:** Analyze the wireless sensor networks using various protocols.

**CLO3:** Evaluate the performance of sensor networks.

**Lab Assignments**

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

**Lab Evaluation:**

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

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

**Suggested Readings:**


1. Lab Manual
2. Sohraby, K., Minoli, D., and TaiebZnati. (2010). Wireless sensor networks –Technology: Protocols and Applications. United States: Wiley.

**Course Code: CST.612**
**Course Title: Data Science with R/Python- Lab**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**Course Objectives**:
To help students understand the basic constructs of Python Interpreter. To demonstrate the working of Python functions and modules w.r.t definition call and scope. To make students acquainted with OOPS and File handling concept in Python and to understand and apply various Python packages for Data handling.

**Course Learning Outcomes:**
After Completion of the lab course the students will be able:
**CLO1:** To create and demonstrate script in R by using basic constructs and control statements of Python.
**CLO2:** To illustrate the use of loading, cleaning the data and preprocessing the data.
**CLO3:** To synthesize the code in for various Data analysis techniques.
**CLO4:** Able to implement the Regression analysis with R.
**Lab Assignments**
Practical will be based on as per the Teaching Learning in the Theory Class**.**

**Lab Evaluation:**
The evaluation of lab criteria will be based on following parameters:

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

**Suggested Readings:**
1. Lab Manua

**Course Code: CST.518**
**Course Title: Complier for HPC Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**
The course is designed to help students apply the Concepts like instruction level, data level and thread level parallelism. The students will be able to design, implement and analyse the parallel programs on shared memory and distributed memory systems.

**Course Learning Outcomes:**
After the completion of the course the students will be able to
**CLO1:** Identify some common machine independent optimizations.
**CLO2:** Apply Compiler techniques and tools for exploiting instructions, data and thread level parallelism.
**CLO3:** Evaluate memory locality optimizations.

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

**Lab Evaluation:**
The evaluation of lab criteria will be based on following parameters:

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

**Suggested Readings:**

1. Lab Manual
2. Wolfe, M. (1995). High-Performance Compilers for Parallel Computing. New Delhi: Pearson Education.

**Course Code: CBS. 611**
**Course Title: Linux OS and Scripting Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:** The Linux OS and Scripting Lab aims to provide students with hands-on exercises that reinforce their understanding and knowledge of various Linux commands and scripting aspects.

**Course Learning Outcomes:**
After the completion of the course the students will be able to
**CLO1:** Demonstrate the use of various Linux commands.
**CLO2:** Implement various scripts.

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

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

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

**Suggested Readings:**

1. Lab Manual

**Course Code: CST.514**
**Course Title: Distributed Database System Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**
To introduce the basic concepts and implementation methods of Distributed Database systems. To uncover trending research issues in Distributed Database systems. To develop various applications related to Distributed Database systems. To put theory to practice by building and furnishing a distributed database query engine, subject to remote Web service calls.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Develop practical skills in the use of approaches for Distributed Database systems.
**CLO2:** Select and apply the appropriate approach for a particular case.
**CLO3:** Apply learned skills for solving practical database related tasks.
**CLO4:** Produce the transaction management and query processing techniques in Distributed Database systems.

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

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

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

**Suggested Readings:**
1. Lab Manual

**Course Code: CST.519**
**Course Title: Information Security Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**
To introduce students to the concept of security, and types of attack. Help students to understand Symmetric & Asymmetric Key Cryptography. The course will also give exposure on Internet Security Protocol.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Design various Classical Cryptographic Algorithms.
**CLO2:** Implement Symmetric & Asymmetric Key Cryptography in various applications.

**Lab Assignments**
Practical will be based on as per the Teaching Learning in the Theory Class**.**
**Lab Evaluation:**
The criteria for evaluation of lab will be based on following parameters:

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

**Suggested Readings:**

1. Lab Manual
2. Forouzan, B. A., & Mukhopadhyay, D. (2015). Cryptography & Network Security. New Delhi: Tata McGraw-Hill Education.
3. Kahate, A. (2017). Cryptography and Network Security. New Delhi: Tata McGraw-Hill Education.

**Course Code: CST.520**
**Course Title: Software Testing & Maintenance Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**

To learn and apply the tools in the area of software testing and its practice in the industry. To apply the software testing process for software quality checking and assurance. To design metrics models for predicting software testing and maintenance requirements.

**Course Outcomes**

After completion of course, students would be able to:

**CLO1:** Apply software testing techniques for verification & validation of software.

**CLO2:** Design and conduct a software test process for a quality checking and assurance.

**CLO3:** Identify software metrics models, testing criteria, strategies, and methods.

**Lab Assignments**

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

**Lab Evaluation:**

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

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

**Suggested Readings:**

Lab Manual

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# Interdisciplinary Course (IDC) Semester-I

**Course Code: CBS.518**
**Course Title: IT Fundamentals**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Course Objectives:**
The course aims to provide a comprehensive understanding of the foundational concepts in Information Technology. It introduces students to essential topics such as computer hardware, software, networking, data storage, operating systems, and the internet. The course also emphasizes practical applications, enabling students to effectively use IT tools for academic and professional tasks. By the end of the course, students will develop the confidence to analyze, interpret, and engage with various IT systems and appreciate the role of IT in solving real-world problems.

**Course Learning Outcomes:**
At the end of this course, students will be able to:
**CLO 1:** Describe different hardware and software components of computer.
**CLO 2:** Use word processing, presentation and spreadsheet software.
**CLO 3:** Illustrate the concept of networking and internet.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**8 Hours** | Fundamentals of Computers: Parts of computers, Hardware, BIOS, Operating systems, Binary system, Logic gates and Boolean Algebra. Introduction to computer network and World Wide Web, Storage space, CPU and Memory. | **CLO 1** |
| | **Learning Activities**: Numerical Based exercises for conversion of Binary to octal, hexadecimal and decimal number system, Identification of various ports by the students on such as Audio ports, USB ports, HDMI Port, Ethernet port | |
| **II**<br>**7 Hours** | MS-Word: Introduction to Word Processing, Creating and Saving Documents, Text Formatting, Tables, Document Review Option, Mail Merge, Inserting Table of Contents, Reference Management. | **CLO 2** |
| | **Learning Activities**: Error free typing exercises, Insertion of in text citations and insertion of Bibliography at the end of the document, Insertion of Tables and figures and cross referencing them from the text. | |

| | | |
|---|---|---|
| **III**<br>**8 Hours** | Applications Software: Introduction to MS Paint, Notepad, Spreadsheet applications, Presentation applications, Internet browsers and Image processing applications. | **CLO 2** |
| | **Learning Activities**: Creation of a PowerPoint presentation by students with various animation and transition effects, Creation of an excel workbook by the students and application of basic mathematical functions (such as sum, average, Count, Mean, Median, Mode) on the data | |
| **IV**<br>**7 Hours** | World Wide Web: Origin and concepts, Latency and bandwidth, searching the internet, Advanced web-search using Boolean logic, Networking fundamentals. | **CLO 3** |
| | **Learning Activities**: **:** searching for some relevant articles using keyword combinations on various electronic databases using advanced search options by students | |

**Transactional Modes:**

- Lecture
- Blended Learning
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Gookin, D. (2007). MS Word for Dummies. United States: Wiley.
2. Harvey, G. (2007). MS Excel for Dummies. United States: Wiley
3. Sinha, P.K. (2004). Computer Fundamentals. New Delhi: BPB Publications.
4. Bott, E. (2009). Windows 7 Inside Out. United States: Microsoft Press.
5. Goel, A., Ray, S. K. (2012). Computers: Basics and Applications. New Delhi: Pearson Education India.
6. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CBS.519**
**Course Title: Programming in C**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Course Objectives:**
This course is designed to develop a strong foundation in programming using the C language, which is critical for understanding system-level and application-level software development. The objective is to enable students to write structured, efficient, and error-free programs by understanding fundamental programming constructs such as variables, control structures, functions, arrays, pointers, and file handling. Students will also gain insight into memory management and algorithmic thinking, preparing them to handle more complex programming tasks and transition smoothly into other advanced languages and systems programming.

**Course Learning Outcomes:**
At the end of this course, students will be able to:
**CLO1:** Describe the concept and need of programming.
**CLO2:** Explain syntax and use of different functions available in C.
**CLO3:** Demonstrate programming in C.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**8 Hours** | Introduction to Programming Language: Types of Programming Language, Structured Programming, Algorithms and Flowcharts, Programming Language.<br>Introduction to C: History, Character Set, Structure of a C Program – constants, variables and Keywords, data typesCLO 1, expression statements, compound statements. | **CLO 1**<br>**CLO 2** |
| | **Learning Activities**: Program Fragments based exercises to find out output of various program fragments using the studied concepts | |
| **II**<br>**8 Hours** | C Operators: Arithmetic, Unary, Relational and Logical, Assignment, Conditional Operator, Increment, decrement Operator, Using library function in math.<br>Data Input Output: Single character input, getchar, getch, getc, single character output putchar, putc, Formatted I/O. | **CLO 2,**<br>**CLO 3** |
| | **Learning Activities**: Program Fragments based exercises | |
| **III**<br>**7 Hours** | C Constructs: If statement, while statement, do….while statement, for statement, switch statement, nested control statement, break, continue, goto statement.<br>C Functions: Functions, Definiton and scope, Assessing and Prototyping, Types of functions, Passing arguments to functions. | **CLO 2,**<br>**CLO 3** |
| | **Learning Activities**: Program fragments based exercises, Creating User defined function to perform simple activities and using them in C program | |

| | | |
|---|---|---|
| **IV**<br>**7 Hours** | Arrays and Strings: Single dimensional array, Multi-dimensional array, Initializing array using static declaration, character array and strings, String Handling functions. | **CLO 2, CLO 3** |
| | **Learning Activities**: **:** Program fragment based exercises, Pseudocode to implement single and multi dimensional arrays concept for practical programs | |

**Transactional Modes:**

- Lecture
- Blended Learning
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Rajaraman, V. (2008). Computer Basics and C Programming PHI Learning.
2. Brown, T. D. (1987) C for Basic Programmers. United States: Silicon Press.
3. Kanetkar, Y. P. (2010). Let Us C. New Delhi: BPB Publications.
4. Balagurusamy. (2008). Programming in ANSI C. New Delhi: Tata Mcgraw-Hill.
5. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.530**
**Course Title: Introduction to Digital Logic**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Course Objectives:**
The course introduces the principles of digital logic design and its application in the development of digital systems. It covers topics such as number systems, logic gates, Boolean algebra, combinational and sequential circuits, and memory elements. The objective is to help students understand how digital circuits work at the logic level and how they form the basis of computer architecture. By the end of the course, students will be equipped with the skills to design and analyze digital systems, laying the groundwork for further study in embedded systems, computer architecture, and hardware design.

**Course Learning Outcomes:**
At the end of this course, students will be able to:
**CLO1:** Describe the digital signal along with the operations applicable on them.
**CLO2:** Discuss different number systems and conversion between them along with memory devices used to store such data.
**CLO3:** Apply the Boolean laws in different situation.

| Activities: Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**8 Hours** | Introduction: Digital Signals, basic digital circuits: AND operation, OR operation and NOT operation.<br>Number Systems: Introduction, Binary number system, Octal number system, Hexadecimal Number system, Conversion of one number system to other, Gray code. | **CLO1**<br>**CLO2** |
| | **Learning Activities**: Web based Simulation learning | |
| **II**<br>**7 Hours** | Logic Gates and Boolean Algebra: Boolean Laws, Boolean expression and functions, Logic Gates. | **CLO3** |
| | **Learning Activities**: Web based Simulation learning | |
| **III**<br>**8 Hours** | Combinational Circuit Design: Karnaugh Map representation of logic functions, SOP, POS, Simplification of logic functions using K-Map. | **CLO3** |
| | **Learning Activities**: Exercise based learning | |
| **IV**<br>**7 Hours** | Flip-Flops: 1-bit memory cell, S-R Flip Flop, J-K Flip Flop, D-Flip Flop, T- Flip Flop. | **CLO3** |
| | **Learning Activities**: **:** Web based simmulation | |

**Transactional Modes:**
- Lecture
- Blended Learning
- E-tutorial

- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Mano, M. and Charles, K. (2007). Logic and Computer Design Fundamentals. New Delhi: Pearson Education.
2. Jain, R.P. (2006). Modern Digital Electronics. New Delhi: Tata McGraw Hill.
3. Kharate, G.K. (2010). Digital Electronics. United States: Oxford Higher Education.
4. Research Articles from SCI & Scopus indexed Journal.

**Course Code: CST.531**
**Course Title: Multimedia and Its Applications**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Course Learning Outcomes:**
At the end of this course, students will be able to:
**CLO1:** Identify and analyze different types of multimedia along with their representation.
**CLO2:** Differentiate between formats of all types of multimedia.
**CLO3:** Plan where we can use these multimedia.

| **Activities: Units/Hours** | **Contents** | **Mapping with Course Learning Outcome** |
|---|---|---|
| **I**<br>**8 Hours** | Introductory Concepts: Multimedia-Definitions, Basic properties and medium types. Multimedia applications, Uses of Multimedia.<br>Sound/ Audio: Basic Sound Concepts, Music. Speech: Generation, Analysis and Transmission. | **CLO 1** |
| | **Learning Activities**: Group Discussion | |
| **II**<br>**7 Hours** | Images and Graphics: Basic concepts: Image representation, image format, Graphics Format, Computer Image Processing. Video and Animation: Basic Concepts: Video Signal Representation, Computer Video Format. Television: Conventional Systems, Enhanced Definition Systems, High-Definition Systems. | **CLO 2** |
| | **Learning Activities**: Web based learning | |
| **III**<br>**7 Hours** | Data Compression: Storage space, coding requirements, JPEG, MPEG.<br>Miscellaneous: Optical Storage Media, Mutlimedia Operating Systems, Multimedia Communication Systems. | **CLO 3** |
| | **Learning Activities**: Simulation based Learning | |
| **IV**<br>**8 Hours** | Documents and Hypertext: Document Architecture, Manipulation of Multimedia Data, Hypertext, Hypermedia and Multimedia and example.<br>Multimedia Applications: Media Preparation, composition, Integration, communication, Consumption, and Entertainment. | **CLO 3** |
| | **Learning Activities**: **:** Group Discussion | |

**Transactional Modes:**

- Lecture
- Blended Learning
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Steinmetz, R. (2009). Multimedia: Computing Communications & Applications. New Delhi: Pearson Education India.
2. Vaughan, T. (2008). Multimedia: making it work. New Delhi: Tata McGraw-Hill Education.
3. Rao, K.R., Bojkovic, Z. S. and Milovanovic, D. A. (2002). Multimedia Communication Systems: Techniques, Standards, and Networks. United States: Prentice Hall.
4. Andleigh, P.K. (2007). Multimedia Systems Design. United States: Prentice Hall
5. Rimmer, S. (2007). Advanced Multimedia Programming. New Delhi: Windcrest/McGraw-Hill.
6. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CBS.532**
**Course Title: Introduction to MATLAB**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Course Objectives:**
The objective of this course is to introduce students from diverse academic backgrounds to the fundamentals of MATLAB, a powerful computational tool used in engineering, science, and data analysis. The course aims to equip students

**Course Learning Outcomes:**
At the end of this course, students will be able to:
**CLO1:** Describe the basic syntax of MATLAB along with various functions available in it.
**CLO2:** Analyze all the functions in graphical manner.
**CLO3:** Design a GUI interface for any software.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**8 Hours** | **Introduction**: MatLab, MatLab Syntax and interactive computations.<br>Live Demonstration of MATLAB command prompt | **CLO 1** |
| | **Learning Activities**: Assignment based learning | |
| **II**<br>**7 Hours** | **Programming:** in Matlab using procedures and functions: Arguments and return values, M-files, Formatted console input-output, String handling.<br>Live Demonstration of MATLAB M-files | **CLO 1, CLO 2** |
| | **Learning Activities**: Assignment based learning | |
| **III**<br>**8 Hours** | **Control Statements:** Conditional statements: If, Else, Elseif. Repetition statements: While, For.<br>**Manipulating Text:** Writing to a text file, Reading from a text. | **CLO 2** |
| | **Learning Activities**: Creation of text files and assignment based learning | |
| **IV**<br>**7 Hours** | **Graph Plots:** Basic plotting, Built in functions<br>**GUI Interface:** Attaching buttons to actions, Getting Input, Setting Output Using the toolboxes. | **CLO 3** |
| | **Learning Activities**: **:** Creation of GUI relevant to the departments. | |

**Transactional Modes:**

- Lecture
- Blended Learning
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Attaway. (2012). Matlab: A Practical Introduction to Programming and Problem Solving. Elsevier
2. Pratap, R. (2010). Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers. New Delhi: Oxford.
3. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.607**
**Course Title: Basics of Python Programming**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Course Objective**

The objective of this course is to introduce students to the foundational concepts of programming using Python. It aims to develop an understanding of programming logic, control structures, and core Python constructs such as variables, operators, lists, dictionaries, and functions. The course also focuses on practical skills such as file handling, working with structured data formats (CSV, Excel, PDF, Word), and data visualization using libraries like pandas and matplotlib. Through hands-on lab sessions, students will gain the ability to write, debug, and implement Python programs for real-world problem-solving and data analysis tasks.

**Course Learning Outcomes:**

After the completion of course, participants will be able to:

**CLO1:** Explain basics of programming.

**CLO2:** Define various constructs of python programming.

**CLO3:** Develop python code to handle data stored in files.

**CLO4:** Develop python code to represent the data in graphical mode.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**08 Hours** | Introduction to algorithm, flowchart and programming,<br>Python Introduction, Installing and setting Python environment, variables and its types, Operators. Flow control: if, if-else, for, while, range () function, continue statement, pass statement. | **CLO1** |
| | **Activities:** Lab based practices for above concepts | |
| **II**<br>**08 Hours** | **Lists:** Basic Operations, Iteration, Indexing, Slicing. Dictionaries: Basic dictionary operations, Basic String operations | **CLO2** |
| | **Activities:** Lab based practices for above concepts | |
| **III**<br>**06 Hours** | **Functions:** Definition, Call, Arguments. Pattern Matching with Regular Expressions, Introduction to pandas library, plotting data using matplotlib | **CLO2, CLO4** |
| | **Activities:** Lab based practices for above concepts | |
| **IV**<br>**08 Hours** | File handling: Reading and Writing Files, working with Excel Spreadsheets, working with PDF and Word Documents, working with CSV Files | **CLO3, CLO4** |
| | **Activities:** Lab based practices for above concepts | |

**Transactional Modes:**

- Lecture
- Blended Learning
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Sweigart, AI. (2014). Automate the Boring Stuff with Python Practical Programming for Total Beginners. Switzerland: No Starch Press.
2. Mark, L. (2013). Learning Python. California: Oreilly Media.
3. Research Articles from SCI & Scopus indexed Journal.

# SEMESTER -II

**Course Code: CST.508**
**Course Title: Machine Learning**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

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

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

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**16 Hours** | **Introduction to learning Techniques:** Supervised Learning (Regression/Classification)<br>Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes<br>Linear models: Linear Regression, Logistic Regression, Generalized Linear Models<br>Support Vector Machines, Nonlinearity and Kernel Methods<br>Beyond Binary Classification: Multi-class/Structured Outputs, Ranking | **CLO1** |
| | **Activities:** Brainstorming, assignment based learning | |
| **II**<br>**14 Hours** | ● **Unsupervised Learning**<br>● Clustering: K-means/Kernel K-means<br>● Dimensionality Reduction: PCA and kernel PCA<br>● Matrix Factorization and Matrix Completion<br>● Generative Models (mixture models and latent factor models) | **CLO1 CLO 2** |
| | **Activities:** Exercise based learning and practical hands on training | |

| | | |
|---|---|---|
| **III**<br>**14 Hours** | Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests).<br>Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning.<br>Introduction to ANN and Deep learning. | **CLO2**<br>**CLO4** |
| | **Activities:** Exercise based learning and practical hands on training | |
| **IV**<br>**16 Hours** | Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference.<br>Simulation Tool for Machine Learning, Hands on with recent tools WEKA, R, MATLAB<br>Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications. | **CLO2** |
| | **Activities:** Analysis of various case studies | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Murphy, K. (2012). Machine Learning: A Probabilistic Perspective. Cambridge: MIT Press.
2. Hastie, T., Tibshirani, R., and Friedman, J. (2017). The Elements of Statistical Learning. New York: Springer.
3. Bishop, C. (2011). Pattern Recognition and Machine Learning. New York: Springer.
4. Shalev-Shwartz, S., and Ben-David, S. (2014). Understanding Machine Learning: From Theory to Algorithms. New Delhi: Cambridge University Press.
5. Kubat, M. (2015). An introduction to machine learning, New York: Springer Science.
6. Barber, D. (2014). Bayesian reasoning and machine learning. New Delhi: Cambridge University Press.
7. Flach, P. (2015). Machine Learning. New Delhi: Cambridge University Press.
8. Mitchell, M.T. (2013). Machine Learning. New Delhi: Tata McGraw Hill Education Private Limited.
9. Research Articles from SCI & Scopus indexed Journ

**Course Code: CST.522**
**Course Title: Soft Computing**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To introduce the students to soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario. To give students knowledge with hands-on experience of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Identify and describe soft computing techniques and their roles in building intelligent machines.
**CLO2:** Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
**CLO3:** Apply genetic algorithms to optimization problems.
**CLO4:** Evaluate and compare solutions using various soft computing approaches for a given problem.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**14 Hours** | **Introduction to Soft Computing:** Evolution of Computing: Soft Computing Constituents, From Conventional, Major areas of Soft Computing, applications of Soft Computing.<br>Activity: Brainstorming, assignment based learning<br>**Neural Networks:** Introduction, Brief history, Neural Networks Characteristics, architecture, and properties.<br>Neural Network Learning Algorithm Machine Learning Using Neural Networks. | **CLO1** |
| | **Activities:** Exercise based learning and practical hands on training. | |
| **II**<br>**16 Hours** | **Fuzzy Logic:** Fuzzy Sets, Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations.<br>Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making, Fuzzy Models. | **CLO2** |
| | **Activities:** Assignment and Exercise based learning | |
| **III**<br>**14 Hours** | **Genetic Algorithms:** Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition. Introduction to other optimization techniques. | **CLO3** |
| | **Activities:** Exercise and case study based learning | |

| | | |
|---|---|---|
| **IV**<br>**16 Hours** | **Swarm intelligence:** Overview, mechanism, technologies like particle swarm optimization, ant colony optimization, cuckoo search.<br>**Introduction to hybrid systems**: Neuro Fuzzy, Neuro Genetics and Fuzzy Genetic system.<br>Recent trends in soft computing techniques. | **CLO4** |
| | **Activities:** Student presentation and group discussion | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Jang, J. R. S., Sun, C. T., and Mizutani E. (1997). Neuro - Fuzzy and Soft Computing, New Delhi: Prentice-Hall of India, Pearson.
2. Klir, G. J., and Yuan, B. (2015). Fuzzy Sets and Fuzzy Logic - Theory and Applications. New Delhi: Pearson Education India.
3. Ross, J. T. (2011). Fuzzy Logic with Engineering Applications. United States: John Wiley & Sons.
4. Rajasekaran, S., and Vijayalakshmi Pai, G.A. (2013). Neural Networks, Fuzzy Logic and Genetic Algorithms. United States: Prentice Hall India Learning.
5. Priddy, K. L., and Keller, E. P. (2005). Artificial Neural Networks: An Introduction. Washington USA, SPIE Press.
6. Gen, M., and Cheng, R. (1999). Genetic Algorithms and Engineering Optimization. United States: Wiley-Interscience.
7. Research Articles from SCI & Scopus indexed Journal

**Course Code: CST.523**
**Course Title: Computer Vision**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
to provide students with a solid theoretical foundation, practical skills, and ethical awareness necessary to excel in the field of computer vision and contribute to advancements in research, development, and applications in various industries and domains.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Understand the fundamental concepts and techniques in computer vision, including image and video processing, pattern recognition, and machine learning.
**CLO2:** Develop proficiency in implementing and applying various computer vision algorithms and techniques for image analysis, object detection and recognition, and video understanding.
**CLO3:** Acquire knowledge of different image and video representation methods, feature extraction techniques, and their applications in real-world scenarios.
**CLO4:** Develop expertise in deep learning frameworks and convolutional neural networks (CNNs) for solving complex computer vision tasks

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**14 Hours** | Introduction to Computer Vision: Overview of computer vision and its applications, History and development of computer vision, Image and video representation and acquisition, Image processing basics<br>Image Processing Techniques: Image enhancement and restoration, Image segmentation, Feature extraction and selection, Image filtering and convolution, and Morphological operations | **CLO1** |
| | **Activities:** Assignment based and hands on training | |
| **II**<br>**16 Hours** | Pattern Recognition and Machine Learning<br>Fundamentals of pattern recognition, Supervised and unsupervised learning techniques, Feature representation and dimensionality reduction, Classification algorithms (e.g., Support Vector Machines, Decision Trees, Neural Networks), Evaluation and validation of machine learning models | **CLO1, CLO2** |
| | **Activities:** Learning through Experiment | |

| | | |
|---|---|---|
| **III**<br>**16 Hours** | Image Analysis and Understanding<br>Image feature extraction (e.g., texture, shape, color), Object detection and recognition, Image matching and retrieval, Image-based localization and tracking, Activity recognition and video analysis.<br>Deep Learning for Computer Vision: Introduction to deep learning frameworks (e.g., TensorFlow, PyTorch) | **CLO3** |
| | **Activities:** Review of various techniques, Hands on training | |
| **IV**<br>**14 Hours** | Convolutional Neural Networks (CNNs) for image classification<br>Object detection and localization using CNNs (e.g., Faster R-CNN, YOLO)<br>Semantic segmentation using CNNs (e.g., Fully Convolutional Networks, U-Net)<br>Generative models for image synthesis and style transfer | **CLO4** |
| | **Activities:** Case studies and group discussion | |

**Transactional Modes:**

- Lecture cum Demonstration
- Flipped Class Room
- E-tutorial
- Experimentation
- Online Teaching Tools

**Suggested Readings:**


1. Prince,
2. S.J.D. (2012) Computer Vision: Models, Learning, and Inference, Computer Vision: Models, Learning, and Inference
3. Szeliski, R. (2011). Computer Vision - Algorithms and Applications. New York: Springer.
4. Goodfellow, I., Bengio Y., and Courville, A. (2017). Deep Learning. Cambridge: MIT Press.
5. Fisher, R. B., Dawson-Howe, K., and Fitzgibbon, A. (2013). Dictionary of Computer Vision and Image Processing, United States: Wiley.
6. Klette, R. (2014). Concise Computer Vision: An Introduction into Theory and Algorithms. New York: Springer.
7. Gose, E., Johnsonbaugh, R., and Steve. (2015). Pattern Recognition and Image Analysis. New Delhi: Pearson Education India.
8. Shinghal, R.. (2012). Pattern recognition: Techniques and applications. New Delhi: Oxford university press.
9. Bishop, C.M. (2012). Neural networks for pattern recognition. New Delhi: oxford university press.
10. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CBS.523**
**Course Title: Secure Software Design**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To help students learn to fix software flaws and bugs in various software. To make students aware of various issues like weak random number generation, information leakage, poor usability, and weak or no encryption on data traffic.
Expose students to techniques for successfully implementing and supporting network services on an enterprise scale and heterogeneous systems environment.

**Course Learning Outcomes:**
After completion of course, students would be able to:
C**LO1**: Show Interrelationship between security and software development process.
**CLO2:** Differentiate between various software vulnerabilities.
**CLO3:** Explain software process vulnerabilities for an organization.
**CLO4:** Recognize resource consumption in software.

| Units/Hours | ConteNints | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**13 Hours** | **Secure Software Design:**<br>Identify software vulnerabilities and perform software security analysis, Master security programming practices, Master fundamental software security design concepts, perform security testing and quality assurance. | **CLO1, CLO2** |
| | **Activities:** Case study-based learning | |
| **II**<br>**17 Hours** | **Enterprise Application Development**<br>Describe the nature and scope of enterprise software applications, Design distributed N-tier software application, Research technologies available for the presentation, business and data tiers of an enterprise software application, Design and build a database using an enterprise database system, develop components at the different tiers in an enterprise system, Design and develop a multi-tier solution to a problem using technologies used in enterprise system, Present software solution. | **CLO1** |
| | **Activities:** Group Discussion based learning | |

| | | |
|---|---|---|
| **III**<br>**15 Hours** | **Enterprise Systems Administration**<br>Design, implement and maintain a directory-based server infrastructure in a heterogeneous systems environment, Monitor server resource utilization for system reliability and availability, Install and administer network services (DNS/DHCP/Terminal Services/Clustering/Web/Email). | **CLO3** |
| | **Activities:** Group discussion based learning | |
| **IV**<br>**15 Hours** | Obtain the ability to manage and troubleshoot a network running multiple services, Understand the requirements of an enterprise network and how to go about managing them.<br>Handle insecure exceptions and command/SQL injection, Defend web and mobile applications against attackers, software containing minimum vulnerabilities and flaws. Case study of DNS server, DHCP configuration and SQL injection attack. | **CLO4** |
| | **Activities:** Case study of Various server configuration | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Richardson, T., and Thies, C. N. (2012). Secure Software Design. Massachusetts: Jones & Bartlett Learning.
2. Kenneth, R. Van, W., Mark, G., Graff, D.S., Peters, D. L., Burley, Enterprise Software Security: A Confluence of Disciplines, United States: Addison -Wesley, Professional.
3. McGraw, G. (2006). Software Security: Building Security. New Delhi: Tata McGraw.
4. Stuttard, D. (2011). The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws. United States: Wiley.
5. Solem, J. E. (2012). Programming Computer Vision with Python: Tools and algorithms for analyzing images. California: O'Reilly Media.
6. Fernandez, E. B. (2013). Designing secure architecture using software patterns, United Kingdom: John Wiley & sons limited.
7. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.524**
**Course Title: Internet of Things**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

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

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Describe IoT and its networking and communication aspects.
**CLO2:** Analyze the IoT Design Methodology
**CLO3:** Explain the concepts related to Industry 4.0 and security.
**CLO4:** Design IoT applications on different embedded platform.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**16 Hours** | Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models and APIs IoT and M2M, Difference between IoT and M2M. | **CLO1** |
| | **Activities:** Assignments and Group Discussion. | |
| **II**<br>**14 Hours** | IoT Platforms Design Methodology: Introduction, IoT Design Methodology, Case Study on IoT System for Weather Monitoring. Case Studies Illustrating IoT Design: Home Automation, Environment, Agriculture. | **CLO2** |
| | **Activities:** Analysis of various case studies | |
| **III**<br>**14 Hours** | Introduction: Sensing & actuation, Industry 4.0: Cyber Physical Systems and Next Generation Sensors, Cybersecurity in Industry 4.0, Basics of Industrial IoT: Industrial Processes, Industrial Sensing & Actuation, Security in IIoT, Data Handling and Analytics. | **CLO3** |
| | **Activities:** Group Discussion and Flip Learning. | |
| **IV**<br>**16 Hours** | Developing IoTs: Developing applications through IoT tools including Python/ Arduino/ Raspberry pi, developing sensor-based application through embedded system platform. | **CLO4** |
| | **Activities:** Hands on experience with IoT kits. | |

**Transactional Modes:**

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

**Suggested Readings:**


**1.** Sharma, S. (2018). *Smart Cities Unbundled*. Bloomsbury Publishing.

2. Kamal, R. (2017). *Internet of Things: Architecture and Design Principles*.
3. Chaudhuri, A. (2018). *Internet of Things, for Things, and by Things*. CRC Press.
4. Dargie, W., and Poellabauer, C. (2010). Fundamentals of Wireless Sensor Networks: Theory and Practice. Wiley-Blackwel.
5. DaCosta, F., and Henderson B. (2014). Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, New York: Apress Publications.
6. Holler, J., Tsiatsis V., Mulligan, C., Avesand, S., Karnouskos, S., & Boyle, D. (2014). From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence. Massachusetts: Academic Press.
7. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.XXX**
**Course Title: Affective Computing**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

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

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

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

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

**Recommended Books:**


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

**Course Code: CST.525**
**Course Title: GPU Computing**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To help students learn parallel programming with Graphics Processing Units (GPUs).

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Explain parallel programming
**CLO2:** Demonstrate programing on GPUs
**CLO3:** Outline the process of debugging and profiling parallel programs.
**CLO4:** Design various complex problems using GPU computing

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | **Introduction:** History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA Open CL / Open ACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps / Wave fronts, Thread blocks / Workgroups, Streaming multiprocessors, 1D / 2D /3D thread mapping, Device properties, Simple Programs.<br>**Activities:** Assignment Based Learning, Case studies, Simple Implementation | **CLO1** |
| **II**<br>**15 Hours** | **Memory:** Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories.<br>**Activities:** Implementation Based Learning, Matrices Computation. | **CLO1** |
| **III**<br>**14 Hours** | **Synchronization:** Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Worklists, Linked-lists. Synchronization across CPU and GPU<br>**Functions:** Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries. | **CLO2, CLO3** |

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| | **Activities** Assignment Based Learning, Implementation of Worklists and Linklists, Live Demonstration | |
| **IV**<br>**16 Hours** | Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects.<br>Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based- Synchronization - Overlapping data transfer and kernel execution, pitfalls.<br>Case Studies: Image Processing, Graph algorithms, Simulations, Deep Learning Advanced topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing. | **CLO4** |
| | **Activities:** Case studies, Live implementation | |

**Transactional Modes:**

- Lecture
- Flipped Class
- E-tutorial
- Programme Learning
- Online Teaching Tools

**Suggested Readings:**


1. Kirk, D., Hwu, W., and Kaufman, M. (2010). Programming Massively Parallel Processors: A Hands-on Approach. Massachusetts: Morgan Kaufmann.
2. Cook, S., and Kaufman, M. (2014). CUDA Programming: A Developer's Guide to Parallel Computing with GPUs. Elsevier.
3. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.539**
**Course Title: Natural Language Processing**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To understand the basic ideas and principles of NLP. To familiarize with NLP Problem. To appreciate the use of NLP for various Applications

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Understand the role of NLP in Various Applications.
**CLO2:** To design and implement Various Language Corpus.
**CLO3:** Critically Analyse Part of Speech and Lexical Analysis.
**CLO4:** To know about applications of in NLP in Various Field of Computer Science Problems

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**14 Hours** | Regular Expression and Automata, Pattern recognition, Morphology and Finite State Transducers<br><br>Linguistic Essentials: Part of Speech and Marphology, Phrase Structure grammars, Dependency-Arguments and Adjuncant, Phrase structure Ambiguity, Semantics and Pragmatics. | **CLO1, CLO2** |
| | **Activities:** Discussion<br>Practical – Installation of NLTK. | |
| **II**<br>**15 Hours** | **Pre-Processing and Feture extraction:** Token (nltk.tokenize), Stop Words(nltk.corpus), Stem, lemmatize (nltk.stem)<br>**Corpus Based Work & Collocation:** Getting Setup for Corpora and its software. Low level Formatting issues. Frequency, Mean, Variance of words<br>**Word Sense Disambiguation:** Methdological Preliminaries, Supervised Disambiguation, Dictionary Based Disambiguation, Unsupervised Disambiguation. | **CLO2** |
| | **Activities: Assignment based and implementation Based Learning through Python** | |

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|---|---|---|
| **III**<br>**16 Hours** | **Lexical Acquisition:** Evaluation Measure, Verb Subcategorisation, Semantic Similarity(Vector Space and Probabilistic Measure).<br>**Features to vectors:** one hot encoding, Bag of Words, N-gram, Word2Vec.<br>**Markov Model:** Markov Model, Hidden markov Model(HMM), HMM Implementation. | **CLO3, CLO4** |
| | **Activities:** Implementation of Model with Python Libraries and assignment based learning. | |
| **IV**<br>**15 Hours** | **Part of Speech tagging:** Markov Model Taggers, HMM taggers, Transformation Based Learning of tags, Local Language Tagging, Tagging Accuracy, Uses of tagging.<br>**Statistical Alignment & Machine Translation:** Text Alignment, Word Alignment, and Statistical machine Translation, Clustering and Hierarchal Clustering<br>**Recent Trends in NLP** | **CLO4** |
| | **Activities:** Implementation and solution of Machine Translation with Python. | |

**Transactional Modes:**

- Lecture
- Google Co-lab
- Collaborative Learning
- Peer Learning/Teaching
- Github/Kaggle

**Suggested Readings:**


1. Christopher D. Manning and Hinrich Schutze, *Foundations of Natural Language Processing*, MIT Press. Cambridge, MA: May 2003.
2. Nitin Indurkhya, Fred J. Damerau "Handbook of Natural Language Processing", Second Edition, CRC Press, 2010.
3. James Allen "Natural Language Understanding", Pearson Publication 8th Edition. 2012
4. Daniel Jurafsky and James H. Martin "Speech and Language Processing", 3rd edition, Prentice Hall, 2009.
5. Christopher D. Manning and Hinrich Schutze, *Foundations of Statistical Natural Language Processing*, MIT Press. Cambridge, MA: May 1999.

**Course Code: CBS.525**
**Course Title: Secure Coding**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
The outcome of this course is to explain the most frequent programming errors leading to software vulnerabilities and identify security problems in software.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Define secure programs and list various risks in the software.
**CLO2:** Classify different errors that lead to vulnerabilities.
**CLO3:** Analyze various possible security attacks.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | **Software Security**: Security Concepts, Security Policy, Security Flaws, Vulnerabilities, Exploitation and Mitigations. Software Security problems, Classification of Vulnerabilities.<br>**Security Analysis:** Problem Solving with static analysis: Type Checking, Style Checking, Program understanding, verifications and property checking, Bug finding and Security Review.<br>**Activities:** Group Discussion based learning | **CLO1** |
| **II**<br>**15 Hours** | **Strings:** Common String manipulating Errors, String Vulnerabilities and Exploits, Mitigation Strategies for strings, String handling functions, Runtime protecting strategies, Notable Vulnerabilities.<br>**Integer Security**: Integer data Type, Integer Conversions, Integer Operations, Integer Vulnerabilities, Mitigation Strategies.<br>**Activities:** Implementation of above concepts in various programming Languages | **CLO2** |
| **III**<br>**15 Hours** | **Handling Inputs:** What to validate, How to validate, Preventing metadata Vulnerabilities.<br>**Buffer Overflow**: Introduction, Exploiting buffer overflow vulnerabilities, Buffer allocation strategies**,** Tracking buffer sizes, buffer overflow in strings, Buffer overflow in Integers Runtime protections | **CLO3** |

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|---|---|---|
| | **Activities:** Implementation of above concepts in various programming Languages | |
| **IV**<br>**15 Hours** | **Web Applications:** Input and Output Validation for the Web: Expect That the Browser Has Been Subverted, **HTTP Considerations**: Use POST, Not GET, Request Ordering, Error Handling, Request Provenance<br>**Maintaining Session State:** Use Strong Session Identifiers, Enforce a Session Idle Timeout and a Maximum Session Lifetime, Begin a New Session upon Authentication. | **CLO3** |
| | **Activities** :Implementation of above concepts in various programming Languages | |

**Transactional Modes:**

- Lecture
- Case Studies
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Seacord, R. C. (2013). Secure Coding in C and C++. United States: Addison Wisley Professional.
2. Chess, B., and West J. (2007). Secure Programming with static Analysis. United States: Addison Wisley.
3. Seacord, R. C. (2009). The CERT C Secure Coding Standard. Pearson Education, United States: Addison-Wesley.
4. Howard, M., LeBlanc, D. (2002). Writing Secure Code. New Delhi: Pearson Education.
5. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CBS.623**
**Course Title: Network Security**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:** The course is structured to uncover and understand the current trends in computer networks through literature readings and to encourage a performance-oriented approach to analyzing computer and communications networks. It also provides hands-on experience in securing networks.

**Course Learning Outcomes:**

After completion of course, students would be able to:
**CLO1:** Describe the basics of networking and VLANS.
**CLO2:** Explain IP addressing, routing and subnetting.
**CLO3:** Demonstrate the configuration of Cisco Routers, IPv4 Addresses and Routes, DHCP, and Connectivity with ping, traceroute and telent.
**CLO4:** Design the network with Access Control Lists, Network Address Translation and Firewalls.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I 14Hours** | Networking Fundamentals: Perspectives on Networking, TCP/IP Networking Model, OSI Networking Model. Ethernet LANs and Switches: Building Ethernet LANs with Switches, Installing and operating Cisco LAN Switches, Configuring Ethernet Switching. Virtual LAN: introduction to VLAN, VLAN Links, VLAN Tagging, VLAN Trunk Protocol (VTP). | **CLO1** |
| | **Activities:** Brainstorming, assignment-based learning | |
| **II 16Hours** | Fundamentals of IPv4 Addressing and Routing: Overview of Network layer Functions, IPv4 Addressing: Rules for IP Addresses, Class A, B, and C IP networks. IPv4 Routing, IPv4 Routing Protocols. IPv4 Addressing and Subnetting: Perspectives on IPv4 Subnetting. | **CLO2** |
| | **Activities:** Exercise based learning and practical hands-on training | |
| **III 16Hours** | Implementing IPv4: Operating Cisco Routers, Configuring IPv4 Addresses and Routes: IP Routing, Configuring Connected Routes, Configuring Static Routes. Configuring and Verifying Host Connectivity: Configuring Routers to Support DHCP, Verifying Host IPv4 Settings, Testing Connectivity with ping, traceroute and telent. | **CLO3** |
| | **Activities**: Exercise based learning and practical hands-on training | |
| **IV 14Hours** | Firewalls: Firewall Basics, Types of Firewalls: Packet Filter, State-full Filter, Application Filter, Proxy Firewalls, Network Address Translation: Basic concepts and NAT Configuration. | **CLO4** |

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|---|---|---|
| | Access Control Lists: Ingress and Egress Filtering, Types of Access Control Lists, ACL types: standard and extended, ACL commands. Wireless Network Security. implementation of Denial of service (DoS) attacks, Distributed DoS (DDoS) attack and various types of DoS attacks. | |
| | **Activities:** Exercise based learning and practical hands on training | |

**Transactional Modes:**

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

**Suggested readings:**


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

**Course Code: CST.529**
**Course Title: Blockchain Technology**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
The outcome of this course is to introduce students to the concept of Blockchain, crypto primitives, Bitcoin basics, distributed consensus, consensus in Bitcoin, permissioned Blockchain, hyper ledger fabric and various applications where Blockchain is used.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Describe the basic concept of Blockchain, Crypto Primitives, Bitcoin Basics
**CLO2:** Identify the area in which they can apply permission or permission less blockchain.
**CLO3:** Apply Block chaining concept in various applications.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | **Introduction to Blockchain:** What is Blockchain, Public Ledgers, Blockchain as Public Ledgers, Bitcoin, Blockchain 2.0, Smart Contracts, Block in a Blockchain, Transactions, Distributed Consensus, The Chain and the Longest Chain, Cryptocurrency to Blockchain 2.0, Permissioned Model of Blockchain | **CLO-1** |
| | **Activities:** Case studies based Learning, Group Discussion. | |
| **II**<br>**15 Hours** | Basic Crypto Primitives: Cryptographic Hash Function, Properties of a hash function, Hash pointer and Merkle tree, Digital Signature, Public Key Cryptography, A basic cryptocurrency. Bitcoin Basics: Creation of coins, Payments and double spending, FORTH – the precursor for Bitcoin scripting, Bitcoin Scripts, Bitcoin P2P Network, Transaction in Bitcoin Network, Block Mining, Block propagation and block relay. | **CLO-1** |
| | **Activities: :** Live Demonstration , Implementation Based Learning of hash functions, Group Discussions | |
| **III**<br>**15 Hours** | Distributed Consensus: Why Consensus, Distributed consensus in open environments, Consensus in a Bitcoin network.<br>Consensus in Bitcoin: Bitcoin Consensus, Proof of Work (PoW) – basic introduction, Hashcash PoW, Bitcoin PoW, Attacks on PoW and the monopoly problem, Proof of Stake, Proof of Burn and Proof of Elapsed Time. The life of a Bitcoin Miner, Mining Difficulty, Mining Pool.<br>Permissioned Blockchain: Permissioned model and use cases, Design issues for Permissioned blockchains, Execute contracts, | **CLO-2** |

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|---|---|---|
| | State machine replication, Consensus models for permissioned blockchain, Distributed consensus in closed environment, Paxos, RAFT Consensus, Byzantine general problem. | |
| | **Activities:** Group Discussion, Assignment Based Learning, Case studies | |
| **IV**<br>**15 Hours** | Blockchain Components and Concepts: Actors in a Blockchain, Components in Blockchain design, Ledger in Blockchain.<br>Hyperledger Fabric architecture and design: Ordering Services, Channels in Fabric, Fabric Peer and Client application and fabric certificate authority.<br>Hyperledger Fabric: Architecture and Transaction Flow.<br>Hyperledger Membership and Identity Management: Organization and Consortium Network, Membership Service Provide, Transaction Signing. | **CLO-3** |
| | **Activities:** Assignment Based Learning, Live Demonstration. | |

**Transactional Modes:**

- Lecture cum Demonstration
- Blended Learning
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Gaur, N., Desrosiers, L., Ramakrishna, V., Novotny, P., Baset, S., and O'Dowd A. (2018). Hands-On Blockchain with Hyperledger: Building decentralized applications with Hyperledger Fabric and Composer. United Kingdom: Packt Publishing Ltd. Packt.
2. Badr, B., Horrocks, R., and Xun(Brian), Wu. (2018). Blockchain By Example: A developer's guide to creating decentralized applications using Bitcoin, Ethereum, and Hyperledger. United Kingdom: Packt Publishing Ltd.
3. Dhillon, V., Metcalf D., and Hooper M. (2017). Blockchain Enabled Applications: Understand the Blockchain Ecosystem and How to Make it Work for You.New York: Apress.
4. Mukhopadhyay M. (2018). Ethereum Smart Contract Development: Build blockchain-based decentralized applications using solidity. United States: Packt Publishing Ltd.
5. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CBS. 626**
**Course Title: Quantum Computing & Quantum Machine Learning**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**

To provide fundamental concepts of quantum information processing and quantum machine learning, and take the discussion forward to potentials offered, technological bottlenecks and the way forward.

To expose the participants to the state-of-the-art in quantum computing and quantum machine learning with its possible impact on the society.

**Course Learning Outcomes:**

After completion of course, students would be able to:

**CLO1:** To understand the basic concepts and terminologies in quantum information processing and quantum computing.

**CLO2:** To understand the basic concepts Non-local Correlation and Entanglement.

**CLO3:** To design new or modify existing quantum machine learning algorithms.

**CLO4**: To grasp the working principle of a quantum computer and understand image processing algorithms in real world implementations.

**CLO5**: To understand the current scenario in Google, IBM, D-wave, IonQ etc.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | Basics of Quantum Information and Linear Algebra: Why Quantum Computing, Classical to quantum mechanics, Hilber space, Bases vectors and linear independence, Operators and matrices, Hermitian and Unitary operators, Measurements in quantum mechanics. | **CLO1, CLO5** |
| | **Activities:** Exercise based learning, Demonstration of above theory using Mathemetica/ MATLAB tools | |
| **II**<br>**15 Hours** | Introduction to quantum information: Qubits and quantum gates, Quantum circuits, Quantum parallelism, Bloch sphere, Bell states, Density operators, Pure and Mixed states, Information and entropy, Von-Neumann entropy. | **CLO1** |
| | **Activities:** Assignment based learning, Demonstration of above theory using Mathemetica/ MATLAB tools | |

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|---|---|---|
| **III**<br>**14 Hours** | Quantum Distance Measures, Trace distance, Fidelity, No-cloning Theorem, Einstein-Podolsky-Rosen paradox, Entanglement and Nonlocality: Quantum entanglement, bi-partite and multiqubit systems, Bell-type inequalities and nonlocality, entanglement classes and measures. | **CLO2** |
| | **Activities:** Assignment-based learning, Demonstration of Entanglement and Non-locality through animated videos. | |
| **IV**<br>**16 Hours** | Introduction to Quantum machine learning, Quantum Embedding, Quantum feature maps and kernels, Variational circuits, Quantum Support Vector Machine. Comparison between the classical and Quantum machine learning, Quantum Neural Networks<br>Quantum image representation, Quantum image Processing, Applications of Quantum image processing. | **CLO3, CLO4** |
| | **Activities:** Case studies, Assignment based Learning | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Nielsen, M. A. and Chuang, I. L., (2010), Quantum Computation and Quantum Information, 10th Anniversary addition, Cambridge University Press
2. Griffiths, D. J., (2016), Introduction to Quantum Mechanics, Reprint edition, Pearson Prentice Hall, 2006.
3. Bouwmeester, D., Ekert, A. and Zeilinger, A., (2000), The Physics of Quantum Information, Reprint edition, Springer Berlin Heidelberg.
4. Quantum Computing A developers guide, Pierpaolo Marturano (2023) De Gruyter denbourg
5. Dancing with Python Learn to code with Python and Quantum Computing, Robert S. Sutor (2021) PacktPub
6. Introduction to Quantum Computing, Ray LaPierre (2021) Springer
7. Research Articles
8. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CBS.524**
**Course Title: Big Data Analytics and Visualization**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

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

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

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | **Big Data Introduction:** What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data and web analytics.<br>**Big Data Technologies: Big Data Architecture in PySpark, Spark ecosystem overview, Spark SQL, MLlib, Spark Streaming, RDD vs DataFrame vs Dataset, PySpark setup**<br>**Data Gathering and Preparation:** Data formats, parsing and transformation, Scalability and real-time issues. | **CLO1** |
| | **Activities:** Case Study and Group Discussion | |
| **II**<br>**15 Hours** | **Data Cleaning:** Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation.<br>**Visualization:** Descriptive and comparative statistics, Designing visualizations, Time series, Geo-located data, Correlations and connections, Hierarchies and networks, interactivity. | **CLO2, CLO3** |
| | **Activities:** Implementation above theory with Python code | |

| | | |
|---|---|---|
| **III**<br>**15 Hours** | NoSQL: Introduction to NoSQL, aggregate data models, key-value and document data models.<br>**Vector Databases: Introduction to Vector databases, Embedding Fundamental, Working with FAISS, Vector Database Schema and Metadata.** | **CLO3** |
| | **Activities:** Implementation and designing with Spark/MongoDB | |
| **IV**<br>**15 Hours** | **Text preprocessing:** Loading and cleaning raw text files, Tokenization, stop words, stemming, lemmatization (NLTK, spaCy)<br>**Big Data Text Analytics:** Understanding Text Analytics in Big Data, Predictive Analysis with Text, Document-Term Matrix with `scikit-learn`, Basic sentiment analysis, Topic modeling (LDA), TF-IDF scoring and vectorization. | **CLO4** |
| | **Activities:** Implementation and usage of tools over the cloud | |

**Transactional Modes:**

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

**Suggested Readings:**


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

**Course Code: CST.517**
**Course Title: Machine Learning Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

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

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

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

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

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

**Suggested Readings:**

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

**Course Code: CST.527**
**Course Title: Soft Computing Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**Course Objectives**: The primary outcomes of this lab course is to provide a practical introduction to various techniques in soft computing and their applications.

**Course Learning Outcomes:**
After Completion of the lab course the students will be able to:
**CLO1:** Create programs to implement simple applications using the fuzzy logic.
**CLO2:** Distinguish various types of neural networks and write programmes to implement the same.
**CLO3:** Use optimization based on GA and implement some of its applications.

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

**Lab Evaluation:**
The evaluation of lab criteria will be based on following parameters:

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

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

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**Course Code: CST.533**
**Course Title: Computer Vision Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

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

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Implement edge detection and segmentation algorithms.
**CLO2:** Apply common feature extraction algorithms in practice and implementing the same.
**CLO3:** Perform experiments in Computer Vision using CNN with real-world data for Image segmentation, classification, Pattern Analysis, and object detection.

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

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

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

**Suggested Readings:**
Lab Manual

**Course Code: CBS.539**
**Course Title: Secure Software Design Lab**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**

To fix software flaws and bugs in various software. Students will aware of various issues like weak random number generation, information leakage, poor usability, and weak or no encryption on data traffic. Learn Methodologies and tools for developing secure software with minimum vulnerabilities and flaws.

**Course Learning Outcomes:**

After completion of course, students would be able to:

**CLO1:** Learn the use of various tools for software vulnerability.

**CLO2:** Apply different techniques for identification of software flaws.

**CLO3:** Track the resolution of flaws in software.

**CLO4:** Interrelate security and software development process.

**Suggested Readings:**

Lab Manual

**Lab Assignments**

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

**Lab Evaluation:**

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

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

**Course Code: CST.534**
**Course Title: IOT (Internet of Things) Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

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

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

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

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

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

**Suggested Readings:**
1. Lab Manual

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

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**

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

**Course Learning Outcomes:**

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

**Lab Assignments**

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

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

**Lab Evaluation:**

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

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

**Suggested Readings**

**1.** Lab Manuals

**Course Code: CBS.625**
**Course Title: Network Security Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**
The Network Security Lab aims to provide students with hands-on exercises that reinforce their understanding and knowledge of various network security aspects.

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

**Course Learning Outcomes:**
After completion of course, students would be able to:

**CLO1:** Demonstrate the configuration of VLANs, IP addressing, routing and subnetting.
**CLO2:** Implement IPv4 Addresses, Routes, DHCP and connectivity with ping, traceroute and telent.
**CLO3:** Design Access Control Lists and Network Address Translation.

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

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

**Suggested Readings:**
1. Lab Manual

**Course Code: CST.535**
**Course Title: GPU Computing Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**
The objective of GPU Computing is to introduce the fundamentals of graphics processing units and corresponding programming environments. Introduce the learner to fundamental and advanced parallel algorithms through the GPU programming environments.

**Course Learning Outcomes:**
After completion of course, students would be able to
**CLO1:** To design, formulate, solve and implement high performance versions of standard single threaded algorithms.
**CLO2:** To demonstrate the architectural features in the GPU hardware accelerators.
**CLO3:** To design and deploy parallel programs.

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

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

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

**Suggested Readings:**
1. Lab Manual

**Course Code: CST.536**
**Course Title: Blockchain Technology Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Course Objectives:**

The objective of this course is to introduce students to the concept of Blockchain, crypto primitives, Bitcoin basics, distributed consensus, consensus in Bitcoin, permissioned Blockchain, hyper ledger fabric and various applications where Blockchain is used.

**Course Learning Outcomes:**

**CLO1:** Design the basic concept of Blockchain, Crypto Primitives, Bitcoin Basics
**CLO2:** Identify the area in which they can apply permission or permission less blockchain.
**CLO3:** Apply Block chaining concept in various applications.

**Lab Assignments**

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

**Lab Evaluation:**

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

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

**Suggested Readings:**


1. Lab Manual
2. Gaur, N., Desrosiers, L., Ramakrishna, V., Novotny, P., Baset, S., & O'Dowd A. (2018). Hands-On Blockchain with Hyperledger: Building decentralized applications with Hyperledger Fabric and Composer. United Kingdom: Packt Publishing Ltd. Packt.
3. Badr, B., Horrocks, R., and Xun(Brian), Wu. (2018). Blockchain By Example: A developer's guide to creating decentralized applications using Bitcoin, Ethereum, and Hyperledger. United Kingdom: Packt Publishing Ltd.

**Course Code: CBS. 538**
**Course Title: Quantum Computing & Quantum Machine Learning- Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

## Course Objectives:

To provide one-to-one correspondence between theory and hands-on in terms of in-depth knowledge of fundamentals of Quantum Information Processing. To develop skills with hand-on experience of simulation of quantum computation in order to work in the field of Quantum Information Processing and Quantum Machine Learning. To acquire deeper understanding to design, develop, and analyse efficient algorithms in the field of Quantum Computing.

**Course Learning Outcomes:**

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

**CLO1:** Write a script to simulate qubits, multi-qubit pure and mixed quantum states, the celebrated Bell states and density matrices associated with entangled systems.

**CLO2:** Write a script to simulate quantum circuits composed of single and multi-qubit quantum gates.

**CLO3:** Write a script to simulate different measures of entanglement and nonlocality in pure and mixed two and three-qubit states.

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

**CLO5**: Simulate different quantum machine learning algorithms such as QSVM.

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

**Lab Assignments**

List of Practical will be based on Elective subject opted by the students

**Lab Evaluation:**

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

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

**Suggested Readings**

**2.** Lab Manuals

**Course Code: CBS.534**
**Course Title: Big Data Analytics and Visualization Lab**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

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

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

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

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

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

**Suggested Readings:**
1. Lab Manual

# Value Added Course

As per the availability of faculty

**Course Code: CBS.504**
**Course Title: Report writing using LaTeX**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Total Hours: 30**

**Course Objectives:**

The objective of this course is to equip students with the fundamental knowledge and practical skills required to create professional and structured documents using LaTeX. It aims to familiarize students with the basic commands and environments in LaTeX, enabling them to write articles, reports, theses, and other academic or technical documents. The course also focuses on building the capability to script various types of documents and integrate elements such as tables, figures, equations, and references. Additionally, it encourages the development of problem-solving skills to debug and troubleshoot LaTeX compilation issues effectively.

**Course Learning Outcomes:**

After the completion of course, participants will be able to:

CLO1: Use the basic commands in Latex.
CLO2: Develop scripts in Latex for different type of documents.
CLO3: Illustrate troubleshooting in the latex scripts.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**08 Hours** | **Latex Introduction:** Installing and setting Latex environment in Windows and Linux.<br>**Document Structure:** Essential in preparing the structure of documents, Creating Titles at different levels, Sections, Labelling and preparing Table of Contents. | **CLO-1** |
| | **Activities:** Live Demonstration of LaTeX scripts.<br>Assignment to write the LaTeX scripts. | |
| **II**<br>**08 Hours** | **Formatting Text:** Font Effects, Colored Text, Font Size, Bullets and lists, Comments, Spacing and Special Characters. | **CLO-1**<br>**CLO-2** |
| | **Activities:** Live Demonstration of LaTeX scripts.<br>Assignment to write the LaTeX scripts. | |
| **III**<br>**08 Hours** | **Tables:** Working with tables, Styles, Borders, Wrapping, Inserting new rows columns and caption of Tables.<br>**Figures:** Working with Figures, Formatting of Figures, caption, Alignment and wrapping Text around figures. | **CLO-1**<br>**CLO-2** |

| | | |
|---|---|---|
| | **Activities:** Live Demonstration of LaTeX scripts.<br>Assignment to write the LaTeX scripts. | |
| **IV**<br>**08 Hours** | **Equation:** Inserting Equation, Mathematical Symbols, Fractions, Roots, Sums & Integrals and Greek Letters.<br>**References:** BibTeX File, Inserting the bibliography, Citing References, Styles of References | **CLO-1, CLO-2**<br>**CLO-3** |
| | **Activities:** Live Demonstration of LaTeX scripts.<br>Assignment to write the LaTeX scripts. | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Lamport, L. (2014), Latex A document preparation system. New York: Adisson Wesley Publishing Company.
2. Kotwiz. S. (2015). Latex Cook Book. United Kingdom: Packt Publishing Lmt.
3. Nicola Louise Cecilia Talbot. (2013). Using LaTeX to Write a PhD Thesis, Dickimaw Books.
4. Research Articles from SCI & Scopus indexed Journals.

# Value Added Course

**(For other departments only as per the availability of faculty)**

**Course Code: CST.505**
**Course Title: Basics of Machine Learning**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Course Objectives:**

The objective of this course is to develop a strong understanding of the issues and challenges associated with machine learning. It aims to provide students with insights into the strengths and limitations of various popular machine learning approaches. The course also focuses on enabling students to apply appropriate machine learning techniques for effective data handling and knowledge extraction. Furthermore, it equips learners with the skills to evaluate the performance of algorithms and design solutions for real-world applications.

**Course Learning Outcomes:**

At the end of this course, students will be able to:
**CLO1:** Recognize the characteristics of machine learning strategies
**CLO2:** Pre-process the data before applying to any real-world problem and can evaluate its performance
**CLO3:** Apply various supervised learning methods to appropriate problems
**CLO4:** Identify and integrate more than one technique to enhance the performance of learning.

| Units/Hours | Contents/ Activities | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**8 Hours** | **Introduction**: Brief Introduction to Machine Learning, History and background of History and background of AI and ML, Comparison of AI, ML and DL, Supervised Learning, Unsupervised Learning, Reinforcement Learning, Examples of various Learning Paradigms | **CLO 1** |
| | **Learning Activities**: Assignment based learning | |
| **II**<br>**7 Hours** | Python Ecosystem for ML: Data loading for ML Projects, Understanding data with Statistics, Understanding data with visualization, Preprocessing and feature extraction | **CLO 2** |
| | **Learning Activities**: Implementation & demonstration | |
| **III**<br>**8 Hours** | Machine Learning patterns Introduction: - Classification(Linear Regression, Logistic Regression, Support Vector Machine, Naïve Bayes, Decision Tree, Random Forest), Clustering | **CLO 3** |
| | **Learning Activities**: Real time examples and implementation. | |

| | | |
|---|---|---|
| **IV**<br>**7 Hours** | **Recent Trends:** Recent Trends and Applications of Machine Learning in different fields. | **CLO 4** |
| | **Learning Activities**: **:** Presentations | |

**Transactional Modes:**

- Lecture
- Blended Learning
- E-tutorial
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, “Mathematics for Machine Learning”, Cambridge University Press, 2019.
2. Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
3. Ethem Alpaydin,"Introduction to Machine Learning”, MIT Press, Prentice Hall of India, Third Edition 2014.

# Value Added Course

As per the availability of faculty

**Course Code: CST. XXX**
**Course Title: AI for Education**
**Total Hours: 30**

| L | T | P | Cr |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Course Objectives:**

This course aims to familiarize students and educators with Artificial Intelligence (AI) tools that enhance teaching, learning, and research practices. It provides hands-on experience with AI-powered applications for content creation, personalized learning, assessment, academic writing, and research productivity. The course encourages ethical and effective integration of AI into academic environments while promoting critical thinking about the use and limitations of AI in education.

**Course Learning Outcomes:**

After the completion of course, participants will be able to:

**CLO1:** Understand the fundamentals of AI and its relevance in the education sector.
**CLO2:** Use AI tools for teaching support, student engagement, and content creation.
**CLO3:** Employ AI-driven platforms for academic writing, citation management, and research enhancement.
**CLO4:** Apply AI-based tools for assessment, feedback, and personalization of learning.
**CLO5:** Evaluate ethical and responsible use of AI in education.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**8 Hours** | **Introduction to AI in Education (Theory + Demo)**<br><br>Overview of AI and Machine Learning concepts, Role of AI in modern education systems, Use cases of AI for teachers, students, and researchers, Types of AI tools: Generative AI, Predictive AI, and Analytical AI, Responsible and ethical use of AI in academics | **CLO1**<br>**CLO5** |
| | **Activities:** Live demonstration of AI use cases in education, Assignment on identifying 5 AI tools with academic use cases | |
| **II**<br>**8 Hours** | **AI Tools for Teaching and Learning**<br><br>Content creation tools: ChatGPT, Copilot, Canva AI, Tome AI, Lecture generation & presentation tools: Gamma, | **CLO2**<br>**CLO4** |

| | | |
|---|---|---|
| | SlidesAI, AI tools for student engagement: Mentimeter, Curipod, EdPuzzle, ClassPoint, Personalized learning apps: Scribehow, Diffit, MagicSchool.ai, AI-driven LMS integrations and virtual assistants | **CLO5** |
| | **Activities:** Live demonstration of AI tools for lesson planning and student engagement, Assignment to design a 3-slide AI-generated micro lesson with quiz | |
| **III**<br>**08 Hours** | **AI Tools for Students and Academic Writing**<br>Note-taking tools: Otter.ai, Notion AI, Grammar and writing enhancement: Grammarly, Quillbot, Hemingway, Summarization and reading tools: Scholarcy, TLDRthis, Reference and citation: EndNote, Zotero, Mendeley (with AI plugins), Avoiding plagiarism and responsible AI use in writing | **CLO3**<br>**CLO5** |
| | **Activities:** Live demonstration of AI tools for writing and referencing, Assignment to write an academic paragraph using AI tools with proper citations | |
| **IV**<br>**08 Hours** | **AI for Research and Assessment**<br>Literature review tools: Elicit, Research Rabbit, Connected Papers, Data analysis and visualization: ChatGPT Code Interpreter, SciSpace, Wolfram Alpha, Assessment generation: QuestionWell, Testportal, Formative, Feedback tools and rubrics generation using AI, Limitations and biases in AI tools for research and evaluation, Introduction to Prompt Engineering | **CLO3**<br>**CLO4**<br>**CLO5** |
| | **Activities:** Live demonstration of AI tools for research and assessment, Assignment to create a mini research workflow using two or more AI tools | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign.

2. Luckin, R. (2021). *AI in education: A guide for students and teachers*. Routledge.

3. Fitzpatrick, D., Fox, A., & Weinstein, B. (2023). *The AI classroom: The ultimate guide to artificial intelligence in education*. IMPress.

4. Huang, R., & Yang, J. (2023). *Artificial intelligence for education: Technologies and applications*. Springer.

# SEMESTER-III

**Course Code: CST.551**
**Course Title: Optimization Techniques**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
The outcome of this course is to provide insights to the mathematical formulation of real world problems and to optimize these mathematical problems using nature based algorithms. And the solution is useful especially for NP-Hard problems.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Formulate optimization problems.
**CLO2:** Explain and apply the concept of optimality criteria for various types of optimization problems.
**CLO3:** Solve various constrained and unconstrained problems in Single variable as well as multivariable.
**CLO4:** Apply the methods of optimization in real life situations.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | Engineering application of Optimization, Formulation of design problems as mathematical programming problems.<br>General Structure of Optimization Algorithms, Constraints, the Feasible Region. | **CLO1** |
| | **Activities:** Assignment Based Learning, Practice Examples | |
| **II**<br>**15 Hours** | **Branches of Mathematical Programming**: Optimization using calculus, Graphical Optimization, Linear Programming, Quadratic Programming, Integer Programming, Semi Definite Programming. | **CLO2** |
| | **Activities:** Numerical Based Questions | |
| **III**<br>**15 Hours** | Optimization Algorithms like Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc. | **CLO2,CLO3** |
| | **Activities:** Implementation of algorithms, Numerical Based questions for Genetic optimization | |

| | | |
|---|---|---|
| **IV**<br>**15 Hours** | Real life Problems and their mathematical formulation as standard programming problems. Recent trends: Applications of ant colony optimization, genetics and linear and quadratic programming in real world applications. | **CLO4** |
| | **Activities:** Case studies, Group Discussions, Presentations by students | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Wolsey, L. (1998). Integer programming. United States: Wiley-Interscience.
2. Antoniou, A., and Wu-Sheng, Lu. (2007). Practical Optimization Algorithms and Engineering Applications. New Delhi: Springer.
3. Edwin, K., Chong, P., and Zak S. H. (2017). An Introduction to Optimization, New Delhi: Wiley-India.
4. Bertsimas, D., & Weismantel, R. (2005). Optimization over integers. Waltham: Dynamic Ideas.
5. Karlof, J. K. (2005). Integer programming: theory and practice. London: CRC Press Inc.
6. Williams, H. P. (2010). Logic and Integer Programming. New York: Springer.
7. Chen, D., Batson, R. G., and Dang, Y., (2010). Applied Integer Programming: Modelling and Solution. United States: John Wiley and Sons.
8. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.631**
**Course Title: Intelligent Systems**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
This course provides a comprehensive introduction to the field of intelligent systems, focusing on the theories, algorithms, and applications of artificial intelligence and machine learning techniques. Students will gain a deep understanding of intelligent systems and their practical implementations. The course covers topics such as knowledge representation, reasoning, problem-solving, machine learning, natural language processing, computer vision, and robotics.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Demonstrate a comprehensive understanding of the principles and concepts of intelligent systems, including knowledge representation, reasoning, problem-solving, machine learning, natural language processing, computer vision, and robotics.
**CLO2:** Apply various techniques for knowledge representation and reasoning in intelligent systems, such as propositional and predicate logic, semantic networks, frames, and ontologies.
**CLO3:** Implement and evaluate different problem-solving methods and algorithms, including state-space search, uninformed and heuristic search algorithms, and optimization techniques.
**CLO4:** Utilize machine learning algorithms and evaluate their performance for various applications, such as classification, regression, clustering, and reinforcement learning. Demonstrate knowledge of the fundamental principles of intelligent systems.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | Definition and goals of intelligent systems, Historical overview of AI and intelligent systems and Applications of intelligent systems<br>Knowledge Representation and Reasoning: Knowledge-based systems structures, its basic components.<br>Propositional and predicate logic, Semantic networks and frames, Ontologies and knowledge graphs, Issues in knowledge representation<br>Problem-Solving and Search Algorithms: Problem formulation and state-space search | **CLO1, CLO2** |

| | | |
|---|---|---|
| **II**<br>**15 Hours** | Uninformed search algorithms (breadth-first, depth-first, etc.)<br>Heuristic search algorithms (A*, IDA*, etc.)<br>Optimization and search such as stochastic annealing and genetic algorithm.<br>Reasoning under uncertainty: Bayesian reasoning, Certainty factors and Dempster-Shafer Theory of Evidential reasoning,<br>Introduction to statistical learning and induction learning. | **CLO2,**<br>**CLO3** |
| | **Activities:** Assignment based learning, Demonstration of above theory using Mathematical / MATLAB tools | |
| **III**<br>**15 Hours** | Introduction to machine learning: Supervised, unsupervised, and reinforcement learning<br>Evaluation and performance metrics<br>Classification and Regression Algorithms: Decision trees and ensemble methods (random forests, boosting)<br>Naive Bayes classifiers, Support Vector Machines (SVM)<br>Neural Networks and Deep Learning: Introduction to artificial neural networks, Multilayer Perceptrons (MLPs), Convolutional Neural Networks (CNNs) for computer vision | **CLO4** |
| | **Activities:** Assignment based learning, Demonstration of supervised, unsupervised and reinforcement learning. | |
| **IV**<br>**15 Hours** | Natural Language Processing: Basics of natural language processing, Text preprocessing and feature extraction, Sentiment analysis and text classification<br>Computer Vision: Image preprocessing and feature extraction, Object detection and recognition, Image segmentation and clustering<br>Robotics and Intelligent Agents: Introduction to robotics and intelligent agents, Robot perception and control, Autonomous navigation and planning<br>Ethical and Social Implications of Intelligent Systems:<br>Bias and fairness in AI, Privacy and security considerations, Ethical frameworks and responsible AI | **CLO1,**<br>**CLO4** |
| | **Activities:** Demonstration of above theory using Mathemetica/ MATLAB tools, Case based study of realization of quantum computing. | |

**Transactional Modes:**

- Lecture
- Peer Learning/Teaching
- E-tutorial
- Case Studies
- Online Teaching Tools

**Suggested Readings:**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |


1. Russell, S., and Norvig, P. (2015). Artificial Intelligence: A Modern Approach. New Delhi: Pearson Education India.
2. Grosan, C., and Abraham, A. (2011) Intelligent Systems: A Modern Approach, Springer.
3. Rich, E., Knight, K.N., Shivashankar, B. (2012). Artificial intelligence. New Delhi: Tata McGraw hill education private limited.
4. Wilkins, N. (2020) Artificial Intelligence: The Ultimate Guide to AI, The Internet of Things, Machine Learning, Deep Learning + a Comprehensive Guide to Robotics, Bravex Publications.
5. Sutton, R.S., and Barto, A.G.(2018) Reinforcement Learning: An Introduction, Bradford Books.
6. Research Articles from SCI & Scopus indexed Journal


**Course Code: CST.554**
**Course Title: Mobile Applications & Services**
**Total Hours: 60**

**Course Objectives:**
This course presents the three main mobile platforms and their ecosystems, namely Android, iOS, and PhoneGap/Web OS. It explores emerging technologies and tools used to design and implement feature-rich mobile applications for smartphones and tablets

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Explain the fundamentals, frameworks, and development lifecycle of mobile application platforms including iOS, Android, and PhoneGap.
**CLO2:** Identify the target platform and users.
**CLO3:** Design and develop a mobile application prototype in one of the platforms (challenge project).

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | **Introduction:** Introduction to Mobile Computing, Introduction to Android Development Environment, Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools, Generic UI Development Android User. | **CLO-1** |
| | **Activities:** Group Discussion, Case studies. | |
| **II**<br>**15 Hours** | **More on Uis:** VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI, Multichannel and Multimodal Uis, . Storing and Retrieving Data, Synchronization and Replication of Mobile Data, Getting the Model Right, Android Storing and Retrieving Data, Working with a Content Provider. | **CLO-1** |
| | **Activities:** Assignment Based Learning, Live Demonstration | |

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|---|---|---|
| **III**<br>**15 Hours** | **Communications via Network and the Web:** State Machine, Correct Communications Model, Android Networking and Web, Telephony Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony<br>Notifications and Alarms-Performance, Performance and Memory Management, Android Notifications and Alarms, Graphics, Performance and Multithreading, Graphics and UI Performance, Android Graphics. | **CLO-2** |
| | **Activities:** Implementation based Learning, Live Demonstrations of Android Notifications and Graphics | |
| **IV**<br>**15 Hours** | **Putting It All Together:** Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Services Android **Multimedia:** Mobile Agents and Peer-to-Peer Architecture, Android Multimedia Platforms and **Additional Issues:** Development Process, Architecture, Design, Technology Selection, Mobile App Development Hurdles, Testing, Security and Hacking, Active Transactions, More on Security, Hacking Android.<br>Recent trends in Communication protocols for IOT nodes, mobile computing techniques in IOT, agents based communications in IOT. | **CLO-3** |
| | **Activities:** Case studies on recent trends, Presentations by students, Assignment based Learning. | |

**Transactional Modes:**

- Lecture
- Peer Learning/Teaching
- E-tutorial
- Experimentation
- Online Teaching Tools

**Suggested Readings:**


1. Lee, W. (2012). Beginning Android TM 4 Application Development. United Sates: John Wiley & Sons.
2. B'far, R.. (2013). Mobile computing principles: Designing and developing mobile applications with UML and XML. New Delhi: Cambridge university press.
3. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.632**
**Course Title: Deep Learning**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
To understand the basic ideas and principles of Neural Networks. To familiarize with Matching Deep network for Right Problem. To appreciate the use of Deep Learning for various Applications. To understand and implement Deep Learning Architectures

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Understand the role of Deep learning in Various Applications.
**CLO2:** To design and implement Various Deep Learning Architecture.
**CLO3:** Critically Analyse Different Deep Learning Models in various Projects.
**CLO4:** To know about applications of Deep Learning in NLP and Sequence Modelling

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**14 Hours** | Feed Forward Neural Networks, Gradient Descent, Back Propagation Algorithm, Vanishing, Gradient problem, Mitigation<br>Defining Deep Learning, Common Architecture of Deep Networks, Building Blocks of Deep Networks: RBM, Autoencoders, Variational Autoencoders | **CLO1, CLO2** |
| | **Activities:** Discussion of role of Neural Networks and Compression of features using Autoencoders.<br>Practical – Installation of TensorFlow and Keras. | |
| **II**<br>**15 Hours** | **Unsupervised Pretrained Networks:** Deep Belief Network, Generative Adversarial Network. **Convolutional Neural Networks(CNN):** General Architecture, Input Layers, Convolutional Layers, Pooling Layers, Fully Connected Layers.<br>**Recurrent Neural Networks:** General Architecture, Modelling with Time Dimensions, LSTM Network, Recursive Neural Network: Network Architecture, Varieties of Recursive Neural Networks | **CLO2** |
| | **Activities:** Discussion of role of CNN, RNN in Machine Learning. Assignment based learning for Concept of convolution and need for Pooling, Implementation of CNN and RNN with Tensor Flow | |

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|---|---|---|
| **III**<br>**16 Hours** | Matching Deep network for Right Problem, Modelling text Data with RNN, Implementation of LSTM and GRU layer. Generative RNN, Using RNN dropout to fight Overfitting. Using Bi-directional RNNs, Using Regularisation<br>Modelling Sequencing Data Using RNN. Implementing 1D Convolution and pooling for sequencing Data, Combining CNNs and RNNs for processing long Sequence. Training and evaluation of Model. Large Language models: BERT and GPT. | **CLO3, CLO4** |
| | **Activities:** Implementation of algorithms and assignment based learning. | |
| **IV**<br>**15 Hours** | Tunning CNN: CNN Architecture Patterns, Configuring Convolution Layers, Configuring Pooling Layers and Transfer Learning.<br>Tunning RNN: Preparing Network input data and Input Layer, Output layer and Run Output Layer, Training the Network, Common Issues with LSTM, Padding and Masking, Scoring with Masking. | **CLO4** |
| | **Activities:** Implementation and solution of CNN and RNN, case study of recent trends in Deep Learning. | |

**Transactional Modes:**

- Lecture
- Google Co-lab
- Collaborative Learning
- Peer Learning/Teaching
- Github/Kaggle

**Suggested Readings:**


1. Ian Good Fellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2020.
2. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2021.
3. Phil Kim, “Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence”, Apress , 2017.
4. Ragav Venkatesan, Baoxin Li, “Convolutional Neural Networks in Visual Computing”, CRC Press, 2018.
5. Navin Kumar Manaswi, “Deep Learning with Applications Using Python”, Apress, 2018.
6. Joshua F. Wiley, “R Deep Learning Essentials”, Packt Publications, 2016.
7. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.556**
**Course Title: Cost Management of Engineering Projects**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
This course provides students with skills and knowledge of cost management of engineering projects. The course will enable students to understand the key components of engineering project.

**Course Learning Outcomes:**
After the completion of the course the students will be able to
**CLO1:** Employ their knowledge and skills together to understand the basics of a successful project.
**CLO2:** Explain the cost behaviour and profit planning
**CLO3:** Compare various quantitative methods for cost management

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | Introduction and Overview of the Strategic Cost Management Process<br>Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making. | **CLO1** |
| | **Activities:** Numerical Example for above concepts | |
| **II**<br>**15 Hours** | **Project:** meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance.<br>Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process. | **CLO1,CLO 2** |
| | **Activities:** Case study of IT Companies | |

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|---|---|---|
| **III**<br>**15 Hours** | Cost Behaviour and Profit Planning Marginal Costing: Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. | **CLO3** |
| | **Activities:** Case study and Numerical example to understand the above theory. | |
| **IV**<br>**15 Hours** | Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.<br>Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory. | **CLO4** |
| | **Activities:** Case study and Numerical Example for better understanding. | |

**Transactional Modes:**

- Lecture
- E-tutorial
- Problem Solving
- Self-Learning
- Online Teaching Tools

**Suggested Readings:**


1. Horngren, C. T., and Datar, S. M. (2017). Cost Accounting a Managerial Emphasis. New Delhi: Pearson Education.
2. Riahi-Belkaoui, A. (2001). Advanced Management Accounting. California: Greenwood Publication Group.
3. Kaplan, R. S., and Alkinson, A. A. (1998). Management Accounting. United States: Prentice Hall.
4. Bhattacharya, A. K. (2012). Principles & Practices of Cost Accounting. Allahabad, A. H. Wheeler publisher.
5. Vohra, N. D. (2017). Quantitative Techniques in Management. New Delhi: Tata McGraw Hill Education.
6. Rao, Thukaram M.E. (2011). Cost and management accounting. New Delhi: New age international publishers.
7. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CBS.553**
**Course Title: Cyber Law**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
The objective of this course is to provide knowledge about the basic information on IT Act and Cyber law as well as the legislative and judicial development in the area.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Analyze fundamentals of Cyber Law.
**CLO2:** Discuss IT Act & its Amendments.
**CLO3:** Relate Cyber laws with security incidents.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I**<br>**15 Hours** | Concept of Cyberspace, Issues of Jurisdiction in Cyberspace: Jurisdiction Principles under International law, Jurisdiction in different states, Position in India. Conflict of Laws in Cyberspace, International Efforts for harmonization Privacy in Cyberspace. | **CLO1** |
| | **Activities:** Case Studies on Jurisdiction | |
| **II**<br>**15 Hours** | Electronic Commerce, Cyber Contract, Intellectual Property Rights and Cyber Laws. UNCITRAL Model Law, Digital Signature and Digital Signature Certificates, E-Governance and Records. | **CLO2** |
| | **Activities:** Brainstorming Sessions on Significance of UNCITRAL in day to day life of a common man. | |
| **III**<br>**15 Hours** | Define Crime, Mens Rea, Crime in Context of Internet, Types of Cyber Crime, Computing Damage in Internet Crime, Offences under IPC (Indian Panel Code, 1860), Offences & Penalties under IT Act 2000, IT Act Amendments, Investigation & adjudication issues, Digital Evidence. | **CLO2**<br>**CLO3** |
| | **Activities** Exercises and problem solving skills on cyber disputes. | |

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|---|---|---|
| **IV**<br>**15 Hours** | Obscenity and Pornography, Internet and potential of Obscenity, International and National Instruments on Obscenity & Pornography, Child Pornography,<br>Important Case Studies. | **CLO3** |
| | **Activities:** Exercises and problem solving skills on cyber crimes. | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Ahmad, F. (2015). Cyber Law in India, Faridabad: New era law publications.
2. Sharma, J.P., Kanojia, S. (2016). Cyber Laws, New Delhi: Ane Books Pvt Ltd.
3. Chander, H. (2012). Cyber Laws and IT Protection. New Delhi: Prentice Hall India Learning Private Limited.
4. Justice Yatindra Singh. (2016). Cyber Laws. New Delhi: Universal Law Publishing Co.
5. Chaubey, R.K. (2012). An Introduction to cyber-crime and cyber law, Kolkata: Kamal Law House.
6. Tiwari, G. (2014). Understanding Laws: Cyber Laws & Cyber Crimes. New York: Lexis Nexis.
7. Seth, K. (2013). Justice Altamas Kabir, Computers Internet and New Technology Laws. New York: Lexis Nexis.
8. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.557**
**Course Title: Software Metrics**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
Understand the underlying concepts, principles and practices in Software Measurements. Designing of Metrics model for software quality prediction and reliability.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Explain the role of software Metrics in Industry size software
**CLO2:** Prepare empirical investigation of software for a quality measurement
**CLO3:** Examine software reliability and problem solving by designing and selecting software reliability models.

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

| | | |
|---|---|---|
| **III**<br>**15 Hours** | **Measuring Internal Product attributes:** Software Size, Length, reuse, Functionality, Complexity, Software structural measurement, Control flow structure, Cyclomatic Complexity, Data flow and data structure attributes Architectural measurement.<br>**Measuring External Product attributes:** Software Quality Measurements, Aspectes of Quality Measurements, Maintainability Measurements, Usability and Security Measurements. | **CLO2** |
| | **Activities:** Case study with Bugzila and JEERA tools | |
| **IV**<br>**15 Hours** | Measuring software Reliability: Concepts and definitions, Software reliability models and metrics, Fundamentals of software reliability engineering (SRE), Reliability management model. | **CLO3** |
| | **Activities:** Case study with Bugzila and JEERA tools | |

**Transactional Modes:**

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

**Suggested Readings:**


1. Fenton, N. E. and Pfleeger, S. L. (1996). Software Metrics: A Rigorous and Practical Approach. New York: International Thomson Computer Press.
2. Kan, S. H. (2002). Metrics and Models in Software Quality Engineering. United States: Addison-Wesley Professional.
3. Anirban, B. (2015). Software Quality Assurance, Testing and Metrics. United States: Prentice Hall India Learning.
4. Tian, J. (2010). Software quality engineering: Testing, quality assurance and quantifiable improvement. New Delhi: Wiley India.
5. Research Articles from SCI & Scopus indexed Journals.

**Course Code: CST.633**
**Course Title: Ethics in Data Science**
**Total Hours: 60**

| L | T | P | Cr |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**Course Objectives:**
Ethics of Data Science is designed to build studentsÕ ethical imaginations and skills for collecting, storing, sharing and analyzing data derived from human subjects including data used in algorithms. The course provides historical background to understand the tenets of informed consent, discrimination, and privacy. Using case study design, students will explore current applications of quantitative reasoning in organizations, algorithmic transparency, and unintended automation of discrimination via data that contains biases rooted in race, gender, class, and other characteristics.

**Course Learning Outcomes:**
After completion of course, students would be able to:
**CLO1:** Describe the basic notions of Data Ethics.
**CLO2:** Explain the Ethics of Data Collecting Ethics.
**CLO3:** Employ correct and meaningful way of data Sharing and Gathering through scrapping.
**CLO4:** Learn the Privacy and surveillance.

| Units/Hours | Contents | Mapping with Course Learning Outcome |
|---|---|---|
| **I 16 Hours** | Overview of ethical issues in data-driven organizations: Overview of data science as an ethical practice, Introduction to the unique ethical challenges of 'big data', Ethical Theory Philosophical frameworks for assessing fairness, Early theories of fairness, Moving towards contemporary theories of fairness | **CLO1** |
| | **Learning Activities**: Learning on the basis of Assignment and Discussion | |
| **II 14 Hours** | Research ethics for data science: Ethical side effects of the publish or perish system: p-hacking and small sample size, The misapplication of informed consent in dataveillance practices. | **CLO2** |
| | **Learning Activities**: Learning on the basis of Assignment and Discussion | |
| **III 16 Hours** | Techniques of data ethics: Getting from data to individuals: Internet traces and Geofingerprints. All data are human data: On the discriminatory trouble with training data. The ethics of data scraping and storage, Mosaic data, found data, and designed data. | **CLO3** |
| | **Learning Activities**: Learning on the basis of Assignment and Discussion | |
| **IV 14 Hours** | Privacy and Surveillance, Special topics in surveillance: Adtech, Special topics in surveillance: Employment, Differential privacy. | **CLO4** |
| | **Learning Activities:** Learning on the basis of Assignment and Discussion | |

**Transactional Modes:**

- Lecture
- Flipped Learning
- Collaborative Learning
- Peer Learning/Teaching
- Online Teaching Tools

**Suggested Readings:**


1. Ethics and Data Science, by DJ Patil, Hilary Mason, and Mike Loukides, 25 July 2018.
2. Barocas, Solon and Selbst, Andrew. (2016) Big data's disparate impact. California Law Review. Vol. 104(3).
3. The International consortium of investigators for fairness in trial data sharing. (2016) Toward fairness in data sharing. The New England Journal of Medicine. 375: 405-407.

**Course Code: CST.600**
**Course Title: Dissertation Part I**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 20 | 10 |

**Course Objectives:**

The student shall have to write his/ her synopsis including an extensive review of literature with simultaneous identification of scientifically sound (and achievable) objectives backed by a comprehensive and detailed methodology. The students shall also present their synopsis to the synopsis approval committee. The second objective of Dissertation would be to ensure that the student learns the nuances of the scientific research. Herein the student shall have to carry out the activities/experiments to be completed during Dissertation (as mentioned in the synopsis).

**Course Outcomes**

**CLO1:** The students would present their work to the Evaluation Committee (constituted as per the university rules).

# SEMESTER –IV

**Course Code: CST.600**
**Course Title: Dissertation Part II**

| L | T | P | Cr |
|---|---|---|---|
| 0 | 0 | 32 | 16 |

**Course Objectives:**
In Dissertation the student shall have to carry out the activities/experiments to be completed during Dissertation (as mentioned in the synopsis).

**Course Learning Outcomes:**
CLO1: The students would present their work to the evaluation Committee (constituted as per the university rules).
One research paper (either communicated to a Journal or accepted/ presented/published in conference proceedings) out of the dissertation research work is compulsory. The Evaluation criteria shall be as detailed below:

| Evaluation By | Maximum Marks | Evaluation Criteria |
|---|---|---|
| External expert, HoD and senior-most faculty of the department | 50 | Dissertation report (30), presentation (10), final viva-voce (10) |
| Supervisor | 50 | Continuous assessment (regularity in work, mid-term evaluation) dissertation report, presentation, final viva-voce |
| **Total** | 100 | |

Student will be given final marks based the average marks by the Evaluation Committee

**Timeline Work of Dissertation:**

| Month | JAN | FEB | MAR | APR | MAY | JUNE |
|---|---|---|---|---|---|---|
| **Dissertation** | Bi- Weekly report submitted to Supervisor | Bi- Weekly report submitted to Supervisor | Report submission in 1st week | Pre- Submission Presentation in 3st week<br>Report submission in 4th week | Final Submission of Dissertation/ Industrial Project and External Evaluation | |