CENTRAL UNIVERSITY OF PUNJAB BATHINDA

M. Tech Computer Science & Engineering

Session - 2024-26

Department of Computer Science & Technology

Programme Educational Learning Outcomes

1. 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.
2. To enable students to gain research and development competence to sustain in academia as well as industry.
3. 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 Outcome

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	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)						
CST.514	Distributed database system– Lab	Skill Development	0	0	2	**1**
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	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**					
Elective IV (opt any one)						
CST.525	GPU computing					
CST.539	**Natural Language Processing**					
CBS.525	Secure coding					
CBS.623	**Network security**					
CST.529	Blockchain technology					
CST.627	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					
Elective Lab IV (opt any one)						
CBS.625	**Network security – Lab**	Skill Development	0	0	2	**1**
CST.535	GPU computing – Lab					
CST.626	**Natural Language Processing– Lab**					
CST.536	Blockchain technology – Lab					
CST.628	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**	**26**

Course Structure of M.Tech Computer Science & Technology
SEMESTER- III

Course Code	Course Title	Course Type	L	T	P	Cr
CST.551	Optimization techniques	Opt any one Discipline Elective/MOOC course list approved by the department	4	0	0	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.559	Capstone lab	Core	0	0	2	1
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 Assesment: [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.

L	T	P	Cr
4	0	0	4

Course Code: CST.606

Course Title: **Research Methodology and IPR**

Total Hours: 60

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 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.

Activities: Units/Hours	Contents	Mapping with Course Learning Outcome
I 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 15 Hours	Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper 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 14 Hours	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	CLO3
	Learning Activities: Case Studies	
IV 16 Hours	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. 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

Text Books
1. Kumar, R. (2019). Research Methodology: A Step by Step Guide for beginners. New Delhi: SAGE Publications Ltd.

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. Halbert, (2006). Resisting Intellectual Property. New Delhi: Taylor & Francis Ltd.
4. Mayall, (2011). Industrial Design. New Delhi: McGraw Hill.
5. Niebel, (1974). Product Design. New Delhi: McGraw Hill.
6. Asimov, M. (1976). Introduction to Design. United States: Prentice Hall.
7. Merges, R. P., Menell, P. S., & Lemley, M. A. (2003). Intellectual Property in New Technological Age. United States: Aspen Law & Business.
8. Flick, U. (2011). Introducing research methodology: A beginner's guide to doing a research project. New Delhi: Sage Publications India.
9. Research Articles from SCI & Scopus indexed Journals.

L	T	P	Cr
4	0	0	4

Course Code: CBS.513

Course Title: Mathematical and Statistical Foundation of Computer Science

Total Hours: 60

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 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 **15 Hours**	Distribution Function: Probability mass, density. Cumulative distribution functions, Probability distributions (Binomial, Poisson and Normal). Expected value, Probabilistic inequalities, Random samples, sampling distributions of estimators Kurtosis and Skewness. **Sampling Distributions and Point Estimation of parameters: General Concepts of Point Estimation, Unbiased Estimators, Variance of a Point Estimator, Standard Error: Reporting a Point Estimate Methods of Point Estimation(Method of Moments, Method of**	**CLO1**

	Maximum Likelihood, Bayesian Estimation of Parameters)	
	Activities: Exercise based learning.	
II **15 Hours**	Basic Statistics: Differences between parametric and non- parametric statistics, Univariant and multivariant analysis. Frequency distribution. Mean, Median, Mode, Standard deviation, Variation, Standard error, significance testing and levels of significance, One-way and two-way analysis of variance (ANOVA), Critical difference (CD). Introduction to Fuzzy Set Theory.	**CLO2**
	Activities: Analysis of live data from dataworld.org/Kaggle.com.	
III **15 Hours**	**Statistical Inference for Single and Two Samples: Tests on the Mean of a Single and Two Sample Normal Distribution, known and Un-known Variance, Tests on the Variance and Standard Deviation of a Normal Distribution. A Nonparametric Test for the Difference in Two Means** Graph Theory: Isomorphism, Planar graphs, graph colouring, Hamilton circuits and Euler cycles. Specialized techniques and Algorithms to solve combinatorial enumeration problems.	**CLO3**
	Activities: Simulation based learning from web resources.	
IV **15 Hours**	**R Programming: Introduction to R, , Function, Control Flow and Loops, Working with Vector and matrices, Reading and Writing Data inn Files, Working with data, Statistical and Mathematical Operations and Model implementation as studied above** Computer science and engineering applications with any of following area: Data mining, Computer security, Software engineering, Computer architecture, Bioinformatics, Machine learning. Recent Trends in various distribution functions in mathematical field of computer science for varying fields like, soft computing, and computer vision.	**CLO4**
	Activities: Problem solving and solution design of computer engineering problem.	

Transactional Modes:

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

Text Book
1. Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (2013). Probability and statistics for engineers and scientists (10th ed.). Pearson.

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.
5. Research Articles from SCI & Scopus indexed Journals.

L	T	P	Cr
4	0	0	4

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

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

UNIT I: Network layer and protocol
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.

UNIT II: Data forwarding and Routing
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 Routing: BGP, Broadcast and Multicast Routing: Broadcast Routing Algorithms.

UNIT III: Unicast and Multicast routing protocols
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).

UNIT IV: Transport and application layer protocol

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.

Transactional Modes:

● Lecture
● Blended Learning
● Collaborative Learning
● Peer Learning/Teaching

Textbook:

1. Data Communication and Networking 5E Forouzan Behrouz A. McGraw Hill Education (India), New Delhi, 2005, ISBN-13:978-1-25-906475-3

 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

L	T	P	Cr
4	0	0	4

Code: CST.509

Course Title: Wireless Sensors Networks

Total Hours: 60

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 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 16 Hours	Introduction to Wireless Sensor Networks: Course Information, Introduction to Wireless Sensor Networks: Motivations, Applications, Performance metrics, History and Design factors. Network Architecture: Traditional layered stack, Cross-layer designs, Sensor Network Architecture.	CLO3
	Learning Activities:	

II 14 Hours	Medium Access Control Protocol design: Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled. Introduction to Markov Chain: Discrete time Markov Chain definition, properties, classification and analysis. MAC Protocol Analysis: Asynchronous duty-cycled. X-MAC Analysis (Markov Chain).	CLO1 CLO2
	Learning Activities:	
III 13 Hours	Routing protocols for WSN: Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast Opportunistic Routing Analysis: Analysis of opportunistic routing (Markov Chain).	CLO3 CLO4
	Learning Activities:	
IV 17 Hours	Security: Possible attacks, countermeasures, SPINS, Static and dynamic key Distribution. Introduction to Network Simulations: Introduction to Network Simulator, Description of the module and simulation example. Advanced Topics: Recent development in WSN standards, software applications.	
	Learning Activities:	

Transactional Modes:

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

Textbooks:
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.

Suggested Readings:

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.

L	T	P	Cr
4	0	0	4

Course Code: CST.609
Course Title: Data Science with R

Total Hours: 60

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 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 15 Hours	Introduction to R, Features of R, Basics of R,Assignment, Modes, Operators, Special numbers, Logical values , Basic Functions, R Data Data Structures, Control Structures. Vectors: Definition, Declaration, Generating Indexing, Naming , Adding & Removing elements , Operations on Vectors , Recycling , Special Operators , Vectorized if, then else,Vector Equality – Functions for vectors , Missing values , NULL values , Filtering & Subsetting.	CLO1
	Learning Activities: Implementation and solution of real time problem	

II 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, Factors and Tables.	CLO2
	Learning Activities: Assignment based Learning of real time problem	
III 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 Preprocessing, 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 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

Textbook:
1. Wickham, H., & Grolemund, G. (2023). R for data science (2nd ed.). O'Reilly Media.

Suggested Readings:

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

L	T	P	Cr
4	0	0	4

Course Code: CST.510
Course Title: Compiler for HPC

Total Hours: 60

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 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 15 Hours	High Performance Systems, Structure of a Compiler, Programming Language Features, Languages for High Performance. Data Dependence: Data Dependence in Loops, Data Dependence in Conditionals, Data Dependence in Parallel Loops, Program Dependence Graph. 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 15 Hours	Array Region Analysis, Pointer Analysis, I/O Dependence, Procedure Calls, Inter-procedural Analysis. 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. 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 15 Hours	Concurrency Analysis: Concurrency from Sequential Loops, Concurrency from Parallel Loops, Nested Loops, Round off Error, Exceptions and Debuggers. 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 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. Scalable Shared-Memory Machines: Global Cache Coherence, Local Cache Coherence, Latency Tolerant Machines. 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

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

Suggested Readings:

1. Muchnick, S. (1997). Advanced Compiler Design and Implementation. Elsevier.
2. Allen. (2001). Optimizing Compilers for Modern Architectures. California: Morgan Kaufmann.
3. Research Articles from SCI & Scopus indexed Journals.

L	T	P	Cr
4	0	0	4

Course Code: CBS. 608
Course Title: Linux OS and Scripting

Total Hours: 60

Course Objectives:
1. Familiarize students with the Linux environment, and able to run commands on a standard Linux operating system.
2. 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.
3. Develop the skills necessary for system programming and inter and intra process communication programming.

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
Unit 1 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.	CLO1
	Activities: Assignments and Group Discussion.	
Unit-II 14 Hours	**Shell Scripting Basics:** Shell Scripting Basics, Kernel, Shell, Shell Scripting, Types of Shells, Starting a Shell, Run a Shell Script. **Scripting Standards:** Scripting Standards, Scripts Naming Convention, Script File Permissions, Shell Script Format, Sequence of Script Execution.	CLO2
	Activities: Brainstorming, assignment-based learning	
Unit-III 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.	CLO3
	Activities: Hands on experience and Brainstorming.	
Unit-IV 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, User Directory Assignment, Exploitation scripting: Building exploits with Python, Creating Metasploit Exploits.	CLO4
	Activities: Hands on experience and Brainstorming.	

Transactional Modes:
● Lecture cum Demonstration
● Peer Learning/Teaching
● E-tutorial
● Self-Learning
● Online Teaching Tools

Text Book:
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.

Suggested Readings:

1. Robbins, A., Beebe, N. H. F. (2005). Classic Shell Scripting: Hidden Commands that Unlock the Power of Unix. Germany: O'Reilly Media, Incorporated.
2. Shotts, W. (2012). The Linux command line: a complete introduction. In No Starch Press eBooks. http://ci.nii.ac.jp/ncid/BB11395808
3. Cannon, J. (2015). Shell Scripting: How to Automate Command Line Tasks Using Bash Scripting and Shell Programming. CreateSpace.

L	T	P	Cr
4	0	0	4

Code: CST. 511
Course Title: Distributed Database System

Total Hours: 60

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 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 15 Hours	Introduction: Distributed data processing; what is a DDBS; Advantages and disadvantages of DDBS; Problem areas; Overview of database and computer network concepts. 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 15 Hours	Distributed Database Design: Alternative design strategies; Distributed design issues; Fragmentation; Data allocation. Semantics Data Control: View management; Data security; Semantic Integrity Control. 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 15 Hours	Distributed Query Optimization: Factors governing query optimization; Centralized query optimization; ordering of fragment queries; Distributed query optimization algorithms. Transaction Management: The transaction concept; Goals of transaction management; Characteristics of transactions; Taxonomy of transaction models. Concurrency Control: Concurrency control in centralized database systems; Concurrency control in DDBSs; Distributed concurrency control algorithms; Deadlock management.	CLO2
	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 15 Hours	Reliability: Reliability issues in DDBSs; Types of failures; Reliability techniques; Commit Protocols; Recovery protocols. Parallel Database Systems: Parallel architectures; parallel query processing and optimization; load balancing. 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

Textbook:
1. Deshpande, S., (2014). Distributed Databases. New Delhi: Dreamtech Press.

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. Saeed, K. R., Frank, S. H. (2010). Distributed Database Management Systems: A Practical Approach. New Delhi: Wiley.
4. Research Articles from SCI & Scopus indexed Journals.

L	T	P	Cr
4	0	0	4

Course Code: CST.512
Course Title: Information Security

Total Hours: 60

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 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

Unit I	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.	
Unit II	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.	
Unit III	Key Management: Symmetric-Key Distribution, Public-Key Distribution. Morden symmetric key Cryptographic Algorithms: Data Encryption Standard (DES), Triple DES, IDEA, Advance Encryption Algorithm (AES). Asymmetric key Cryptographic Algorithms: - Public-Key Cryptography Principles, Diffie–Hellman key exchange algorithm, Knapsack algorithm, RSA. Message Integrity and Message Authentication: Message Integrity, Approaches to Message Authentication, MD5, SHA-512, Digital Signature: Basics and Digital Signature Scheme.	CLO3 and CLO4
	Learning Activities: Implementation and web based simulation of various cryptographic algorithms.	
Unit IV	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

Activities: Brainstorming, assignment based learning			

Transactional Modes:

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

Textbook:
1. Kahate, A. (2011). Cryptography and Network Security. New Delhi:Tata McGraw-Hill Higher Ed.

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

L	T	P	Cr
4	0	0	4

Course Code: CST.513
Course Title: Software Testing & Maintenance

Total Hours: 60

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 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.

Activities: Units/Hours	Contents	Mapping with Course Learning Outcome
I 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. 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 15 Hours	Testing of OO systems: Objects and Classes, OO Testing, Class Testing, Regression Testing, Non-Functional Testing, Acceptance Testing, Mutation Testing. 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 CLO2
	Learning Activities: Case study of various organisation projects	
III 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. 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 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	CLO3

	Refactoring: Principles of Refactoring, Bad Smells in code, Composing Methods of Refactoring, Moving features between objects.	
	Learning Activities: Statistical Modelling of maintenance and Refactoring	

Transactional Modes:

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

Textbook:
1. Pressman, R. S., & Maxim, B. R. (2024). Software engineering: A practitioner's approach (9th ed.). McGraw Hill.

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

	T	P	Cr
4	0	0	4

Course Code: CST.506
Course Title: Advanced Data Structures

Total Hours: 60

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 Outcomes
After completion of course, students would be able to:
CLO1: Describe various types of data structures and list their strengths and weaknesses.
CLO2: Classify non-randomized and randomize algorithms.
CLO3: Use data structures for various applications.
CLO4: Summarize suitable data structure for computational geometry problems.

Units/Hours	Contents	Mapping with Course Learning Outcome
I 14 Hours	Introduction to Basic Data Structures: Importance and need of suitable data structures and algorithms. Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries. 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	
II 16 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. Binary Search Trees, AVL Trees, Red Black Trees, 2-3 Trees, Splay Trees. Binary Heaps, Fibonacci heaps, Data Structures for Disjoint Sets.	CLO 2
	Learning Activities: Visual Modelling of data structure	
III 16 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). Non-linear Data structure: Graph, Dynamic graph, Graph travels.	CLO 3
	Learning Activities: Web based Training via simulation modelling	

IV 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. 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

Textbooks:

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.

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

L	T	P	Cr
0	0	2	1

Course Code: CST.515
Course Title: Advanced Data Structures – Lab

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 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.

L	T	P	Cr
0	0	2	1

Course Code: CST.611
Course Title: Advance computer networks Lab

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 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.

L	T	P	Cr
0	0	2	1

Course Code: CST.516

Course Title: Wireless Sensors Networks Lab

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 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.

L	T	P	Cr
0	0	4	2

Course Code: CST.612
Course Title: Data Science with R/Python- Lab
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 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:
   Lab Manual

L	T	P	Cr
0	0	2	1

Course Code: CST.518
Course Title: Complier for HPC Lab

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 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.

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L	T	P	Cr
0	0	2	1

Course Code: CBS. 611
Course Title: Linux OS and Scripting Lab

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.

Lab Assignments
Practical will be based on as per the Teaching Learning in the Theory Class**.**
Course Outcomes:
CLO1: Demonstrate the use of various linux commands.
CLO2: Implement various scripts.

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

L	T	P	Cr
0	0	2	1

Course Code: CST.514
Course Title: Distributed Database System Lab

Course Objectives:
The objective of this course is to:
- 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 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:

Lab Manual

	T	P	Cr
	0	0	2	1

Course Code: CST.519
Course Title: Information Security Lab

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.

Learning Outcomes

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.

L	T	P	Cr
0	0	2	1

Course Code: CST.520
Course Title: Software Testing & Maintenance Lab

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
.

Interdisciplinary Course (IDC) Semester-I

L	T	P	Cr
2	0	0	2

Course Code: CBS.518
Course Title: IT Fundamentals

Total Hours: 30

Course 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.

-

Activities: Units/Hours	Contents	Mapping with Course Learning Outcome
I 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 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 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 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 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: **: 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

Textbooks:
1. Gookin, D. (2007). MS Word for Dummies. United States: Wiley.
2. Harvey, G. (2007). MS Excel for Dummies. United States: Wiley

Suggested Readings:

1. Sinha, P.K. (2004). Computer Fundamentals. New Delhi: BPB Publications.
2. Bott, E. (2009). Windows 7 Inside Out. United States: Microsoft Press.
3. Goel, A., Ray, S. K. (2012). Computers: Basics and Applications. New Delhi: Pearson Education India.
4. Research Articles from SCI & Scopus indexed Journals.

L	T	P	Cr
2	0	0	2

Course Code: CBS.519
Course Title: Programming in C

Total Hours: 30

Course 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.

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

	Learning Activities: Program fragments based exercises, Creating User defined function to perform simple activities and using them in C program		
IV 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

Textbook:

1. Rajaraman, V. (2008). Computer Basics and C Programming PHI Learning.

Suggested Readings:

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

L	T	P	Cr
2	0	0	2

Course Code: CST.530
Course Title: Introduction to Digital Logic

Total Hours: 30

Course 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 8 Hours	**Introduction:** Digital Signals, basic digital circuits: AND operation, OR operation and NOT operation. **Number Systems:** Introduction, Binary number system, Octal number system, Hexadecimal Number system, Conversion of one number system to other, Gray code.	CLO1 CLO2
	Learning Activities: Web based Simulation learning	
II 7 Hours	**Logic Gates and Boolean Algebra**: Boolean Laws, Boolean expression and functions, Logic Gates.	CLO3
	Learning Activities: Web based Simulation learning	
III 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 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

Textbooks:
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.

Suggested Readings:
3. Kharate, G.K. (2010). Digital Electronics. United States: Oxford Higher Education.
4. Research Articles from SCI & Scopus indexed Journals.

L	T	P	Cr
2	0	0	2

Course Code: CST.531
Course Title: Multimedia and Its Applications

Total Hours: 30

Course 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 8 Hours	**Introductory Concepts:** Multimedia-Definitions, Basi properties and medium types. Multimedia applications, Uses o Multimedia. **Sound/ Audio:** Basic Sound Concepts, Music. **Speech** Generation, Analysis and Transmission. **Learning Activities**: Group Discussion	CLO 1
II 7 Hours	**Images and Graphics:** Basic concepts: Image representatio image format, Graphics Format, Computer Image Processing. **Video and Animation:** Basic Concepts: Video Signa Representation, Computer Video Format. Televisio Conventional Systems, Enhanced Definition Systems, High Definition Systems. **Learning Activities**: Web based learning	CLO 2
III		

7 Hours	**Data Compression:** Storage space, coding requirements, JPEG MPEG. **Miscellaneous:** Optical Storage Media, Mutlimedia Operating Systems, Multimedia Communication Systems.	CLO 3
	Learning Activities: Simulation based Learning	
IV 8 Hours	**Documents and Hypertext:** Document Architecture, Manipulation of Multimedia Data, Hypertext, Hypermedia and Multimedia and example. **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

Textbooks:
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.

Suggested Readings:

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.

L	T	P	Cr
2	0	0	2

Course Code: CBS.532
Course Title: Introduction to MATLAB

Total Hours: 30

Course 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.

Activities: Units/Hours	Contents	Mapping with Course Learning Outcome
I 8 Hours	**Introduction**: MatLab, MatLab Syntax and interactive computations. Live Demonstration of MATLAB command prompt	CLO 1
	Learning Activities: Assignment based learning	
II 7 Hours	**Programming:** in Matlab using procedures and functions: Arguments and return values, M-files, Formatted console input-output, String handling. Live Demonstration of MATLAB M-files	CLO 1, CLO 2
	Learning Activities: Assignment based learning	

III 8 Hours	**Control Statements:** Conditional statements: If, Else, Elseif. Repetition statements: While, For. **Manipulating Text:** Writing to a text file, Reading from a text.	CLO 2
	Learning Activities: Creation of text files and assignment based learning	
IV 7 Hours	**Graph Plots:** Basic plotting, Built in functions **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

Textbooks:
1. Attaway. (2012). Matlab: A Practical Introduction to Programming and Problem Solving. Elsevier

Suggested Readings:

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.

L	T	P	Cr
2	0	0	2

Course Code: CST.607
Course Title: Basics of Python Programming

Total Hours: 32

Course 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 08 Hours	Introduction to algorithm, flowchart and programming, 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 08 Hours	**Lists:** Basic Operations, Iteration, Indexing, Slicing. Dictionaries: Basic dictionary operations, Basic String operations	**CLO2**
	Activities: Lab based practices for above concepts	
III 08 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 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

Textbooks:

1. Sweigart, AI. (2014). Automate the Boring Stuff with Python Practical Programming for Total Beginners. Switzerland: No Starch Press.

Suggested Readings:
2. Mark, L. (2013). Learning Python. California: Oreilly Media.
3. Research Articles from SCI & Scopus indexed Journal.

L	T	P	Cr
4	0	0	4

Course Code: CST.508
Course Title: Machine Learning

Total Hours: 60

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

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

Units/Hours	Contents	Mapping with Course Learning Outcome
I 16 Hours	**Introduction to learning Techniques:** Supervised Learning (Regression/Classification) ● Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes ● Linear models: Linear Regression, Logistic Regression, Generalized Linear Models ● Support Vector Machines, Nonlinearity and Kernel Methods ● Beyond Binary Classification: Multi-class/Structured Outputs, Ranking **Activities:** Brainstorming, assignment based learning	CLO1
II 14 Hours	**Unsupervised Learning** ● Clustering: K-means/Kernel K-means ● Dimensionality Reduction: PCA and kernel PCA ● Matrix Factorization and Matrix Completion ● Generative Models (mixture models and latent factor models) **Activities:** Exercise based learning and practical hands on training	CLO1 and CLO 2
III 14 Hours	Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests). Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning. Introduction to ANN and Deep learning. **Activities:** Exercise based learning and practical hands on training	CLO2 CLO4

IV 16 Hours	Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference. Simulation Tool for Machine Learning, Hands on with recent tools WEKA, R, MATLAB Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.	CLO2	
	Activities: Analysis of various case studies		

Transactional Modes:

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

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

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 Journals.

L	T	P	Cr
4	0	0	4

Course Code: CST.522
Course Title: Soft Computing

Total Hours: 60

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 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 14 Hours	**Introduction to Soft Computing:** Evolution of Computing: Soft Computing Constituents, From Conventional, Major areas of Soft Computing, applications of Soft Computing. Activity: Brainstorming, assignment based learning **Neural Networks:** Introduction, Brief history, Neural Networks Characteristics, architecture, and properties. Neural Network Learning Algorithm Machine Learning Using Neural Networks.	CLO1
	Activities: Exercise based learning and practical hands on training.	
II 16 Hours	**Fuzzy Logic:** Fuzzy Sets, Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations. Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making, Fuzzy Models.	CLO2
	Activities: Assignment and Exercise based learning	
III 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 16 Hours	**Swarm intelligence:** Overview, mechanism, technologies like particle swarm optimization, ant colony optimization, cuckoo search. **Introduction to hybrid systems**: Neuro Fuzzy, Neuro Genetics and Fuzzy Genetic system. 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

Textbook:
1. Rajasekaran, S., and Vijayalakshmi Pai, G.A. (2013). Neural Networks, Fuzzy Logic and Genetic Algorithms. United States: Prentice Hall India Learning.

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. Priddy, K. L., and Keller, E. P. (2005). Artificial Neural Networks: An Introduction. Washington USA, SPIE Press.
5. Gen, M., and Cheng, R. (1999). Genetic Algorithms and Engineering Optimization. United States: Wiley-Interscience.
6. Research Articles from SCI & Scopus indexed Journal

L	T	P	Cr
4	0	0	4

Course Code: CST.523
Course Title: Computer Vision

Total Hours: 60

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 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 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 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 16 Hours	Pattern Recognition and Machine Learning 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 16 Hours	Image Analysis and Understanding 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. Deep Learning for Computer Vision: Introduction to deep learning frameworks (e.g., TensorFlow, PyTorch)	**CLO3**

	Activities: Review of various techniques, Hands on training		
IV 14 Hours	Convolutional Neural Networks (CNNs) for image classification Object detection and localization using CNNs (e.g., Faster R-CNN, YOLO) Semantic segmentation using CNNs (e.g., Fully Convolutional Networks, U-Net) 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

Textbook:

1. Goodfellow, I., Bengio Y., and Courville, A. (2017). Deep Learning. Cambridge: MIT Press.

Suggested Readings:

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

L	T	P	Cr
4	0	0	4

Course Code: CBS.523

Course Title: Secure Software Design

Total Hours: 60

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 Outcomes
After completion of course, students would be able to:
    CLO1: 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 13 Hours	**Secure Software Design:** 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 17 Hours	**Enterprise Application Development** 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 15 Hours	**Enterprise Systems Administration** 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 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. 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

Textbook:

1. McGraw, G. (2006). Software Security: Building Security. New Delhi: Tata McGraw.

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. Stuttard, D. (2011). The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws. United States: Wiley.
4. Solem, J. E. (2012). Programming Computer Vision with Python: Tools and algorithms for analyzing images. California: O'Reilly Media.
5. Fernandez, E. B. (2013). Designing secure architecture using software patterns, United Kingdom: John Wiley & sons limited.
6. Research Articles from SCI & Scopus indexed Journals.

	L	T	P	Cr
	4	0	0	4

Course Code: CST.524
Course Title: Internet of Things

Total Hours: 60

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

Course Outcomes
After completion of course, students would be able to:
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
Unit-1 16Hours	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.	
Unit-2 14Hours	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	
Unit-3 14Hours	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.			
Unit-4 16Hours	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

Text Book

1. Sharma, S. (2018). Smart Cities Unbundled. Bloomsbury Publishing.
2. Kamal, R. (2017). Internet of Things: Architecture and Design Principles.

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.

L	T	P	Cr
4	0	0	4

Course Code: CST.525
Course Title: GPU Computing

Total Hours: 60

Course Objectives:

To help students learn parallel programming with Graphics Processing Units (GPUs).

Course 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 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. **Activities:** Assignment Based Learning, Case studies, Simple Implementation	**CLO1**
II 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. **Activities:** Implementation Based Learning, Matrices Computation.	**CLO1**
III 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 **Functions:** Device functions, Host functions, Kernels functions, Using libraries (such as Thrust), and developing libraries. **Activities** Assignment Based Learning, Implementation of Worklists and Linklists, Live Demonstration	**CLO2,CLO3**
	Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects.	**CLO4**

IV 16 Hours	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. Case Studies: Image Processing, Graph algorithms, Simulations, Deep Learning Advanced topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing.	
	Activities: Case studies, Live implementation	

Transactional Modes:

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

Textbooks:
1. Kirk, D., Hwu, W., and Kaufman, M. (2010). Programming Massively Parallel Processors: A Hands-on Approach. Massachusetts: Morgan Kaufmann.

Suggested Readings:

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

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

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

Textbooks:
1. Kirk, D., Hwu, W., and Kaufman, M. (2010). Programming Massively Parallel Processors: A Hands-on Approach. Massachusetts: Morgan Kaufmann.

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.

L	T	P	Cr
4	0	0	4

Course Code: CBS.525
Course Title: Secure Coding

Total Hours: 60

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

CLO1: Define secure programs and list various risks in the softwares.
CLO2: Classify different errors that lead to vulnerabilities.
CLO3: Analyze various possible security attacks.

Units/Hours	Contents	Mapping with Course Learning Outcome
I 15 Hours	**Software Security**: Security Concepts, Security Policy, Security Flaws, Vulnerabilities, Exploitation and Mitigations. Software Security problems, Classification of Vulnerabilities. **Security Analysis:** Problem Solving with static analysis: Type Checking, Style Checking, Program understanding, verifications and property checking, Bug finding and Security Review.	CLO1
	Activities: Group Discussion based learning	
II 15 Hours	**Strings:** Common String manipulating Errors, String Vulnerabilities and Exploits, Mitigation Strategies for strings, String handling functions, Runtime protecting strategies, Notable Vulnerabilities. **Integer Security**: Integer data Type, Integer Conversions, Integer Operations, Integer Vulnerabilities, Mitigation Strategies.	CLO2
	Activities: Implementation of above concepts in various programming Languages	

III 15 Hours	**Handling Inputs:** What to validate, How to validate, Preventing metadata Vulnerabilities. **Buffer Overflow**: Introduction, Exploiting buffer overflow vulnerabilities, Buffer allocation strategies**,** Tracking buffer sizes, buffer overflow in strings, Buffer overflow in Integers Runtime protections		**CLO3**
	Activities: Implementation of above concepts in various programming Languages		
IV 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 **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

Text Book:
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.

Suggested Readings:

1. Howard, M., LeBlanc, D. (2002). Writing Secure Code. New Delhi: Pearson Education.
2. Research Articles from SCI & Scopus indexed Journals.

L	T	P	Cr
4	0	0	4

Course Code: CBS.623
Course Title: Network Security

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 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
Unit 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	
Unit 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	
Unit 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,	**CLO3**

	Verifying Host IPv4 Settings, Testing Connectivity with ping, traceroute and telent.	
	Activities: Exercise based learning and practical hands-on training	
Unit 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. Access Control Lists: Ingress and Egress Filtering, Types of Access Control Lists, ACL types: standard and extended, ACL commands. Wireless Network Security. implementation of Denial of service (DoS) attacks, Distributed DoS (DDoS) attack and various types of DoS attacks.	**CLO4**
	Activities: Exercise based learning and practical hands on training	

- **Transactional Modes:**
  - ● Lecture
  - ● Case Studies
  - ● Collaborative
  - ● Self-Learning
  - ● Online Teaching Tools

Textbook:
1. Riggs, C., & Group, T. &. F. (2019). Network Perimeter Security: Building Defense In-Depth. Auerbach Publications.
2. Northcutt S. 2005. Inside Network Perimeter Security, 2nd   Ed., Pearson Education

Suggested Readings:
1. Stallings, W. (2017). Network Security Essentials: Applications and Standards.
2. Daimi, K. (2018). Computer and Network Security Essentials. In Springer eBooks. https://doi.org/10.1007/978-3-319-58424-9
3. Ibe, O. C. (2017). Fundamentals of Data Communication Networks. John Wiley & Sons. Forouzan,B.A, 2009, Data Communications and Networking, 4th Ed. Tata McGraw Hill Education.
4.

L	T	P	C r
4	0	0	4

Course Code: CST.529
Course Title: Blockchain Technology

Total Hours: 60

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 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 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 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 15 Hours	Distributed Consensus: Why Consensus, Distributed consensus in open environments, Consensus in a Bitcoin network. 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.	CLO-2
	Permissioned Blockchain: Permissioned model and use cases, Design issues for Permissioned blockchains, Execute contracts, 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 15 Hours	Blockchain Components and Concepts: Actors in a Blockchain, Components in Blockchain design, Ledger in Blockchain. Hyperledger Fabric architecture and design: Ordering Services, Channels in Fabric, Fabric Peer and Client application and fabric certificate authority. Hyperledger Fabric: Architecture and Transaction Flow. 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

Textbook:
1. 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.

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. 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.
3. Mukhopadhyay M. (2018). Ethereum Smart Contract Development: Build blockchain-based decentralized applications using solidity. United States: Packt Publishing Ltd.
4. Research Articles from SCI & Scopus indexed Journals.

Course Code: CST.627
Course Title: Quantum Computing & Quantum Machine Learning

Total Hours: 60

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 Outcomes

● Participants will understand the basic concepts and terminologies in quantum information processing and quantum machine learning.
● To work in the field of quantum information processing and quantum machine learning and to design efficient quantum algorithms to solve different computing problems.
● To design new or modify existing quantum machine learning algorithms for supervised and unsupervised learning.
● To grasp the working principle of a quantum computer and understand the impact of noise in real world implementations.
● To understand some of the long-standing issues in quantum computing, and way forward in Noise-Intermediate-Scale-Quantum and Quantum machine learning era.
● To understand the current scenario in Google, IBM, D-wave, IonQ etc.

Course 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 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. Activities: Exercise based learning, Demonstration of above theory using Mathemetica/ MATLAB tools	CLO1
	Activities: Assignment Based Learning, Case studies, Simple Implementation	
II 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. Activities: Assignment based learning, Demonstration of above theory using Mathemetica/ MATLAB tools	CLO1
	Activities: Implementation Based Learning, Matrices Computation.	

III 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. Activities: Assignment-based learning, Demonstration of Entanglement and Non-locality through animated videos.	CLO2,CLO3
	Activities Assignment Based Learning, Implementation of Worklists and Linklists, Live Demonstration	
IV 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 Quantum image representation, Quantum image Processing, Applications of Quantum image processing.	CLO4
	Activities: Case studies, Live implementation	

Transactional Modes:

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

Textbook:

1. Quantum Computing A developers guide, Pierpaolo Marturano (2023) De Gruyter denbourg

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. Dancing with Python Learn to code with Python and Quantum Computing, Robert S. Sutor (2021) PacktPub
5. Introduction to Quantum Computing, Ray LaPierre (2021) Springer
6. Research Articles
7. Research Articles from SCI & Scopus indexed Journals.

L	T	P	Cr
4	0	0	4

Course Code: CBS.524
Course Title: Big Data Analytics and Visualization

Total Hours: 60

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 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 15 Hours	**Big Data Introduction**: What is big data, why big data, convergence of key trends, unstructured data, industry examples of big data, web analytics, big data and marketing, fraud and big data, risk and big data, big data and healthcare, big data in medicine, advertising and big data, big data technologies, open source technologies, cloud and big data, mobile business intelligence, Crowd sourcing analytics, inter and trans firewall analytics. **Data Gathering and Preparation:** Data formats, parsing and transformation, Scalability and real-time issues.	**CLO1**
	Activities: Case Study and Group Discussion	
II 15 Hours	**Data Cleaning:** Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation. **Visualization:** Descriptive and comparative statistics, Designing visualizations, Time series, Geo-located data, Correlations and connections, Hierarchies and networks, interactivity.	**CLO2, CLO3**
	Activities: Implementation above theory with Python code	

III 15 Hours	**Big Data Technology:** Big Data Architecture, Big Data Warehouse, Functional Vs. Procedural Programming Models for Big Data **NoSQL:** Introduction to NoSQL, aggregate data models, key-value and document data models.	CLO3
	Activities: Implementation and designing with Spark/MongoDB	
IV 15 Hours	**Big Data Tools:** Hadoop: Introduction to Hadoop Ecosystem, HDFS, Map-Reduce programming, Spark, PIG, JAQL, Understanding Text Analytics and Big Data, Predictive Analytics of Big Data, Role of Data Analytics.	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

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

Suggested Readings:

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

L	T	P	Cr
0	0	2	1

Course Code: CST.517
Course Title: Machine Learning Lab

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

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

L	T	P	Cr
0	0	4	2

Course Code: CST.527
Course Title: Soft Computing Lab

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

Learning outcome:
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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L	T	P	Cr
0	0	2	1

Course Code: CST.533
Course Title: Computer Vision Lab

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 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

L	T	P	Cr
0	0	2	1

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

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 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

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 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:
Lab Manual

L	T	P	Cr
0	0	2	1

Course Code: CBS.625
Course Title: Network Security Lab

Credit Hour: 1

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 Outcomes:
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

L	T	P	Cr
0	0	2	1

Course Code: CST.535
Course Title: GPU Computing Lab

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 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:
Lab Manual

L	T	P	Cr
0	0	2	1

Course Code: CST.536
Course Title: Blockchain Technology Lab

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 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.

L	T	P	Cr
0	0	2	1

Course Code: CST.628
Course Title: Quantum Computing & Quantum Machine Learning- Lab

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 Outcomes:
At the end of the course the student will be able to:
- Write a script to simulate qubits, multi-qubit pure and mixed quantum states, the celebrated Bell states and density matrices associated with entangled systems.
- Write a script to simulate quantum circuits composed of single and multi-qubit quantum gates.
- Write a script to simulate different measures of entanglement and nonlocality in pure and mixed two and three-qubit states.
- Write a script to simulate different noisy channels to analyse the effect of noise on entanglement and efficiency of a protocol.
- 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
Lab Manuals

L	T	P	Cr
0	0	2	1

Course Code: CBS.534
Course Title: Big Data Analytics and Visualization Lab

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

Course 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:
Lab Manual

As per the availability of faculty

L	T	P	Cr
2	0	0	2

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

Total Hours: 32

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

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

L	T	P	Cr
2	0	0	2

Course Code: CST.505
Course Title: Basics of Machine Learning

Total Hours: 30

Learning Objectives:
1. Students have understanding of issues and challenges of Machine Learning.
2. Understanding of the strengths and weaknesses of many popular machine learning approaches.
3. Apply suitable machine learning techniques for data handling and to gain knowledge from it.
4. Evaluate the performance of algorithms and to provide solution for various real-world applications.

Course 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 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 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	

	Machine Learning patterns Introduction: - Classification(Linear Regression, Logistic Regression, Support Vector Machine, Naïve Bayes, Decision Tree, Random Forest), Clustering	
III 8 Hours		CLO 3
	Learning Activities: Real time examples and implementation.	
IV 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

Textbook:
1. Tom M. Mitchell, ―Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

Suggested Readings:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2019.
2. Ethem Alpaydin,"Introduction to Machine Learning", MIT Press, Prentice Hall of India, Third Edition 2014.

L	T	P	Cr
4	0	0	4

Course Code: CST.551   `
Course Title: Optimization Techniques

Total Hours: 60

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 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 15 Hours	Engineering application of Optimization, Formulation of design problems as mathematical programming problems. General Structure of Optimization Algorithms, Constraints, the Feasible Region.	**CLO1**
	Activities: Assignment Based Learning, Practice Examples	

II 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 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 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

Textbooks:
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.

Suggested Readings:

1. Edwin, K., Chong, P., and Zak S. H. (2017). An Introduction to Optimization, New Delhi: Wiley-India.
2. Bertsimas, D., & Weismantel, R. (2005). Optimization over integers. Waltham: Dynamic Ideas.
3. Karlof, J. K. (2005). Integer programming: theory and practice. London: CRC Press Inc.
4. Williams, H. P. (2010). Logic and Integer Programming. New York: Springer.
5. Chen, D., Batson, R. G., and Dang, Y., (2010). Applied Integer Programming: Modelling and Solution. United States: John Wiley and Sons.

6. Research Articles from SCI & Scopus indexed Journals.

L	T	P	Cr
4	0	0	4

Course Code: CST.631

Course Title: Intelligent Systems

Total Hours: 60

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 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 **15 Hours**	Definition and goals of intelligent systems, Historical overview of AI and intelligent systems and Applications of intelligent systems Knowledge Representation and Reasoning: Knowledge-based systems structures, its basic components. Propositional and predicate logic, Semantic networks and frames, Ontologies and knowledge graphs, Issues in knowledge representation Problem-Solving and Search Algorithms: Problem formulation and state-space search	**CLO1, CLO2**
II **15 Hours**	Uninformed search algorithms (breadth-first, depth-first, etc.) Heuristic search algorithms (A*, IDA*, etc.) Optimization and search such as stochastic annealing and genetic algorithm. Reasoning under uncertainty: Bayesian reasoning, Certainty factors and Dempster-Shafer Theory of Evidential reasoning, Introduction to statistical learning and induction learning.	**CLO2, CLO3**
	Activities: Assignment based learning, Demonstration of above theory using Mathematical / MATLAB tools	
III **15 Hours**	Introduction to machine learning: Supervised, unsupervised, and reinforcement learning Evaluation and performance metrics Classification and Regression Algorithms: Decision trees and ensemble methods (random forests, boosting) Naive Bayes classifiers, Support Vector Machines (SVM) 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.	

		CLO1, CLO4
IV **15 Hours**	Natural Language Processing: Basics of natural language processing, Text preprocessing and feature extraction, Sentiment analysis and text classification Computer Vision: Image preprocessing and feature extraction, Object detection and recognition, Image segmentation and clustering Robotics and Intelligent Agents: Introduction to robotics and intelligent agents, Robot perception and control, Autonomous navigation and planning Ethical and Social Implications of Intelligent Systems: Bias and fairness in AI, Privacy and security considerations, Ethical frameworks and responsible AI	
	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

Textbook:
1. Russell, S., and Norvig, P. (2015). Artificial Intelligence: A Modern Approach. New Delhi: Pearson Education India.

Suggested Readings:

1. Grosan, C., and Abraham, A. (2011) Intelligent Systems: A Modern Approach, Springer.
2. Rich, E., Knight, K.N., Shivashankar, B. (2012). Artificial intelligence. New Delhi: Tata McGraw hill education private limited.
3. 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.
4. Sutton, R.S., and Barto, A.G.(2018) Reinforcement Learning: An Introduction, Bradford Books.
5. Research Articles from SCI & Scopus indexed Journals.

L	T	P	C r
4	0	0	4

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 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 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 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	
III 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 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 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. 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

Textbooks:
1. Lee, W. (2012). Beginning Android TM 4 Application Development. United Sates: John Wiley & Sons.

Suggested Readings:

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.

L	T	P	Cr
4	0	0	4

Course Code: CST.632
Course Title: Deep Learning

Total Hours: 60

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 Outcomes:
After completion of course, students would be able to:
1. Understand the role of Deep learning in Various Applications.
2. To design and implement Various Deep Learning Architecture.
3. Critically Analyse Different Deep Learning Models in various Projects.
4. To know about applications of Deep Learning in NLP and Sequence Modelling

Units/Hours	Contents	Mapping with Course Learning Outcome

I Introduction **14 Hours**	Feed Forward Neural Networks, Gradient Descent, Back Propagation Algorithm, Vanishing, Gradient problem, Mitigation 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. Practical – Installation of TensorFlow and Keras.	
II Architecture of Deep Network **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. **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	
III Building Deep network **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 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 Tunning Deep Network **15 Hours**	Tunning CNN: CNN Architecture Patterns, Configuring Convolution Layers, Configuring Pooling Layers and Transfer Learning. 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

Textbooks:
1. Ian Good Fellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2020.
2. Francois Chollet, "Deep Learning with Python", Manning Publications, 2021.

Suggested Readings:

1. Phil Kim, "Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence", Apress , 2017.
2. Ragav Venkatesan, Baoxin Li, "Convolutional Neural Networks in Visual Computing", CRC Press, 2018.
3. Navin Kumar Manaswi, "Deep Learning with Applications Using Python", Apress, 2018.
4. Joshua F. Wiley, "R Deep Learning Essentials", Packt Publications, 2016.
5. Research Articles from SCI & Scopus indexed Journals.

L	T	P	C r
4	0	0	4

Course Code: CST.556
Course Title: Cost Management of Engineering Projects

Total Hours: 60

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 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 15 Hours	Introduction and Overview of the Strategic Cost Management Process 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 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. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.	CLO1,CLO2
	Activities: Case study of IT Companies	

III 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 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. 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

Textbooks:
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.

Suggested Readings:

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.

L	T	P	Cr
4	0	0	4

Course Code: CBS.553
Course Title: Cyber Law

Total Hours: 60

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 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 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. **Activities:** Case Studies on Jurisdiction	**CLO1**
II 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. **Activities:** Brainstorming Sessions on Significance of UNCITRAL in day to day life of a common man.	**CLO2**

III 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** **CLO3**
	Activities Exercises and problem solving skills on cyber disputes.	
IV 15 Hours	Obscenity and Pornography, Internet and potential of Obscenity, International and National Instruments on Obscenity & Pornography, Child Pornography, 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

Textbooks:
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.

Suggested Readings:

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.

L	T	P	Cr
4	0	0	4

Course Code: CST.557
Course Title: Software Metrics

Total Hours: 60

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

Course 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 15 Hours	**Overview of Software Metrics:** Measurement in Software Engineering, Scope of Software Metrics, Measurement and Models Meaningfulness in measurement, Measurement quality, Measurement process, Scale, Measurement validation, Object-oriented measurements. **Goal based framework for software measurement:** Software measure classification, Goal-Question-Metrics(GQM) and Goal-Question-Indicator-Metrics (GQIM), Applications of GQM and GQIM.	CLO1
	Activities: Case study and Group Discussion on OO methodology	

II 15 Hours	**Empirical Investigation:** Software engineering investigation, Investigation principles, Investigation techniques, Planning Formal experiments, Case Studies for Empirical investigations. **Object–oriented metrics:** Object-Oriented measurement concepts, Basic metrics for OO systems, OO analysis and design metrics, Metrics for productivity measurement, Metrics for OO software quality.	**CLO1, CLO2**
	Activities: Case study with Understand and Metrics Tools	
III 15 Hours	**Measuring Internal Product attributes:** Software Size, Length, reuse, Functionality, Complexity, Software structural measurement, Control flow structure, Cyclomatic Complexity, Data flow and data structure attributes Architectural measurement. **Measuring External Product attributes:** Software Quality Measurements, Aspectes of Quality Measurements, Maintainability Measurements, Usability and Security Measurements.	**CLO2**
	Activities: Case study with Bugzila and JEERA tools	
IV 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

Textbooks:
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.

Suggested Readings:

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.

L	T	P	Cr
4	0	0	4

Course Code: CST.633
Course Title: Ethics in Data Science

Total Hours: 60

Course Objectives:
Ethics of Data Science is designed to build studentsŌ 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 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

Textbooks:
1. Ethics and Data Science, by DJ Patil, Hilary Mason, and Mike Loukides, 25 July 2018.

Suggested Readings:

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.

L	T	P	Cr
0	0	2	1

Course Code: CST.559
Course Title: Capstone Lab

In this, the student has to select an area and specify the base paper in that area to implement the same and show the results.
Evaluation criteria will be based on objectives stated and achieved

Course Objectives:
The objective of this lab is to help a team of students develop and execute an innovative project idea under the direction of the Capstone course Incharge.

Course Outcomes
After the completion of the course the students will be able to
CLO1: Apply the four phases of project development: requirements analysis, design, implementation, and documentation.

Timeline Work:

Month	AUG	SEP	NOV
Seminar	Submit area and Objectives to be achieved	Weekly report to faculty Incharge.	3rd week submit report 4th week Presentation

 Evaluation Criteria:

Evaluation Parameter	Marks	Evaluated By
Area & Objectives	5	**Evaluation Committee**
Reports and Implementation	10	
Presentation and Viva-voce	10	
Total	**25**	

L	T	P	Cr
0	0	20	10

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

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

L	T	P	Cr
0	0	32	16

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

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 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	JUN
Dissert ation	Bi- Weekly report submitted to Supervisor	Bi- Weekly report submitted to Supervisor	Report submis sion in 1st week	Pre- Submission Presentation in 3st week Report submission in 4th week	Final Submission of Dissertation/ Industrial Project and External Evaluation	