CENTRAL UNIVERSITY OF PUNJAB

Master's Programme Course Structure

School: Engineering & Technology								
Department: Computer Science & Technology								
Programme: M-Tech. (Computer Science & Technology)								
Batch: 2018-19								
Semester : I								
S.No.	**Course Code**	**Course Title**	**Course Type**	**Name of Course Coordinator**	**Credit Hours**			
					L	**T**	**P**	**Total credit**
1.	CST.501	Research Methodology and Statistics for Engineering	FC		3	1	-	4
2.	CST.506	Advanced Data Structures and Algorithms	CC		3	1	-	4
3.	CST.507	Advanced Computer Networks	CC		3	1	-	4
4.	CST.508	Python Programming	CC		3	1	-	4
5.	CST.509	Advanced Data Structures and Algorithms Lab (Practical)	CC		-	-	4	2
6.	CST.510	Python Programming-Lab (Practical)	CC		-	-	4	2
7.	XXX.YYY	Inter-Disciplinary Elective -1 (From Other Departments)	IDC		2	-	-	2
				Total	**14**	**4**	**8**	**22**

Semester : II								
S.No.	**Course Code**	**Course Title**	**Course Type**	**Name of Course Coordinator**	**Credit Hours**			
					L	**T**	**P**	**Total credit**
1.	CST.521	Digital Image Processing	CC		3	1	-	4
2.	CST.522	Advanced Compiler Design	CC		3	1	-	4
3.	CST.523	Advanced Software Engineering	CC		3	1	-	4
4.	CST.524	Information Security	EC-1		3	1	-	4
	CST.525	Advanced Computer Architecture						
	CST.526	Cloud Computing and Security						
	CST.527	Soft Computing						
5.	CST.528	Distributed System	EC-2		3	1	-	4
	CST.529	Data Warehouse and Mining						
	CST.530	Wireless Ad-hoc Sensor Networks and IoTs						
	CST.531	Web Services						
6.	CST.532	Digital Image Processing – Lab (Practical)	CC		-	-	4	2
7.	CST.533	Distributed Operating System-Lab (Practical)	EC-2		-	-	4	2
8.	CST.534	Data Warehouse and Mining-Lab (Practical)						
	CST.535	Wireless Ad-hoc Sensor Networks and IoTs -Lab (Practical)						
	CST.536	Advanced Web Technologies-Lab (Practical)						
8.	XXX.YYY	Inter-Disciplinary Elective-2 (From Other Departments) (Practical)	IDC		2	-	-	2
				Total	**17**	**5**	**8**	**26**

Semester : III								
S.No.	**Course Code**	**Course Title**	**Course Type**	**Name of Course Coordinator**	**Credit Hours**			
					L	**T**	**P**	**Total credit**
1.	CST.551	Capstone Lab-I	EC		-	-	8	4
2.	CST.552	Big Data Analytics	EC		3	1	-	4
3.	CST.553	Embedded System Design						
	CST.554	E-Privacy: Privacy and Trust in the Electronic Society						
	CST.555	Information Retrieval						
4.	CST.556	Dissertation	EC		-	-	-	16
				Total	**3**	1	**8**	**24**

Semester : IV								
S.No.	**Course Code**	**Course Title**	**Course Type**	**Name of Course Coordinator**	**Credit Hours**			
					L	**T**	**P**	**Total credit**
1.	CST.571	Capstone Lab-II	EC		-	-	8	4
2.	CST.600	Dissertation	EC		-	-	-	20
				Total			**8**	**24**

The ratio of students is offered elective courses will be maintained evenly and the elective course will be allocated to the students based on his/her merit & preference.

SEMESTER I

CST.501 Research Methodology and Statistics for Engineering Credits: 3-1-0

Objective: The objective of this course is to ensure that a student learns basis of scientific research and statistical methods to arrive at and verify the conclusions drawn.
Course Outcomes: Upon completion of this course, the students will be able to:

- Prepare research proposal and plan
- Understand how to interpret data using hypothesis testing
- Describe the concept of multivariate analysis
- Explain the concept of plagiarism and intellectual property rights

Unit I

General principles of research: Meaning and importance of research, Critical thinking, Formulating hypothesis and development of research plan, Review of literature, Interpretation of results and discussion.
Bibliographic index and research quality parameters- citation index, impact factor, *h* index, i10 index, etc. Research engines such as google scholar, Scopus, web of science, etc.
Technical & scientific writing: Technical & Scientific writing - theses, technical papers, reviews, electronic communication, and research papers, etc., Poster preparation and Presentation and Dissertation. Reference Management using various softwares such as Endnote, reference manager, Ref works, etc. Communication skills – defining communication; type of communication; techniques of communication, etc.
Library: Classification systems, e-Library, Reference management, Web-based literature search engines.

Unit II

Plagiarism: Plagiarism, definition, Search engines, regulations, policies and documents/thesis/manuscripts checking through softwares, Knowing and Avoiding Plagiarism during documents/thesis/manuscripts/scientific writing.
Intellectual Property Rights: Intellectual Property, intellectual property protection (IPP) and intellectual property rights (IPR), WTO (World Trade Organization), WIPO (World Intellectual Property Organization), GATT (General Agreement on Tariff and Trade), TRIPs (Trade Related Intellectual Property Rights), TRIMS (Trade Related Investment Measures) and GATS (General Agreement on Trades in Services), Nuts and Bolts of Patenting, Technology Development/Transfer Commercialization Related Aspects, Ethics and Values in IP.

Unit III

Descriptive Statistics: Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart.
Measures: Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots.

Unit IV

Random variables and Distributions: Discrete and continuous random variables. Discrete Probability distributions like Binomial, Poisson and continuous distributions like Normal, F and student-t distribution.

Differences between parametric and non-parametric statistics. Confidence interval, Errors, Levels of significance, Hypothesis testing.

Parametric tests: Test for parameters of Normal population (one sample and two sample problems) z-test, student's t-test, F and chi-square test and Analysis of Variance (ANOVA).

Non-Parametric tests: One sample: Sign test, signed rank test, Kolmogrov-Smirnov test, run test. Critical difference (CD), Least Significant Difference (LSD), Kruskal–Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks.

Text books:

1. Theil, D.V. (2014). David Research Methods for Engineers, Cambridge University Press.
2. Kothari, C.R. (2013). Research Methodology: Methods and Techniques. New Age International.
3. S.C. Gupta (2014), Fundamentals of Statistics, Himalaya Publishing House

Suggested readings:

1. David J. Sheskin (2011), Handbook of Parametric and Nonparametric Statistical Procedures, Chapman and Hall/CRC.2.
2. Best J. W. (1999). Research in Education, New Delhi: Prentice Hall of India Pvt. Ltd.

CST-506 Advanced Data Structures and Algorithms Credits: 3-1-0

Objective: This course will provide knowledge related to various data structures and algorithms.
Course Outcomes: Upon completion of this course, the students will be able to:

- identify the properties, strengths, and weaknesses of different data structures
- examine various existing algorithms
- distinguish among various data structures

Unit I

Introduction to Basic Data Structures: Importance and need of good data structures and algorithms, Linked lists, Queues, Heaps, Hash tables, Binary search trees.

Unit II

Advanced Data Structures: Red-Black Trees, B-trees, Fibonacci heaps, Data Structures for Disjoint Sets.
Design Strategies: Divide-and-conquer, Dynamic Programming, and Greedy Method.

Unit III

Internal and External Sorting algorithms: Linear Search, Binary Search, Bubble Sort, Insertion Sort, Shell Sort, Quick Sort, Heap Sort, Merge Sort, Counting Sort, Radix Sort.
Advanced String Matching Algorithms: The naive string-matching algorithm, Rabin-Karp, String matching with finite automaton, Knuth-Morris-Pratt algorithm.

Unit IV

Graph Algorithms: Elementary graph algorithms, Minimum spanning trees, shortest path algorithms: single source and all pair, Max flow problem and its solutions, recent trends in data. Structures.

Text books:

1. Cormen, T.H., Leiserson, C.E., Rivest, R.L. and Stein, C. (2010). Introduction to Algorithms.3rded. Mit Press.
2. Sridhar, S. (2014). Design and Analysis of Algorithms. Oxford University Press India

Suggested readings:

1. Aho, A.V., Hopcroft, J.E. and Ullman, J. D. (2009). Data Structures and Algorithms. India: Pearson Education.
2. Horowitz, E., Sahni, S. and Rajasekaran, S. (2010). Fundamentals of Computer Algorithms. Galgotia Publications.
3. Weiss, M.A. (2009). Data Structures and Algorithm Analysis in C++. India: Pearson Education.

CST.507 Advanced Computer Networks Credit Hours: 3-1-0

Objective: This course aims to provide advanced background on relevant computer networking Topics to have a comprehensive and deep knowledge in computer networks.

Course Outcomes: After successfully completing this course, students will be able to

- Describe functioning of protocol stacks related to different networks.
- Design IPv4/IPv6 networks.
- Apply various network technologies to deploy networks in different scenarios.
- Assess the performance of various network technologies/protocols.

Unit I

Introduction: Overview of Computer Networks, ISO- OSI and TCP/IP reference models, MAC protocols for LANs, Gigabit Ethernet, and Wireless LAN

IPv6: Overview of IP and IPv4, IPv6: Basic protocol, Extensions and options, Tunneling, Addressing, Neighbor Discovery, Auto-configuration, IPv6 in an IPv4 Internet Migration and Coexistence, Mobile IPv6: Overview, Route Optimization, Handover and its impacts on TCP and UDP, Security requirements.

Unit II

Transport Layer: Conventional TCP, TCP extensions for wireless networks, UDP.

Software Defined Networks: Introduction, Evolution and Importance of SDN, Control and Data Planes, Role of SDN Controllers, Application areas of SDN.

Unit III

Mobile Computing: Introduction, Mobile Computing Architecture, Technologies: Bluetooth, RFID, WiMAX, Security Issues in Mobile Computing.

Cellular Technologies: Cellular Concept: Introduction, Frequency Reuse, Channel Assignment, Handoff Strategies, Interference, Cell Splitting and Sectoring. GSM: GSM services, features, system architecture, GPRS: Introduction, network architecture, data services, applications and limitations, 3G, 4G and 5G.

Unit IV

Ad Hoc Networks: Introduction to Adhoc networks, Issues in Adhoc networks and Proactive and Reactive routing protocols. VANETS: Introduction, architecture, applications and challenges WSNs: Introduction, architecture, applications, challenges, and Current Trends.

Text books:

1.Behrouz A. Forouzan, 2012, Data Communications and Networking, McGraw-Hill.
2. Andrew S. Tanenbaum, David J. Wetherall, 2013, Computer Networks, Pearson.
3. Hesham Soliman,2014, Mobile IPv6 Mobility in Wireless Internet, Pearson Education.

Suggested Books

1. Ashok K. Talukdar,2007, Mobile Computing Technology, Applications and Service Creation, 2nd Edition, McGraw-Hill.
2.Theodore S. Rappaport: Wireless Communications Principles and Practice, Prentice Hall.
3. KazemSohraby, Daniel Minoli, TaiebZnati: Wireless Sensor Networks-Technology, Protocols and Applications, Wiley.

CST.508 **Python Programming** **Credits: 3-1-0**

Objective: The objective of this course is to introduce students to the Python programming language.

Course Outcomes: On completion of the course the students should be able to

- Define python environment and constructs of Python language.
- Explain the various data structures
- Construct scripts in Python language.

Unit I

Python Introduction, Installing and setting Python environment in Windows and Linux, basics of Python interpreter, Execution of python program, Editor for Python code, syntax, variable, types. Flow control: if, ifelse, for, while, range() function, continue, pass, break. Strings: Sequence operations, String Methods, Pattern Matching.

Unit II

Lists: Basic Operations, Iteration, Indexing, Slicing and Matrixes; Dictionaries: Basic dictionary operations; Tuples and Files; Functions: Definition, Call, Arguments, Scope rules and Name resolution; Modules: Module Coding Basics, Importing Programs as Modules, Executing Modules as Scripts, Compiled Python files(.pyc), Standard Modules: OS and SYS, The dir() Function, Packages.

Unit III

Input output and file handling, Object Oriented Programming features in Python: Classes, Objects, Inheritance, Operator Overloading, Errors and Exceptions: try, except and else statements, Exception Objects, Regular expressions, Multithreading, Networking: Socket module.

Unit IV

Data Structure in Python: Search and Sorting Algorithms, Divide and Conquer Algorithm, Dynamic Programing 0/1 knapsack Algorithms, Security Trends with Python Programing.

Text Books:

1. Lutz Mark, (2009). Learning Python, Latest Edition., O'REILLY Media, Inc.
2. Seitz Justin , (2009). Gray Hat Python: Python Programming with Hackers and Reverse Engineers, Latest Edition, No Starch Press, Inc.

Suggested Readings:

1. Berry Paul, (2011). Head First Python. Latest Edition, O'REILLY Media, Inc.
2. Jose Jeeva & Lal P. Sojan, (2016). Introduction to Computing & Problem Solving With Python, Latest Edition, Tata-Mcgraw hills New Delhi

CST.509 **Advanced Data Structure & Algorithm-Lab** **Credits: 2**

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

CST.510 **Python Programming-Lab** **Credits: 2**

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

SEMESTER-II

CST.521 Digital Image Processing Credits: 3-1-0

Objective: The objective of this course is to ensure that a student learns the fundamentals of digital image processing, starting from image capturing to image enhancement, restoration and compression.

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

- Understand image formation and perception of gray and color image data
- Learn techniques in image enhancement and image restoration
- Describe image compression, segmentation and watermarking

Unit I

Introduction: Fundamental steps in Image Processing System, Components of Image Processing System, Elements of Visual Perception, Image Sensing and acquisition, Image sampling & Quantization, Basic Relationship between pixels.

Image Enhancement Techniques: Spatial Domain Methods: Basic grey level transformation, Histogram equalization, Image subtraction, image averaging..

Unit II

Spatial filtering: Smoothing, sharpening filters, Laplacian filters, Frequency domain filters, Smoothing and sharpening filters, Homomorphism filtering.

Image Restoration & Reconstruction: Model of Image Degradation/restoration process, Noise models, Spatial filtering, Inverse filtering, Minimum mean square Error filtering, constrained least square filtering, Geometric mean filter, Image reconstruction from projections.

Color Fundamentals: Color Models, Color Transformations.

Unit III

Image Compression: Redundancies- Coding, Interpixel, Psycho visual; Fidelity, Source and Channel Encoding, Elements of Information Theory; Loss Less and Lossy Compression; Run length coding, Differential encoding, DCT, Vector quantization, Entropy coding, LZW coding; Image Compression Standards-JPEG, JPEG 2000, MPEG; Video compression.

Wavelet Based Image Compression: Expansion of functions, Multi-resolution analysis, Scaling functions, MRA refinement equation, Wavelet series expansion, Discrete Wavelet Transform (DWT), Continuous Wavelet Transform, Fast Wavelet Transform, 2-D wavelet Transform, JPEG-2000 encoding,

Unit IV

Image Segmentation: Discontinuities, Edge Linking and boundary detection, Thresholding, Region Based Segmentation, Watersheds; Introduction to morphological operations; binary morphology- erosion, dilation, opening and closing operations, applications; basic gray-scale morphology operations; Feature extraction; Classification; Object recognition.

Digital Image Watermarking: Introduction, need of Digital Image Watermarking, applications of watermarking in copyright protection and Image quality analysis

Text Books:

1. Gonzalez, R.C. and Woods, R.E. (2009). Digital Image Processing. 2nd ed. India: Person Education.

Suggested Readings:

1. Pratt, W. K. (2001). Digital Image Processing. John Wiley.
2. Jayaraman, S., Veerakumar, T. and Esakkiranjan, S. (2009). Digital Image Processing. Tata Mcgraw-Hill

CST.522 Advanced Compiler Design Credit: 3-1-0

Objective: This course offers a good understanding of Compiler Design and will prepare students to understand various types of problems facing during Compiler Designing. This course helps to design various types of grammar or machines for resolving different computational problems.

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

- Design the Automata and corresponding Regular Grammar
- Perform the Syntax Analysis and Parsing of Grammar
- Learn the functionality of Syntax Directed Translation and Run Time storage organization.

Unit I

Compiler Structure: Synthesis model of compilation, various phases of a compiler, tool based approach for compiler construction.

Lexical analysis: Mechanics of Lexical analysis: DFA, NFA, NFA to DFA Conversion; Translation of Regular Expression to Automata: Conversion and Simulation of NFA and DFA;

Design of Lexical Analysis Generator: Pattern Matching based on NFA, Look-ahead Operator, DFA for Lexical Analyser; Optimisation of DFA-based Pattern Matching: Conversion of Regular expression to NFA and to DFA, State Minimisation in Lexical Analyser.

Unit II

Syntax analysis: Parse Tree Generation, Ambiguity identification in grammar, Ambiguity removal from grammar, Normal Forms of Grammar, CFG versus Regular Expression. **Push Down Automata:** Transition diagram for of CFG, Deterministic PDA, PDA for CFG and CFG for PDA

Parsing: Top-Down Parsing, LL(1) parsing, Recursive Parsing, Predictive Parsing, Non-Recursive Predictive Parsing, Bottom-up Parsing, Reduction, Shift-Reduce parsing.

LR-Parsing: LR parser, SLR Parsing Tables, LR(1) Items, LALR parser, Constructing LALR parsing Tables, Compaction of LR parsing tables

Unit III

Syntax Directed Translation: Syntax Directed Definitions: Inherited And Synthesized Attributes, Dependency Graph, Evaluation Order, Bottom Up and Top Down Evaluation Of Attributes, L- and S-Attributed Definitions.

Run Time System: Storage Organization, Activation Tree, Activation Record, Parameter Passing, Symbol Table, Dynamic Storage Allocation

Unit IV

Intermediate Code Generation: Three Address Code, Types and Declaration, Type Checking, Backpatching.

Code Optimisation: Issues in Design of Code Generator, Target Code, Basics Blocks and Flow Graphs, Sources of Optimisation, DAG-Optimisation, Register Allocation and Assignments. Optimal Code Generation for Expressions,

Peephole optimization Principals

Recent Trends: Parsing trees and Regular grammar for recent problems: email-id, date, month

Text book:

1. Alfered V. Aho Monica S. Lam, Ravi Sethi & Jeffery D Ulman (2009). Compilers Principles, Techniques and Tools". Pearson Education, Latest Edition,
2. Raghvan V.,(2010). Principles of Compiler Design, Tata Mc-Graw Hill, New Delhi.
3. Martin John C., (2010). "Introduction to Languages and Theory of Computation", Tata Mc-Graw Hill, New Delhi 3rd Edition, 2010

Suggested Readings:

1. **Mogensen**, Torben Ægidius, (2011). Introduction to Compiler Design. Springer-Verlag London, Latest Edition.
2. Meduna Alexander. (2007). Elements of Compiler Design, CRC press, Latest Edition.

CST.523 Advanced Software Engineering Credit Hours: 3-1-0

Objective: This course offers a good understanding of Software Systems and will prepare students to resolve various types of practical problems face by software engineers in the industry. This course helps to design various software quality models.

Course Outcomes

- To study software project management concepts
- To understand the role of formal methods and reengineering
- To understand the use of advanced techniques to develop the software.

Unit I

Overview of Software Engineering: Phases in development of Software, Software Engineering Ethics, and Life cycle Revisited (Incremental Development, Agile Methods, and RAD), Model-Driven Architecture, Software Product Line, and Process Modelling**.**

Project Management: Project Planning, Project Control (Work Break Down Structure, GANTT Charts, PERT Charts) Project Team Organization, Risk Management

Unit II

Testing of OO systems: Objects and Classes, OO Testing, Class Testing, Regression Testing, Non Functional Testing, Acceptance Testing

Software Reliability: Basic Ideas of Software Reliability, Software Reliability Models, Classes of Software Reliability Models, Orthogonal Defects Classifications

Unit III

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.

Software Quality: Review, Inspection and Walk through, Software Quality Models, Types of Defects, Cost of fixing the defects, Software Quality Assurance and Control, Challenges in Software Quality, SQA, Process frame work of SQA, ISO 9001:2008, SEI CMMI, Six Sigma**,** Tools for Quality Control (C&E Diagram, Pareto Diagram, histogram, Scatter Plot, Orthogonal Defect Classification)

Unit IV

Software Maintenance: Maintenance Categories, Major causes of Maintenance Problems, Reverse Engineering, Software Evolutions, Organizational and Managerial Issues of Maintenance activities, Maintenance Measurements

Software Refactoring: Principles of Refactoring, Bad Smells in code, Composing Methods of Refactoring, Moving features between objects

Text books:

1. Roger S. Pressman, (2014). Software Engineering a Practitioners Approach, McGraw-Hill 8th Edition.
2. Anirban Basu, (2015). Software Quality Assurance, Testing and Metrics, PHI India, Latest Edition.

Suggested Readings:

1. Hans Van Vliet, Yded, (2015). Software Engineering Principles and Practice, Wiley Publication, Latest Edition.
2. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandriolo. (2015). Fundamental of Software Engineering, Wiley Publication, Latest Edition

CST.524 **Information Security** **Credits: 3-1-0**

Objective: is to provide students with an overall understanding of the main concepts of information systems, cryptographic techniques to highlight the importance in modern organizations.

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

- Explain the principles of information security and its significance
- Identify the domain specific security issues
- Describe the design and working of different cryptographic methods

Unit I

History of Information Systems: Importance of Information Systems, Basics of Information Systems, Changing Nature of Information Systems, Global Information Systems.

Essential Security Terminologies: Hardware, Software, Defining Security, Need for Security, Cyber-Crimes, Three Pillars of Security.

Unit II

Encryption and Decryption: Attackers and Types of Threats, Encryption Techniques, Classical Cryptographic Algorithms: Monoalphabetic Substitutions such as the Caesar Cipher, Cryptanalysis of Monoalphabetic ciphers, Polyalphabetic Ciphers such as Vigenere, Vernam Cipher, Stream and Block Ciphers.

Symmetric Key Systems: Data encryption Standard (DES), DES Structure, DES Analysis, Multiple DES, Advance Encryption Standard (AES).

Unit III

Key Management Protocols: Solving Key Distribution Problem, Diffie-Hellman Key Exchange Algorithm.

Public Key Encryption Systems: Concept and Characteristics of Public Key Encryption System, Rivest-Shamir-Adleman (RSA) Encryption.

Hash Algorithms: Hash concept, Description of Hash Algorithms (MD5 and SHA-1), Digital Signature/Certificate.

Unit IV

Internet Security Protocol: Introduction, Secure Socket Layer, Transport Layer Security, Secure Electronic Transaction, 3-D Secure Protocol, Electronic Money, Email Security, Wireless Application Protocol (WAP) Security.

Text Books:

1. Forouzan, B.A. (2010). Cryptography & Network Security. Tata McGraw-Hill Education.
2. Kahate, A. (2009). Cryptography and Network Security. McGraw-Hill Higher Ed.
3. Godbole, N. (2009). Information Systems Security: Security Management, Metrics, Frameworks and Best Practices. 1st Ed. John Wiley & Sons India.

Suggested Readings:

1. Stallings, W. (2007). Network Security Essentials: applications and standards. 3rd ed. Pearson Education India.
2. Stallings, W. (2014). Cryptography and Network Security: Principles and Practice. 6th ed. Pearson.
3. Kim, D., and Solomon, M. G. (2010). Fundamentals of Information Systems Security. Jones & Bartlett Learning.

CST.525 Advanced Computer Architecture Credit: 3-1-0

Objective: To introduce the concept of Parallel Computing with its different types of architecture includes SIMD, MIMD and Pipelining. Also aware them with modern processors.

Course Outcomes: At the end of the course students will be able to:

1. Demonstrate the advanced concepts of computer architecture.
2. Investigate modern design structures of Pipelined and Multiprocessors systems.
3. Understand the interaction amongst architecture, applications and technology.

Unit I

Introduction to Parallel Processing: Parallelism in uniprocessor system; parallel computer structure, architectural classification schemes.

Memory management and organization: Memory hierarchy, Virtual memory system, memory allocation and management, cache memory management. Mapping and management techniques, memory replacement policies.

Unit II

Pipelining and Vector Architecture: Instruction and arithmetic pipelines design, linear and non-linear pipeline pipeline processors, superscalar and superpipeline design.

SIMD array architecture: SIMD array processors, SIMD interconnection network, Associative array processors.

Unit III

MIMD multiprocessor and Multicomputers:

Multiprocessor architecture (loosely coupled, tightly coupled), interconnection networks, cache coherence and synchronization mechanism multiprocessor operating systems, exploiting concurrency.

Unit IV

Review of modern processors

Pentium Processor: IA 32 and P6 micro architectures, Introduction to embedded systems, ARM Processor architecture and interface.

TEXTBOOK:

1. Sima, D., Fountain, T. and Kacsuk, P. (2002). Advanced Computer Architectures - A Design space approach, Pearson Education..
2. Yiu , (2014). The Definitive Guide to ARM Coretx M3/ M4 Processor, Elsevier.

Suggested Readings:

1. K Hwang, Advanced Computer Architecture, Tata McGraw-Hill Education, 2003
2. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Third Edition, Morgan Kaufmann, May 2002.
3. High-performance Computer Architecture, by Harold Stone Addison Wesley (1993) 3rded.
4. Parallel Computer Architecture: A Hardware/Software Approach David Culler and J.P. Singh with Anoop Gupta, Morgan Kaufmann (August 1998).

CST.526 Cloud Computing and Security Credits: 3-1-0

Objective: This course will introduce cloud computing concepts in detail. This course will also explain the concept of virtualization and its role in cloud computing. Storage related issues of cloud computing will also be discussed.

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

- Understand the key concepts and challenge in cloud computing
- Understand the role of virtualization in cloud computing
- Understand the storage related issues in cloud computing

Unit I

Introduction to cloud computing: Definition, architecture, deployment models, characteristics and cloud Storage. Evolution of cloud, services, projects and challenges, Companies in the Cloud Today. Cloud provider, SAAS, PAAS, IAAS and Others, Organizational scenarios of clouds, Administering & Monitoring cloud services, benefits and limitations, Comparison among SAAS, PAAS, IAAS, Mobile cloud computing.

Unit II

Virtualization: Introduction to virtualization, concept and properties of virtualization, CPU virtualization, memory virtualization, I/O virtualization, Forms of CPU virtualization, Role of Virtualization in cloud computing, Hypervisors, Virtualization Security concerns.

Scheduling in Cloud: Overview of Scheduling problem, Different types of scheduling, Scheduling for independent and dependent tasks, Static vs. Dynamic scheduling, Optimization techniques for scheduling.

Unit III

Cloud Storage

Overview; Storage as a Service, Benefits and Challenges, Storage Area Networks(SANs), Case Study of Amazon S3

Role of Grid in Implementing Cloud Computing: Basics of Grid Computing, Grid Architecture, Distributed computing in Grid and cloud, Interoperability in Grid and cloud.

Unit IV

Cloud Security

Infrastructure Security: Network Level Security, Host Level Security and Application Level Security;

Data Security: Data Security & Privacy Issues; Identity & Access Management; Legal Issues in Cloud Computing

Text Books:

1. Buyya, R., Vecchiola, C., and Thamarai, S.S. (2013). Mastering Cloud Computing: Foundations and Applications Programming. Elsevier Science & Technology.
2. Kris, J. (2013) Cloud computing : Saas, paas, laas, virtualization, business models, mobile, security, and more, Jones & Bartlett Learning.

Suggested Readings:

1. Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter: Cloud Computing: A Practical Approach, McGraw Hill (2010).
2. Magoules, Frederic, Cloud computing : Data-ntensive computing and scheduling, CRC Press (2012).

CST.527 Soft Computing Credits: 3-1-0

Objective: To introduce the concept of Neural Networks, Fuzzy Systems, Genetic Algorithms and Hybrid Systems to the students.

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

- Explain the fuzzy set theory
- Discuss the neural networks and supervised and unsupervised learning networks
- Comprehend genetic algorithms

Unit I

Neural Networks: Introduction to Neuron, Modeling Neuron, Feedforward Neural Network, Learning Methods, Data Normalization, Supervised Training Methods, Unsupervised Training Methods, Hopfield Neural Networks, Bidirectional Associative Memory.

Unit II

Fuzzy Systems: Fuzzy Set Theory: Crisp Sets, Fuzzy Sets, Crisp Relations, Fuzzy Relations, Fuzzy Systems: Predicate Logic, Fuzzy Logic, Fuzzy Rule Based System, Defuzzification Methods, Applications.

Unit III

Genetic Algorithms: Basic Concepts, Working Principle, Encoding, Fitness Function, Inheritance Operators, Cross Over, Inversion and Deletion, Mutation Operator, Bitwise Operators, Generational Cycles, Convergence of Genetic Algorithm, Applications.

Unit IV

Hybrid Systems: Introduction to hybrid systems, Fuzzy Associative Memories, Soft Computing Tools such as WEKA, R etc.

Text Books:

1. Ross J.T., (2009). Fuzzy Logic with Engineering Applications John Wiley & Sons.
2. Rajasekaran, S.Vijayalakshmi Pai, G.A. (2003). Neural Networks, Fuzzy Logic and Genetic Algorithms PHI Learning.

Suggested Readings:

1. Priddy L.K., Keller E.P., (2005). Artificial Neural Networks: An Introduction SPIE Press.
2. Gen, M. Cheng, R. (2000). Genetic Algorithms and Engineering Optimization John Wiley & Sons.

CBS.528 Distributed Systems Credits: 3-1-0

Objective: This course is designed to provide the students with a basic understanding and experiential Course **Outcomes:** Upon completing the course the students should be able to

- Understand the basic concepts of Distributed systems.
- Examine how existing systems have applied the concepts of distributed systems in designing large systems.
- Apply these concepts to develop sample systems.

Unit 1 .

Introduction to Distributed Systems: Definition of distributed systems, their objectives, types, architecture, self-management in distributed systems, introduction to XML, SOAP, and service oriented architecture.

Communication: Interprocess communication, Remote Procedure Call (RPC), Remote Method Invocation (RMI), Remote Object Invocation, Message Oriented Communication.

Unit 2

Processes: Introduction to threads, threads in distributed and non-distributed systems, virtualization, and networked user interfaces, client side software, design issues for servers, code migration.

Naming: General issues with respect to naming, flat naming, distributed hash tables, hierarchical approaches, structured naming, name spaces, name resolution, implementation of a name space, domain name system, X.500 name space, attribute based naming.

Unit 3

Security: Security threats, policies, and mechanisms, design issues, cryptography, secure channels, authentication using public key cryptography, message integrity and confidentiality, digital signatures, session keys, Kerberos, general issues in access control, firewalls.

Distributed Object-based Systems: Distributed objects, general architecture of an EJB server, global distributed shared objects, processes, object servers, communication, static vs. dynamic RMI, Java RMI, naming, CORBA object references.

Unit 4

Distributed File Systems: Architecture, client-server, cluster-based distributed file systems, symmetric architectures, communication, RPC in NFS, naming, Naming in NFS, synchronization, consistency and replication.

Distributed Web-based Systems

Architecture, traditional web-based systems, web services, processes, general organization of the Apache web server, web server clusters, communication, hypertext transfer protocol, simple object access protocol, naming, replication for web hosting systems.

Text Books:

1. Andrew S. Tanenbaum Distributed Systems- Principles and Paradigms. 2nd edition, Pearson Education
2. Distributed Systems – Concepts and Design. George Coulouris, Jean Dollimore, Tim Kindberg. 4th edition, Pearson Education
3. Distributed Systems and Networks. William Buchanan. McGraw-Hill

CST.529 Data Warehousing and Data Mining Credits: 3-1-0

Objective: The objective of this course is to ensure that a student learns to understand and implement basic models and algorithms in data warehousing and data mining. The students will learn how to analyze the data and identify the related issues.

Course Outcome: Upon completion of this course, the students will be able to:

- Describe the concepts related to data warehousing and data mining
- Summarize the dominant data warehousing architectures
- Use information from a variety of different sources and extract knowledge from large data repositories

Unit I

Fundamentals of Data Mining, Data Mining Architecture: Data Mining primitives, Task relevant data, interestingness measures, presentation and visualization of patterns, Data Mining Architecture, Basic Statistical Descriptions of Data, Data Generalization and Summarization, Attributed oriented induction, Analytical characterization, Mining class comparisons, Measuring Data Similarity and Dissimilarity

Unit II

Data warehouse: Basic Concepts, Multi-tier Architecture, Data Warehousing Modeling: Multidimensional Data Model, Schemas for multidimensional data models, OLAP, Data Warehouse Implementation. Further Development of Data Cube Technology, From Data Warehousing to Data Mining Data Cube Computation and Data Generalization

Unit III

Association Rules: Association rules mining, Mining Association rules from single level, multilevel transaction databases, multidimensional relational databases and data warehouses, Correlational analysis, Constraint based association mining

Advanced Pattern Mining: Pattern Mining in Multilevel, Multidimensional space, Constraint-Based Frequent Pattern Mining, Mining High-Dimensional Data and Colossal Patterns.

Unit IV

Classification and Clustering: Classification and prediction, Decision tree induction, Bayesian classification, Rule based Classification, Classification by Support Vector Machine Cluster analysis, Types of data in clustering, Major Clustering Methods: Partitioning Methods, Hierarchical Methods, Density-based methods, Grid-based methods, Model based clustering methods, clustering high dimensional data, clustering with constraints.

Case studies based on recent trends in data mining.

Text Book:

1. Han, J., Kamber, M. and Pei, J. (2011). Data Mining: Concepts and Techniques. Elsevier.
2. Berson, A. and Smith S.J. (2008). Data Warehousing, Data Mining, &OLAP. Tata McGraw-Hill Education

Suggested Readings:

1. Dunham, M.H. (2008). Data Mining: Introductory and Advanced Topics. India: Pearson Education.
2. Data Warehousing Fundamentals – Paulraj Ponnaiah Wiley student Edition

CST.530 Wireless Ad-Hoc Sensor Networks and IoTs Credit 3-1-0

Objective: The main objective of this course is to provide the students with basic as well as advanced knowledge and concepts of Wireless Ad Hoc and Sensor Networks.
Course Outcomes: Upon completion of this course, the students will be able to:

- identify the basic problems, limitations, strengths of MANETs and WSN;
- explain the current wireless MANETs and WSN networking mechanisms
- Implement basic IoT applications on embedded platform

Unit I

MANET Introduction: Basics of Ad Hoc Networks and their applications, Overview of different challenges in implementing Ad Hoc Networks, Overview of different solutions proposed for overcoming the challenges in these networks.

Self-organizing behaviour: Properties of self-organizing systems, Differences between the self-organizing systems and the conventional ones, Mechanisms for ensuring self-organization in MANETs, **Co-operation:** Dealing with misbehaviors in MANETs, Incentive mechanisms for countering misbehaviors.

Unit II

MAC: Need for MAC protocols for MANETs, Classification of MAC protocols, Hidden and exposed terminal problems, Four MAC protocols explained -MACA -MACAW -DBTMA –MARCH. Routing challenges in MANETs, Proactive, reactive, and hybrid routing protocols.

Multicast routing: Challenges of multicasting in MANETs, Classification of multicast routing protocols, **Mobility model:** Basics of mobility models, Classification of mobility models.

Unit III

Transport layer: Problems of using TCP in MANETs, Different transport protocols for MANETs
Opportunistic Mobile Networks: Basic understanding of OMNs/DTNs, How OMNs differ from other networks, **UAV networks:** Basics of UAV Physics, Challenges in UAV networks.

Wireless Sensor Networks: Introduction, Coverage, Topology management, Mobile Sensor Networks MAC, Congestion control, Routing Underwater WSN, Structure of sensor nodes.

Unit IV

Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design ofIoT, Functional blocks of IoT, Communication models & APIs. **IoT& M2M:** Introduction, Machine to Machine, Difference between IoT and M2M, Software defineNetwork.
Implementing IoT concepts with python, Arduino Programming.

Text Books:

1. Murthy, C.S. R. and Manoj, B.S. (2007). Ad hoc Wireless Networks Architectures and protocols,2ndedition, Pearson Education.
2. ObaidatM. S.andMisra, S. Principles of Wireless Sensor Networks,Cambridge University Press, U.K.
3. Vijay Madisetti, ArshdeepBahga, "Internet of Things: A Hands-On Approach"
4. WaltenegusDargie,ChristianPoellabauer, "Fundamentals of Wireless Sensor Networks: Theoryand Practice"

Suggested Readings:

1. Toh, C.K. Ad Hoc Wireless Networks: Protocols and Systems, Prentice Hall PTR Upper Saddle

River, NJ, USA.

2. Misra,S., Woungang, I. and Misra S. C. Guide to Wireless Sensor Networks, Computer Communications and Networks Series, Springer-Verlag, London, U.K.
3. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1 st Edition, Apress Publications, 2013.
4. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014.

CST.531 **Web Services** **Credits: 3-1-0**

Objective: The objective of this course is to ensure that a student learns to understand and implement basic small web pages using Java and Scripting language. The students will also learn how to develop Dynamic Web sites.

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

- Describe the concepts related to Web services
- Develop Web pages using Scripting Languages
- Develop Dynamic Web Pages and learn the advancements in the field of World Wide Web

Unit I

Internet and World Wide Web: Introduction, Internet addressing, ISP, types of Internet connections, introduction to WWW, web browsers, web servers, URL, HTTP, DNS, web applications, tools for web site creation.

HTML: Introduction to HTML, lists, adding graphics to HTML page, creating tables, linking documents, frames, DHTML and cascading style sheets.

Unit II

Java Script: Introduction, programming constructs: variables, operators and expressions, conditional checking, functions and dialog boxes, JavaScript DOM, creating forms, objects like Window, Navigator, History, Location, introduction to cookies,

Unit III

XML: Why XML, XML syntax rules, XML elements, XML attributes, XML DTD displaying XML with CSS.

PHP: Introduction, syntax, variables, statements, operators, decision making, loops, arrays, strings, forms, get and post methods, functions, cookies, and sessions.

Unit IV

PHP and MySQL: Introduction to MySQL, connecting to MySQL database, creation, insertion, deletion and retrieval of MySQL data using PHP, PHP and XML, XML parsers, XML DOM.

Text Books:

1. Deitel,Deitel,Nieto, and Sandhu, XML How to Program, Pearson Education.
2. Herbert Schieldt, Java 2: The Complete Reference, TMH, Fifth Edition.
3. Ivan Bayross : Commercial, Web Enabled Development Application, BPB

Suggested Readings:

1. Schafer Textbooks, HTML,CSS, JavaScript,Perl, Python and PHP, Wiley India

CST.532 **Digital Image Processing-Lab** **Credits: 0-0-2**

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

CST.533 **Elective II-Lab** **Credits: 0-0-2**

Distributed Operating System-Lab

Students will implement the lab practical as per the syllabus of the elective opted by the students

CST.534 **Elective II-Lab** **Credits: 0-0-2**

Data Warehouse and Mining-Lab

Students will implement the lab practical as per the syllabus of the elective opted by the students

CST.535 **Elective II-Lab** **Credits: 0-0-2**

Wireless Ad-Hoc Sensor Networks and IoTs-Lab

Students will implement the lab practical as per the syllabus of the elective opted by the students

CST.536 **Elective II-Lab** **Credits: 0-0-2**

Web Services-Lab

Students will implement the lab practical as per the syllabus of the elective opted by the students

SEMESTER- III

CST.551 **Capstone Lab-I** **Credits: 0-0-4**

The students should be required to implement an application for the Industrial/Scientific/Research Community.

CST.552 **Big Data Analytics** **Credits: 3-1-0**

Objective: To have an advanced level of understanding of most recent advancements in Big Data and using insights, statistical models, visualization techniques for its effective application in Business intelligence.

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

1. Understand the concepts and challenge of Big Data.
2. Collect, Manage, store, query, and analyze various forms of Big Data
3. Understand the impact of Big Data for business decisions and strategy.

Unit I

Introduction to Data Analytics: Data and Relations, Data Visualization, Correlation, Regression, Forecasting

Big Data Technology: Fundamentals of Big Data Types, Big data Technology Components, Big Data Architecture, Big Data Warehouses, Functional vs. Procedural Programming Models for Big Data.

Unit II

Hadoop: Introduction to Hadoop Ecosystem, HDFS, Map-Reduce Programming, Spark, PIG, JAQL. Understanding Text Analytics and Big Data, Predictive analysis on Big Data, Role of Data analyst.

Unit III

Supervised Learning: Regression Bias-Variance Dichotomy, Model Validation Approaches, Logistic Regression, Linear Discriminant Analysis, Quadratic Discriminant Analysis, and Regression.

Supervised Learning for Big Data with Classification technique: Classification Trees Support Vector Machines. Ensemble Methods: Random Forest, Neural Networks, Introduction Deep learning

Unit IV

Unsupervised Learning and Challenges for Big Data Analytics: Clustering, Clustering Analysis, Associative Rule Mining, Challenges for Big data Analytics.

Text Book:

1. Minelli M., Chambers M., Dhiraj A.,Big Data, Big Analytics: Emerging Business
2. White T., Hadoop: The Definitive Guide, O' Reilly Media (2012), 3rd ed.

CST.553 Embedded System Design Credit Hours: 3-1-0

Objective: The objective of the course is to teach the concepts embedded system design. The course focuses on how to write program and peripheral interfacing of AVR microcontroller and develop the applications.

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

- Understand the fundamentals of embedded systems.
- Describe the differences of microprocessor and microcontroller and explain the microcontroller architecture.
- Construct the assemble language programs.

Unit I

Introduction to Embedded System: embedded system architecture, classifications of embedded systems, challenges and design issues in embedded systems, fundamentals of embedded processor and microcontrollers, CISC vs. RISC, fundamentals of Vonneuman/Harvard architectures, types of microcontrollers, and selection of microcontrollers.

Unit II

8051 Architecture : Basic organization, 8051 CPU structure, Register file, Interrupts, Timers, Port circuits, Instruction set, Timing diagram, Addressing modes, Simple Program and Applications.

Unit III

Peripherals and Interfacing Typical Bus structure – Bus – memory organization – Timing characteristics – Extended Model and Memory Interfacing – Polling – Interfacing Basic I/O devices – Analog and Digital interfacing – PWM mode operation – Serial port application.

Unit IV

Introduction to Real Time Operating (RTO): Embedded System Design (Host and target machines – Linkers / Locators for Embedded Software – Debugging techniques – Instruction set simulators Laboratory tools – Practical example – Source code), Case Study: RTOS

Text book:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi Rolin D. McKinlay The 8051 Microcontroller and Embedded Systems, McGraw-Hill
2. Raj Kamal Embedded Systems, Person
3. Manish K Patel, The 8051 Microcontroller based Embedded Systems, McGraw-Hill

Reference Book:

1. Dhananjay V. Gadre, Programming and Customizing the AVR Microcontroller, TAB Electronics
2. T Bezboruah, K C Sharma , A Goswami, Embedded System design based on 8051 and PIC family microcontroller, Lambert

CST.554 E-Privacy: Privacy and Trust in the Electronic Society Credits: 3-1-0

Objective: This subject will provide the knowledge of various concepts involved in efficient E-Privacy that would help in prevent from the crimes.

Course Outcomes:

1. Gain an in-depth look into privacy laws and regulations as well as into technologies for achieving privacy in an electronic world.
2. Differentiate clearly between security and privacy and understand the tradeoffs.
3. Understand various trust metrics, designs and trust models

UNIT I

Introduction: Privacy and Security Issues in a Digital World, Privacy Principles and Policies, Authentication and Privacy, Data Mining, Privacy on the Web, E-mail Security, Impacts on Emerging Technologies. Ethical Aspects of Information Security and Privacy

UNIT II

Data and System Security: Authorization and Access Control, Role-Based Access Control, Database Security Trust Management, Trusted Platforms, Strong Authentication with Physical Unclonable Functions.

UNIT III

Privacy Enhancing: Privacy-Preserving Data Mining, Statistical Database Security, Different Search Strategies on Encrypted Data Compared, Client-Server Trade-Offs in Secure Computation, Federated Identity Management, Accountable Anonymous Communication

UNIT IV

Digital Asset Protection: An Introduction to Digital Rights Management Systems , Copy Protection Systems Forensic Watermarking in Digital Rights Management , Person-Based and Domain-Based Digital Rights Management , Digital Rights Management Interoperability, DRM for Protecting Personal Content

Enhancing Privacy for Digital Rights Management: Privacy Policies, RFID and Privacy, Malicious Software in Ubiquitous Computing

Text Book

1. **Security, Privacy and Trust in Modern Data Management** By Milan Petkovic, Willem Jonker, Springer, ISBN: 978-3-540-69860-9

Reference Book

1. **Security in Computing**, Prentice Hall, Charles P. Pfleeger , Shari Lawrence Pfleeger

CST.555 **Information Retrieval** **Credits: 3-1-0**

Objective: This subject will provide the knowledge of various concepts involved in efficient information retrieval that leads to the development of efficient Web crawling techniques.
Outcomes: Upon completion of this course, the students will be able to:

- Understand efficient techniques for indexing of document object that are to be retrieved
- Analyze the performance of retrieval systems using test collections
- Apply Information Retrieval principles to locate relevant information in large collection of data

Unit I

Introduction: Introduction to Information Retrieval. Inverted indices and Boolean queries. Query optimization. The nature of unstructured and semi-structured text.
The term vocabulary and postings lists: Text encoding: tokenization, stemming, lemmatization, stop words, phrases. Optimizing indices with skip lists. Proximity and phrase queries. Positional indices.

Unit II

Dictionaries and tolerant retrieval: Dictionary data structures. Wild-card queries, permuterm indices, n-gram indices. Spelling correction and synonyms: edit distance, Soundex, language detection.
Index construction: Postings size estimation, sort-based indexing, dynamic indexing, positional indexes, n-gram indexes, distributed indexing, real-world issues.

Unit III

Scoring: Term weighting and the vector space model. Parametric or fielded search. Document zones. The vector space retrieval model. Weighting. The cosine measure. Scoring documents.
Computing scores in a complete search system: Components of an IR system. Efficient vector space scoring. Nearest neighbor techniques, reduced dimensionality approximations, random projection.

Unit IV

Classification: Naive Bayes models. Spam filtering, K Nearest Neighbors, Decision Trees, Support vector machine classifiers.
Web Crawling: What makes the web different? Web search overview, web structure, the user, paid placement, search engine optimization. Web size measurement, Crawling and web indexes. Near-duplicate detection, Link analysis, learning to rank, focused web crawler and its different architectures.

Text Book

1. C. Manning, P. Raghavan, and H. Schütze: *Introduction to Information Retrieval*, CambridgeUniversity Press,2008

2. R. Baeza-Yates, B. Ribeiro-Neto: *Modern Information Retrieval,* Addison-Wesley, 1999

CST.556 **Dissertation** **Credits: 20**

Objectives:

1. 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 Evaluation criteria will be as detailed below:

Evaluation Parameter	**Grade**
Review of literature	Satisfactory/Un-Satisfactory
Identification of gaps in knowledge and Problem Statement	Satisfactory/Un-Satisfactory
Objective formulation & Methodology	Satisfactory/Un-Satisfactory
Presentation	Satisfactory/Un-Satisfactory
Total	Satisfactory/Un-Satisfactory

2. 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).
   The students would present their work to the Evaluation Committee (constituted as per the university rules). The evaluation criteria shall be as detailed below:

Evaluation Parameter	**Maximum Marks**	**Evaluated By**
Mid Term Review and Presentation	Satisfactory/Un-Satisfactory	Evaluation Committee
Continuous evaluation	Satisfactory/Un-Satisfactory	Supervisor
Total	Satisfactory/Un-Satisfactory	
Total Objective 1 + Objective 2	Satisfactory/Un-Satisfactory	

SEMESTER IV

CST.571 **Capstone Lab-II** **Credits: 0-0-4**

The students should be required to implement an application for the Industrial/Scientific/Research Community

CST.600 **Dissertation** **Credits: 20**

In Dissertation the student shall have to carry out the activities/experiments to be completed during Dissertation (as mentioned in the synopsis). The students would present their work to the evaluation Committee (constituted as per the university rules). One research paper (either accepted or published) out of the dissertation research work is compulsory before pre-submission evaluation of dissertation. The Evaluation criteria shall be as detailed below:

Evaluation Parameter	**Maximum Marks**	**Evaluated By**
Parameters by External Expert(As per University Criteria)	Satisfactory/Un-Satisfactory	External Expert
Presentation and defence of research work	Satisfactory/Un-Satisfactory	Evaluation Committee (DAA, Dean SET, CoC, Supervisor)
Total	Satisfactory/Un-Satisfactory	