Department of Computer Science

Learning Outcomes-based Curriculum Framework (LOCF)

for Post-Graduate Programme

M.Sc. Computer Science

(Syllabus effective from 2020 Admission onwards)

UNIVERSITY OF KERALA

2020

PROGRAMME OUTCOMES

PO1	Ability to apply theoretical and advanced knowledge to solve the real world issues.
PO2	Develop research-oriented projects.
PO3	Inculcate the process of lifelong learning to promote self-learning among students.
PO4	Develop moral values and ethics to live a better life.

PROGRAMME SPECIFIC OUTCOMES

PSO1	Develop advanced knowledge in Advanced Database Management Systems, Data Mining, Algorithms, Distributed systems and Information Security related courses.
PSO2	Provide students mathematical and technical skill set of Machine Learning, Data Analytics, Cloud Computing, Pattern Recognition and thereby facilitating them for developing intelligent system based on these technologies.
PSO3	Develop the skill set for industry ready professionals to join the Information Technology field.
PSO4	Prepare and motivate students for doing research in Computer Science and inter-disciplinary fields.
PSO5	Acquire flair on solving real world Case study problems.
PSO6	Hands on experience on doing experiment for solving real life problems using advanced programming languages.
PSO7	Allow graduates to increase their knowledge and understanding of computers and their systems, to prepare them for advanced positions in the workforce.
PSO8	Develop cutting edge developments in computing technology and contemporary research for society.
PSO9	Possess the ability to take up advanced innovative development work in the industry as well as to pursue higher research degree qualifications.
PSO10	Provide great flexibility through extensive choices of electives to respond to rapidly changing industry needs as well as their interests
PSO11	Industrial-style methods of analysis, design, implementation, testing and documentation in software development
PSO12	Produce a new breed of computer science graduates that have a strong mathematical background along with project management skills.
PSO13	Graduates with strong technical expertise, and ability to work effectively in interdisciplinary teams and be able to tackle problems that require both technical and non-technical solution.

Programme structure of **M.Sc. Computer Science**

Semester	Course Code	Name of the course	Credits
I	**Core courses (CC)**		
	CSC-CC-511	Mathematical Foundations of Computer Science	4
	CSC-CC-512	Design and Analysis of Algorithms	4
	CSC-CC-513	Distributed Systems	4
	CSC-CC-514	Design and Analysis of Algorithms Lab	3
	Skill Enhancement Elective (SE)		
	CSC-SE-501	Entrepreneurial Skills and Scientific Writing.	2
	Generic Course (GC)		
	CSC-GC-501	Introduction to Scilab	2
II	**Core courses (CC)**		
	CSC-CC-521	Compiler Construction	4
	CSC-CC-522	Software Engineering for Industry	4
	CSC-CC-523	Theoretical Foundations of Machine Learning	4
	CSC-CC-524	Machine Learning Lab	3
	Discipline Specific Electives (DE)		
	CSC-DE-525(i)	Digital Image Processing	4
	CSC-DE-525(ii)	Natural Language Processing	4
	CSC-DE-525(iii)	Block Chain Technology	4
	CSC-DE-525(iv)	Computational Biology	4
	CSC-DE-525(v)	Cyber Security and Cyber Law	4
III	**Core courses (CC)**		
	CSC-CC-531	Database Systems for Big Data	4
	CSC-CC-532	Database System Lab	3
	CSC-CC-533	Case Study	2
	CSC-CC-534	Seminar	2
	Discipline Specific Electives (DE)		
	CSC-DE-535(i)	Foundations of Robotics	4
	CSC-DE-535(ii)	Internet of Things	4
	CSC-DE-535(iii)	Cloud Computing	4
	CSC-DE-535(iv)	Intelligent Agent based computing	4
	CSC-DE-535(v)	High Performance Computing	4
	CSC-DE-536(i)	Optimization Techniques	4
	CSC-DE-536(ii)	Social Network Analysis	4
	CSC-DE-536(iii)	Artificial Intelligence in Cyber Security	4
	CSC-DE-536(iv)	Smart Applications	4
	CSC-DE-536(v)	Nature Inspired Computing	4
	Generic Course (GC)		
	CSC-GC-502	Computational Social Science	2
IV	**Core courses (CC)**		
	CSC-CC-541	Dissertation and Viva Voce	18

Eligibility:

Candidates shall be required to possess First class Bachelor's Degree in Computer Science/Computer Applications/Electronics/Any other degree in Science with Computer Science or Computer Applications as major components or an equivalent degree recognized by the University of Kerala.

SEMESTER I	Course Code: CSC-CC-511	Credits: 4

MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

	COURSE OUTCOMES

CO1	Describe the concept of probability and statistics.
CO2	Identify the types of distributions and its application in real entities.
CO3	Solve of linear algebra problems including linear equations, matrix calculus, vectors, and basic vector operations.
CO4	Discuss the usage of geometric transformations
CO5	Illustrate different decomposition methods used in linear system of equations
CO6	Solve unconstrained optimization and Linear Programming Problems

TAGGING OF COURSE OUTCOMES

	Course Outcomes	**PSO**	**CL**	**KC**
CO1	Describe the concept of probability and statistics.	PSO2, PSO7, PSO12	U	F
CO2	Identify the types of distributions and its application in real entities.	PSO2, PSO7, PSO12	U	C
CO3	Solve of linear algebra problems including linear equations, matrix calculus, vectors, and basic vector operations.	PSO2, PSO7, PSO12	U	C, P
CO4	Discuss the usage of geometric transformations	PSO2, PSO7, PSO12	U	C
CO5	Illustrate different decomposition methods used in linear system of equations	PSO2, PSO7, PSO12	A	C, P
CO6	Solve unconstrained optimization and Linear Programming Problems	PSO2, PSO7, PSO12	U	C, P

COURSE CONTENT

MODULE I: Probability :Definition, random experiments, random variables, CDF,PDF,PMF, Bayes theorem and conditional probability, Statistics: Introduction, measures,parameter estimations, hypothesis testing and inferences

MODULE II: Distributions-The Binomial distribution, the continuous uniform distribution, Monte-Carlo methods-Finding area, generating distributions, counting, Probabilistic problems, re-sampling.

MODULE III: Linear algebra: Matrices, vectors and determinants, Eigen values, Eigen vectors, Eigen value problems, vector differential calculus-Inner product, cross product, gradient of a scalar field, divergence of a vector field and curl of a vector field.

MODULE IV: Geometric transformations- Translations, Rotation around the origin, rigid motions and homogeneous representations, Affine transformations, Coordinate Transformation on Image Arrays.

MODULE V: Numeric Analysis: Introduction, solution of equations by iteration, numeric linear algebra-Linear Systems: Gauss Elimination, LU factorization, matrix inversion, Least squares method.

MODULE VI: Optimization**:** Basic concepts**, Unconstrained Optimization-method of Steepest Descent, Linear Programming-Normal,** pivotal reduction of a general system of equations, simplex method.

REFERENCES

- Ernest Davis," Linear Algebra and Probability for Computer Science Applications " ,CRC Press, 978-1-4665-0159-1
- Erwin Kreyszig, "Advanced Engineering Mathematics" (10th Edition), 2011 John Wiley & Sons , ISBN-13: 978-0-571-72897-9
- Michael Baron ,"Probability and statistics For computer scientists" (2nd edition), Chapman and Hall/CRC, ISBN 978-0-570-55836-5

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER I	Course Code: CSC-CC-512	Credits: 4

DESIGN AND ANALYSIS OF ALGORITHMS

	COURSE OUTCOMES
CO1	Identify the concepts and terminologies in non-linear data structures tree, graphs and their traversals
CO2	Compare AVL trees, B trees and B+ trees
CO3	Analyze the performance of algorithms
CO4	Explain the concepts including Recurrences, Dynamic programming and Branch and bound methods
CO5	Describe about String Matching and algorithms related to Network Flows
CO6	Discuss about P and NP- class problems
CO7	Explain Bio inspired Algorithms
CO8	Write programs for AVL trees, Red Black Tree

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify the concepts and terminologies in non-linear data structures tree, graphs and their traversals	PSO1	U	F, C
CO2	Compare AVL trees, B trees and B+ trees	PSO6	An	C, P
CO3	Analyze the performance of algorithms	PSO7	An	C, P
CO4	Explain the concepts including Recurrences, Dynamic programming and Branch and bound methods	PSO8	U	C
CO5	Describe about String Matching and algorithms related to Network Flows	PSO7	U	C, P
CO6	Discuss about P and NP- class problems	PSO4	U	C, P
CO7	Explain Bio inspired Algorithms	PSO9	An	C, P
CO8	Write programs for AVL trees, Red Black Tree	PSO2	A	P

COURSE CONTENT

MODULE I: Nonlinear Data Structures-Concepts and terminologies of Trees, binary tree implementation and traversals; AVL tree-importance, left and right rotations of tree.

MODULE II: B trees and B+ trees; Red Black Tree; Graphs – representations and traversals, Spanning Tree, Minimum Spanning Tree;

MODULE III: Analyzing Algorithms- Asymptotic notations, Recurrences; Dynamic Programming- Multistage Graphs, All Pairs Shortest Path;

MODULE IV: Randomized Algorithms; String Matching algorithms, Branch and Bound – Travelling Salesman Problem

MODULE V: Network Flows-Max flow, min-cut theorem; Ford-Fulkerson, Edmonds-Karp algorithm, Bipartite Matching. P and NP-class problems

MODULE VI: Introduction to Bio inspired Algorithms-Concepts and Basics of Genetic algorithms, Swarm intelligence, Particle swarm optimization, Ant colony optimization, Evolutionary algorithm

REFERENCES

- Alfred V. Aho, Data Structures and Algorithms, Addison-Wesley, ISBN 9780201000238
- Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Data Structures and Algorithms in Python; John Wiley & Sons, Incorporated; ISBN 9781118476734
- Nancy Arana-Daniel, Carlos Lopez-Franco, Alma Y. Alanis, Butterworth-Heinemann, Bio-inspired Algorithms for Engineering, ISBN 9780128137895
- Peter Brass, Advanced Data Structures, Cambridge University Press, ISBN 9780511437533
- Rance D. Necaise, Data Structures and Algorithms Using Python, Wiley, ISBN 9780470618295

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER I	Course Code: CSC-CC-513	Credits: 4

DISTRIBUTED SYSTEMS

	COURSE OUTCOMES
CO1	Understand the principles and concept of distributed system
CO2	Identify the challenges and opportunities faced by distributed systems
CO3	Understand the middleware technologies that support distributed applications such as RPC,RMI and object based middleware.
CO4	Apply remote method invocation and objects.
CO5	Understand the issues involved in studying process and resource management
CO6	Improve the performance and reliability of distributed programs.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Understand the principles and concept of distributed system	PSO1	U	F
CO2	Identify the challenges and opportunities faced by distributed systems	PSO1, PSO3, PSO5	U	C, P
CO3	Understand the middleware technologies that support distributed applications such as RPC,RMI and object based middleware.	PSO1, PSO7, PSO8	U	C
CO4	Apply remote method invocation and objects.	PSO7, PSO9	A	C, P
CO5	Understand the issues involved in studying process and resource management	PSO7, PSO13	U	F, C
CO6	Improve the performance and reliability of distributed programs.	PSO8	An	C, P

COURSE OUTCOMES

MODULE I : Introduction to Distributed Computing System - Distributed Computing System Models- What is Distributed Operating System - Issues in Designing a Distributed Operating System -Distributed Computing Environment (DCE). Computer Networks: Networks Types – LAN Technologies - WAN Technologies - Internetworking - ATM Technology.

MODULE II: Message Passing: Desirable Features of a Good Message - Passing System – Issuesin IPC by Message Passing - Synchronization - Buffering - Multi datagram Messages – Encodingand Decoding of Message Data - Process Addressing - Failure Handling - Group Communication.

MODULE III: Distributed Shared Memory: General Architecture of DSM Systems - Design andImplementation: Issues of DSM - Granularity - Structure of Shared Memory Space – ConsistencyModels - Replacement Strategy - Thrashing - Heterogeneous DSM - Advantages of DSM.

MODULE IV: Synchronization: Clock Synchronization - Event Ordering - Mutual Exclusion -Deadlock - Election Algorithms.

MODULE V: Distributed File Systems: Desirable Features of a Good Distributed File System – FileModels - File Accessing Models - File Caching Schemes- File Replication - Fault Tolerance -Atomic Transactions - Design Principles.

MODULE VI: Distributed Object based System - DOO Architecture, DOO Process, and DOO
Communication, and Synchronization in Object Based Systems.

REFERENCES:

- Andrew S. Tanenbaum and Maarten Van Steen, "Distributed Systems: Principles and Paradigms, 2nd edition, Pearson Education, Inc., 2007.
- George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems: Concepts and Design, Addison Wesley/Pearson Education, 2012.
- Liu M.L., "Distributed Computing, Principles and Applications", Pearson Education, 2004.
- Nancy A Lynch, "Distributed Algorithms", Morgan Kaufman Publishers, USA,
- Pradeep K Sinha, "Distributed Operating Systems: Concepts and design", PHI, 2007.

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER I	Course Code: CSC-CC-514	Credits: 3

DESIGN AND ANALYSIS OF ALGORITHMS LAB

	COURSE OUTCOMES
CO1	Implement programs using non-linear data structures.
CO2	Implement algorithms for Multistage Graphs, All Pairs Shortest Path with suitable problems
CO3	Implement Ford-Fulkerson, Edmonds-Karp algorithm with appropriate algorithm design techniques
CO4	Assess the performance of Prim's and Kruskal's algorithm for constructing minimum cost spanning tree.
CO5	Evaluate the performances for AVL tree, RB Tree, , B Tree, B+ tree

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Implement programs using non-linear data structures.	PSO6 PSO9	A	C, P
CO2	Implement algorithms for Multistage Graphs, All Pairs Shortest Path with suitable problems.	PSO1, PSO3, PSO6	A	C, P
CO3	Implement Ford-Fulkerson, Edmonds-Karp algorithm with appropriate algorithm design techniques	PSO1, PSO3, PSO6	A	C, P
CO4	Assess the performance of Prim's and Kruskal's algorithm for constructing minimum cost spanning tree.	PSO3, PSO6	E	C, P
CO5	Evaluate the performances for AVL tree, RB Tree, B Tree, B+ tree	PSO6, PSO3	A, E	C, P

COURSE CONTENT

The exercises related with the following are given for hands-on experiments.

- Binary trees and its traversals
- AVL trees
- Minimum spanning trees
- B trees
- B+ trees

- Red black tree
- Multi stage graphs
- All Pairs shortest path problem
- Ford-Fulkerson
- Edmonds-Karp algorithm

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER I	Course Code: CSC-SE-501	Credits: 2

ENTREPRENEURIAL SKILLS AND SCIENTIFIC WRITING

	COURSE OUTCOMES
CO1	**Demonstrate the ability to plan, organize, and execute a project or new venture with the goal of bringing new products and service.**
CO2	**Develop skillset to carry out scientific research in the field of entrepreneurship.**
CO3	**Prepare scientific reports and communicate the results in journal/conferences.**
CO4	Analyze and prepare research papers and literature review.
CO5	**Assess the commercial viability of new technologies, business opportunities.**

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	**Demonstrate the ability to plan, organize, and execute a project or new venture with the goal of bringing new products and service.**	PSO7	A	C, P
CO2	**Develop skillset to carry out scientific research in the field of entrepreneurship.**	PSO9	C	P
CO3	**Prepare scientific reports and communicate the results in journal/conferences.**	PSO4	C	P
CO4	Analyze and prepare research papers and literature review.	PSO4	An	P
CO5	**Assess the commercial viability of new technologies, business opportunities.**	PSO8	E	C, P

COURSE CONTENT

MODULE I: Introduction to entrepreneurship- Idea generation and business opportunity – Who is an entrepreneur –Traits-Qualities-competence of an entrepreneur Factors affecting entrepreneurship development- Creativity and entrepreneurship -

MODULE II: Steps in Creativity - Innovation and invention- Legal Protection of innovation - Skills of an entrepreneur - Decision making and Problem Solving (steps indecision making) -Procedures for initiation of the Startup-

MODULE III: Introduction to Soft Skills- Communication Skills - Presentation Skills - Time Management Skills- Group Discussion & Interview Skills - Emotional Intelligence Skills -

MODULE IV: Life Skills - Self awareness- Identifying one's strengths and weakness Planning& Goal setting- Leadership skills- Stress Management Skills

MODULE V: How to read a research paper? Structure and Components of Research Report, Data Presentation , Types of Report, Layout of Research Report, Mechanism of writing a research Thesis, Formats of a research paper, IMRAD format,

MODULE VI: Google Scholar, Web of Science, Scopus, Impact Factor, h-Index, g-index, Copyrights and Patents, IPR Laws. Citation, Plagiarism, Creative commons licenses

REFERENCES

- C. R. Kothari – " Research Methodology", New Age International, 2004
- Cecile Niewwenhuizen, Entrepreneurial Skills: Second Edition,Isbn-13: 978-0702176937
- J. W. Bames – "Statistical Analysis for Engineers and Scientists", Tata McGraw-Hill, New York, 1994
- R. Panneerselvam - "Research Methodology", Prentice Hall India, New Delhi, 2014
- Vinod Chandra S S, Anand H S - "Research Methodology", Pearson Education, Chennai, 2017

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER I	Course Code: CSC-GC-501	Credits: 2

INTRODUCTION TO SCILAB

	COURSE OUTCOMES
CO1	Understand the fundamentals and importance of Scilab
CO2	Implement the downloading and installation procedure for scilab software.
CO3	Familiar with Scilab software and its various functions
CO4	Understand basic programming structure and control statements in scilab
CO5	Implement simple arithmetic operations on vectors, matrices and polynomials.
CO6	Compare built in and user defined functions in scilab
CO7	Understand basic graphical operations and image processing in scilab.
CO8	Evaluate basic statistical functions in scilab.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Understand the fundamentals and importance of Scilab	PSO3, PSO7	U	F, C
CO2	Implement the downloading and installation procedure for scilab software.	PSO6, PSO7	A	C, P
CO3	Familiar with Scilab software and its various functions.	PSO3	U	F, C, P
CO4	Understand basic programming structure and control statements in scilab	PSO3, PSO7, PSO11	U	C
CO5	Implement simple arithmetic operations on vectors, matrices and polynomials.	PSO6, PSO7	U	C, P
CO6	Compare built in and user defined functions in scilab.	PSO3, PSO7	An	C, P
CO7	Understand basic graphical operations and image processing in scilab	PSO3, PSO7	U	F, C
CO8	Evaluate basic statistical functions in scilab.	PSO3, PSO7, PSO10	E	C, P

COURSE CONTENT

MODULE I: Scilab**:** Introduction, Why Scilab, downloading & installing scilab, Scilab Environment - manipulating the command line - working directory – comments - variables in memory - the scilab menu bar.

MODULE II: Programming: Basic structure –Scilab data types, variables and constants – input and output handling - Arithmetic operations – control statements -sample programs using control statements.

MODULE III: Scalars & Vectors **-** initializing vectors in scilab, mathematical operations on vectors, relational operations, logical operations on vectors, Mathematical functions on scalars, complex numbers, and trigonometric functions. Matrices– introduction, arithmetic operators for matrices, basic matrix processing, Accessing and Addressing Matrix, Mathematical Operations with Matrix.

MODULE IV: Functions– introduction, built-in functions, and user defined functions. Numerical Linear Algebra- Solving linear equations, Eigen values. **Polynomials** – introduction, creating polynomials, basic polynomial commands, finding roots of polynomial, polynomial arithmetic.

MODULE V: Graphics with scilab - 2D Plotting, 3D Plotting, Data Plotting, Function plotting, Basic Image processing (histogram, Edge detection, smoothening and sharpening).

MODULE VI: Statistics using scilab– basic statistical functions, applying statistical functions on matrices, distributions, frequency of values of a matrix or vector, centre, weighted centre, central moment, correlation, covariance, variance matrix, frequencies, cumulative sum, fisher test.

REFERENCES

- Dr. M. Affouf, Scilab by Example, CreateSpace Independent Publishing 2012.
- Ramachandran Hema, Achuthsankar S Nair, Scilab (A Free Software to Matlab), S Chand 2011.
- Vinu V. Das, Programming in Scilab 4.1, New Age Publishers,2008

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER II	Course Code: CSC-CC-521	Credits: 4

COMPILER CONSTRUCTION

	COURSE OUTCOMES
CO1	Explain about compilers and its design process
CO2	Illustrate different machine languages and language processing tools.
CO3	Identify how lexical tokens are handled in the compilation.
CO4	Analyze the syntax and semantic analysis phase of compilation.
CO5	Illustrate the intermediate code, code optimization and target code generation phases of compilation.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain about compilers and its design process	PSO3, PSO7	U	F, C
CO2	Illustrate different machine languages and language processing tools.	PSO7, PSO9	A	C, P
CO3	Identify how lexical tokens are handled in the compilation.	PSO7, PSO8	U	C
CO4	Analyze the syntax and semantic analysis phase of compilation.	PSO3, PSO7	An	C, P
CO5	Illustrate the intermediate code, code optimization and target code generation phases of compilation.	PSO7, PSO9	A	C, P

COURSE CONTENT

MODULE I: Language Processing System - Compilers: Analysis-Synthesis model, phases of a Compiler. Lexical Analysis: The role of Lexical Analyzer, Input Buffering - Tokens: Expressions and Recognition - Formal Languages –Automata theory – Finite Automata(FA) –Deterministic FA – Non-deterministic FA – Conversion of Finite Automata - Minimization of Finite Automata - Regular Expressions and Regular Languages - Types of Grammars.

MODULE II: Syntax Analysis: Derivation trees and Parse Trees, Ambiguity. Top-Down Parsing: Recursive Descent parsing: Back-tracking and Non-Back-tracking parsing, Predictive parsing, LL Grammars.

MODULE III: Bottom-Up Parsing: Shift Reduce parsing – Operator precedence parsing - LR parsing: Constructing SLR parsing tables, Constructing Canonical LR parsing

tables, Constructing LALR parsing tables - Error Handling and Recovery in Syntax Analyzer - YACC.

MODULE IV: Semantic Errors – Semantics and Semantic errors – Attribute grammars - Syntax directed Translation (SDT): S-attributed SDT, L- attributed SDT, Top-down translation, Bottom-up evaluation of inherited attributes. Type Checking: Type systems, Specification of a simple type checker.

MODULE V: Run-Time Environments: Source Language issues, Storage organization, Storage allocation strategies. Symbol Table - Intermediate Code Generation (ICG): Intermediate languages – Graphical representations - Three Address Code generation - Quadruples & Triples - Assignment statements - Boolean expressions.

MODULE VI: Code Optimization: Principal sources of optimization, Peep-hole optimization - DAG - Optimization of Basic Blocks - Global Data Flow Analysis – Efficient Data Flow Algorithm, Optimization of Basic blocks Code generation: Issues in the design of a code generator.

REFERENCES

- Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, Compilers: Principles, Techniques and Toolsll, Second Edition, Pearson Education, 2009.
- Allen I. Holub, Compiler Design in Cl, Prentice-Hall Software Series, 1993.
- Keith D Cooper and Linda Torczon, Engineering a Compiler, Morgan Kaufmann Publishers Elsevier Science, 2004.
- Randy Allen, Ken Kennedy, Optimizing Compilers for Modern Architectures: A Dependence based Approach, Morgan Kaufmann Publishers, 2002.
- V. Raghavan, Principles of Compiler Designl, Tata McGraw Hill Education Publishers, 2010.

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER II	Course Code: CSC-CC-522	Credits: 4

SOFTWARE ENGINEERING FOR INDUSTRY

	COURSE OUTCOMES
CO1	Use micro services in software development and its application
CO2	Identify latest technologies including agile methodology and continuous software development for software development relevant to software engineering industry practice
CO3	Model an application following the agile software development process flow
CO4	Compare Traditional software development life cycle with Agile Software development life cycle
CO5	Implement a simple application with micro services
CO6	Use advanced software engineering concepts, principles and best practices applicable to software industry.
CO7	Improve students' skill in presenting their idea and findings to their peers by studying, and reflecting on software engineering theory and practice.
CO8	Apply knowledge gained in the course to guide the software requirements engineering, analysis, design, and testing processes.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain about micro services in software development and its application	PSO7	A	C
CO2	Identify latest technologies including agile methodology and continuous software development for software development relevant to software engineering industry practice	PSO11, PSO3	U	C, P
CO3	Model an application following the agile software development process flow	PSO7, PSO11	C	C, P
CO4	Compare Traditional software development life cycle with Agile Software development life cycle	PSO11	An	C, P
CO5	Implement a simple application with micro services	PSO7, PSO3	C	C, P
CO6	Use advanced software engineering concepts, principles and best practices applicable to software industry.	PSO11	A	C, P
CO7	Improve students' skill in presenting their idea and findings to their peers by studying, and reflecting on software engineering theory and practice.	PSO13	C	C, P
CO8	Apply knowledge gained in the course to guide the software requirements engineering, analysis, design, and testing processes.	PSO11	A	P

COURSE CONTENT

MODULE- I : Introduction to software engineering- Software Process- Software developmental life cycle- 4P's in software project management-Software Requirements: Functional and Non-Functional requirements-Software requirements Document- Introduction to Legacy Code - Working with Legacy Code- changing software- Legacy code change algorithm

MODULE- II: Agile Software Development Life Cycle - Agile Software Development vs. Waterfall Software Development - Agile Modeling- Kanban –Scrum- Disciplined Agile Delivery (DAD)- The Agile Process Flow - The Agile Iteration Workflow - Making the Agile Process Work

MODULE- III : Object Oriented Analysis and Design - UML diagrams - Use case diagram- Class diagram- Activity diagram- Sequence Diagram- Design Patterns

MODULE- IV : Microservice Architectures for Software Development- Characteristics of Microservices- Challenges- Advantages and Disadvantages- Microservices and SOA- Implementation of a simple microservice program

MODULE- V: Continuous Software Development- Continuous Integration- Continuous Integration Best Practices – Continuous Integration in Devops – Continuous Delivery pipeline - Continuous Delivery in Agile model

MODULE- VI: Continuous Deployment- Fundamental Principles of Continuous Deployment Scaling Key Agile Practices for Continuous Deployment- Summary of Continuous Integration vs. Continuous Delivery vs. Continuous Deployment

REFERENCES

- **Eberhard Wolff :Microservices: Flexible Software Architecture** 1st Edition ,ISBN-13: 978-0134602417
- James Shore , Shane Warden ;The Art of Agile Development 1st Edition
- Mark S. Merkow, LakshmikanthRaghavan ;Secure and Resilient Software Development ,Released June 2010 Auerbach Publications ISBN: 9781498759618
- Michael C ;Working effectively with legacy code, Feathers, Prentice Hall PTR
- Robert C. Martin :Agile Software Development, Principles, Patterns, and Practices 1st edition by Martin, Robert C. (2002) Paperback.
- Rozanski, Nick,Software systems Architecture : working with stakeholders using viewpoints and perspectives

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER II	Course Code: CSC-CC-523	Credits: 4

THEORETICAL FOUNDATIONS OF MACHINE LEARNING

	COURSE OUTCOMES
CO1	Acquire basic knowledge in machine learning
CO2	Explain complexity of Machine Learning algorithms and their limitations.
CO3	Select and implement machine learning techniques and computing environments that are suitable for the applications under consideration
CO4	Compare different supervised and unsupervised algorithms
CO5	Discuss about reinforcement learning and its method
CO6	Explain different association rule mining algorithms
CO7	Differentiate clustering techniques and algorithms
CO8	Implement Support Vector Machine algorithm and its variants
CO9	Explain different learning algorithms based on decision tree.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Acquire basic knowledge in machine learning	PSO2	U	C
CO2	Explain complexity of Machine Learning algorithms and their limitations.	PSO2	U	C, P
CO3	Select and implement machine learning techniques and computing environments that are suitable for the applications under consideration	PSO4	K	C, P
CO4	Compare different supervised and unsupervised algorithms	PSO3	An	C, P
CO5	Discuss about reinforcement learning and its method	PSO8	U	C, P
CO6	Explain different association rule mining algorithms	PSO6	U	C, P
CO7	Differentiate clustering techniques and algorithms	PSO6, PSO7	An	C, P
CO8	Implement Support Vector Machine algorithm and its variants	PSO6, PSO9	U, A	P
CO9	Explain different learning algorithms based on decision tree.	PSO2	U	C, P

COURSE CONTENT

MODULE I: Learning - types of learning, learning of Input/ Output Function, history and timelines of machine learning, Aspects of machine learning, Machine Learning Applications and examples, intelligent agents. Quantification of classification - Threshold Fixing, ROC Graphics, ROC formulation

MODULE II: Supervised vs. Unsupervised learning - Prediction system, Training, testing and validation datasets, cross validation. Supervised learning model - Bias-variance trade-off, classification problems. Unsupervised learning model - clustering, data compression, PCA. Semi-supervised learning- self-training, co-training, generative methods, graph-based methods, Semi-supervised SVM.

MODULE III: Reinforcement learning - Reinforcement learning model, limitation of reinforcement learning, applications of reinforcement learning. Markov Decision problem, Q-learning, Temporal Difference learning, On-policy and Off-policy learning, learning Automata

MODULE IV: Association Rule mining - Concepts and terminology, Apriori algorithm, Probabilistic correlation algorithm, FP-growth algorithm, Eclat algorithm, Sparse Eclat, Tertius algorithm, Treap mining algorithm

MODULE V: Clustering - k-Means clustering, Facts about k-means, k-Means clustering weakness. Fuzzy clustering, hierarchical clustering Agglomerative and Divisive Clustering, Hierarchical Agglomerative Clustering, Cluster similarity.

MODULE VI: Support Vector Machines- Margins, Learning a maximum hyperplane, Kernel functions, Linear SVM, Non-linear SVM, Applications of SVM. Decision Trees - Decision tree construction, types of decision trees. Decision tree algorithms - C4.5 algorithms, ID3 algorithm, CART, random forest. Univariate trees and Multivariate trees - functional tree, J48 tree,J48-graft, Best-first trees, Naive Bayesian tree.

REFERENCES

- K. Murphy - "Machine Learning: a Probabilistic Perspective", MIT Press, 2012.
- Vinod Chandra S S, Anand H S - "Machine Learning: A Practitioners Approach", Prentice Hall of India, New Delhi, 2020

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER II	Course Code: CSC-CC-524	Credits: 3

MACHINE LEARNING LAB

	COURSE OUTCOMES
CO1	Explain Python programs using packages such as Numpy, Scipy, Pandas, Scikit-learn, etc.
CO2	Implement programs in association rules mining.
CO3	Implement algorithms in reinforcement learning.
CO4	Implement algorithms in clustering, Decision trees.
CO5	Implement algorithms in SVM.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain Python programs using packages such as Numpy, Scipy, Pandas, Scikit-learn, etc.	PSO6	U	C, P
CO2	Implement programs in association rules mining.	PSO7	A	C, P
CO3	Implement algorithms in reinforcement learning.	PSO7, PSO8	A	C, P
CO4	Implement algorithms in clustering, Decision trees.	PSO10	A	C, P
CO5	Implement algorithms in SVM.	PSO6, PSO13U	A	C, P

COURSE CONTENT

Students should practice python programming and implement different algorithms in Machine learning.

List of Experiments

Implement the following algorithms on following methods.

1. Support Vectors Machine.
2. Association rule mining.
3. Reinforcement learning.
4. Clustering.
5. Decision Trees.
6. Classification.

SEMESTER II	Course Code: CSC-DE-525(i)	Credits: 4

DIGITAL IMAGE PROCESSING

	COURSE OUTCOMES
CO1	Define the elements of image processing.
CO2	Differentiate color image models in image representation.
CO3	Discuss about various spacial domain image transformations and filtering.
CO4	Discuss about various frequency domain image transformations and filtering.
CO5	Illustrate different morphological operations on an image.
CO6	Illustrate different boundary representation methods on an image.
CO7	Discuss about image restoration process.
CO8	Discuss about image segmentation process.
CO9	Compare the current technologies and issues specific to Digital Image Processing.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Define the elements of image processing.	PSO4	U	F, C
CO2	Differentiate color image models in image representation.	PSO9	U	C, P
CO3	Discuss about various spacial domain image transformations and filtering.	PSO3, PSO4	U	C, P
CO4	Discuss about various frequency domain image transformations and filtering.	PSO3, PSO7	U	C, P
CO5	Illustrate different morphological operations on an image.	PSO8	A	C, P
CO6	Illustrate different boundary representation methods on an image.	PSO9	A	C, P
CO7	Discuss about image restoration process.	PSO4, PSO12	U	C, P
CO8	Discuss about image segmentation process.	PSO4, PSO12	U	C, P
CO9	Compare the current technologies and issues specific to Digital Image Processing.	PSO8	U	C, P

COURSE CONTENT

MODULE I: Digital Image Fundamentals-Elements of Digital Image Processing Systems, color Image fundamentals, RGB, HSI Color Models, Image sampling, Quantization.

MODULE II: Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering.

MODULE III: Frequency Domain**:** Introduction to Fourier Transform – Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters.

MODULE IV: : Morphological operations: Dilation, Erosion, Opening and Closing; Applications: Boundary extraction - Boundary representation – Chain Code – Boundary descriptors - Regional Descriptors– Shape number – Fourier Descriptor.

MODULE V: Image Restoration: Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering.

MODULE VI: Image Segmentation-Edge detection, Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and Merging – Watershed segmentation algorithm.

REFERENCES

- Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.
- D,E. Dudgeon and RM. Mersereau, , Multidimensional Digital Signal Processing', Prentice Hall Professional Technical Reference, 1990.
- Kenneth R. Castleman, Digital Image Processing, Pearson, 2006.
- Milan Sonka et aI, 'IMAGE PROCESSING, ANALYSIS AND MACHINE VISION',Brookes/Cole, Vikas Publishing House, 2nd edition, 199
- Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Fourth Edition, Pearson Education, 2017.
- Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata McGraw Hill Pvt. Ltd., 2011.
- William K. Pratt, , Digital Image Processing' , John Wiley, New York, 2002

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER II	Course Code: CSC-DE-525(ii)	Credits: 4

NATURAL LANGUAGE PROCESSING

	COURSE OUTCOMES
CO1	Apply the n-gram & Language models in various NLP applications.
CO2	Evaluate the different issues & applications of NLP activity.
CO3	Apply and generalize the different types of Parts-of- speech tagging.
CO4	Identify the different models for computational Morphological analysis.
CO5	Apply and execute the statistical parsing & probabilistic theory.
CO6	Generalize the grammar formalisms & tree banks of syntactical parsing.
CO7	Differentiate between semantic role labelling and semantic parsing.
CO8	Predicate the ambiguity & solutions of different methods.
CO9	Explaining the place and manner of articulation in speech processing.
CO10	Evaluate the recall & F-score method in speech processing.
CO11	List out the applications of NLP in research and development.
CO12	Criticize the Named Entity Recognition & relation extraction methods.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Apply the n-gram & Language models in various NLP applications.	PSO8	A	C
CO2	Evaluate the different issues & applications of NLP activity.	PSO4	E	C, P
CO3	Apply and generalize the different types of Parts-of- speech tagging.	PSO9	A	C, P
CO4	Identify the different models for computational Morphological analysis.	PSO8	U	C, P
CO5	Apply and execute the statistical parsing & probabilistic theory.	PSO12	A	C, P
CO6	Generalize the grammar formalisms & tree banks of syntactical parsing.	PSO8	C	C
CO7	Differentiate between semantic role labelling and semantic parsing.	PSO9	U	C
CO8	Predicate the ambiguity & solutions of different methods.	PSO4	U	C
CO9	Explaining the place and manner of articulation in speech processing.	PSO3	U	C, P
CO10	Evaluate the recall & F-score method in speech processing.	PSO3, PSO4	E	P
CO11	List out the applications of NLP in research and development.	PSO9	U	C
CO12	Criticize the Named Entity Recognition & relation extraction methods.	PSO8	E	C, P

COURSE CONTENT

MODULE I: Introduction - Natural Language Processing – phonology, Morphology, syntax, semantics, and pragmatics – Issues - Applications - The role of machine learning - Probability Basics –Information theory – Collocations -N-gram Language Models - Estimating parameters and smoothing - Evaluating language models.

MODULE II: Morphology and part of speech tagging - Linguistic essentials – Lexical, - Morphology, syntax. Finite State Transducers - Part of speech Tagging - Tagset - Rule-Based Part of Speech Tagging - Markov Models - Hidden Markov Models – Transformation based Models - Maximum Entropy Models. Conditional Random Fields.

MODULEIII :Syntax parsing - Syntax Parsing - Grammar formalisms and treebanks - Parsing with Context Free Grammars - Features and Unification -Statistical parsing and probabilistic CFGs (PCFGs)-Lexicalized PCFGs.

MODULE IV: Semantic analysis - Representing Meaning – Semantic Analysis - Lexical semantics – ambiguity -Word sense disambiguation - Supervised – Dictionary based and Unsupervised Approaches - Compositional semantics - Semantic Role Labeling and Semantic Parsing – Pragmatics - Discourse Analysis.

MODULEV :Speech - Phonetics, Hidden Markov Model, Morphology, Graphical Models for Sequence Labelling in NLP, Consonants (place and manner of articulation) and Vowels; **Phonology:** ASR, Speech Synthesis, Hidden Markov Model and Viterbi, Precision, Recall , F-score, Map.

MODULE VI: Applications - Named entity recognition and relation extraction- IE using sequence labeling-Machine Translation (MT) - Basic issues in MT-Statistical translation-word alignment- phrase-based translation, Question Answering, Text Summarization, Corpus Design, OCR.

REFERENCES:

- Dash, Niladri Sekhar Corpus Linguistics and Language Technology, New Delhi :
  Mittal Publications 2005.
- Jacob Eisenstein, Introduction to Natural Language Processing, 2019.
- Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python.
  Steven 2016.
- James Allen, Natural Language Understanding (2nd Edition) 2nd Edition- 2017.
- Ruslan Mitkov, The Oxford Handbook of Computational Linguistics, Oxford University Press 2003.
- Dan Jurafsky and James H. Martin, Speech and Language Processing (3rd ed. draft), Draft chapters in progress, October 16, 2019
- Philipp Koehn , Statistical Machine Translation, 2016.

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER II	Course Code: CSC-DE-525(iii)	Credits: 4

BLOCK CHAIN TECHNOLOGY

	COURSE OUTCOMES
CO1	Discuss and describe the history, technology, and applications of Block chain
CO2	Analyze the significance of crypto currencies in the digital world
CO3	Identify the functional/operational aspects of crypto currency eco system
CO4	Explain emerging abstract models for Block chain Technology
CO5	Illustrate the working of Ethereum Virtual Machine
CO6	Assess Block chain applications in a structured manner
CO7	Analyze the process of creating a crypto currency
CO8	Create an own Crypto token

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Discuss and describe the history, technology, and applications of Blockchain	PSO2	U	C
CO2	Analyze the significance of cryptocurrencies in the digital world	PSO3, PSO7, PSO9	An	C, P
CO3	Identify the functional/operational aspects of cryptocurrency eco system	PSO8	U	F, C
CO4	Explain emerging abstract models for Blockchain Technology	PSO3, PSO7, PSO9	U	F, C
CO5	Illustrate the working of Ethereum Virtual Machine	PSO7, PSO8	A	C, P
CO6	Assess Blockchain applications in a structured manner	PSO3, PSO7, PSO9	E	C, P
CO7	Analyze the process of creating a crypto currency	PSO3, PSO7, PSO9	An	C, P
CO8	Create an own Crypto token	PSO4, PSO9	Cr	P

COURSE CONTENT

MODULE I: Introduction to Block chain: Evolution and Technology –Applications - Core components of Block Chain technology- Private block chain vs Public block chain - The consensus problem - Asynchronous Byzantine Agreement - AAP protocol and its analysis - Nakamoto Consensus on permission-less, nameless, peer-to-peer network

MODULE II: Abstract Models for BLOCKCHAIN - GARAY model - RLA Model - Proof of Work (PoW) as random oracle - formal treatment of consistency, liveness and fairness - Proof of Stake (PoS) based Chains - Hybrid models (PoW + PoS)

MODULE III: cryptographic basics for cryptocurrency - a short overview of Hashing, signature schemes, encryption schemes and elliptic curve cryptography

MODULE IV: Bitcoin - Wallet - Blocks - Merkley Tree - hardness of mining - transaction verifiability - anonymity - forks - double spending - mathematical analysis of properties of Bitcoin.

MODULE V: Ethereum - Ethereum Virtual Machine (EVM) - Wallets for Ethereum - Solidity - Smart Contracts - some attacks on smart contracts

MODULE VI: (Trends and Topics) - Zero Knowledge proofs and protocols in Blockchain - Succinct non interactive argument for Knowledge (SNARK) - pairing on Elliptic curves - Zcash.

REFERENCES

- R.Pass et al, Fruitchain, a fair blockchain, PODC 2017 (eprint.iacr.org/2016/916).
- J.A.Garay et al, The bitcoin backbone protocol - analysis and applications EUROCRYPT 2015 LNCS VOl 9057, (VOLII), pp 281-310. (Also available at eprint.iacr.org/2016/1048) . (serious beginning of discussions related to formal models for bitcoin protocols).
- R.Pass et al, Analysis of Blockchain protocol in Asynchronous networks , EUROCRYPT 2017, (eprint.iacr.org/2016/454) . A significant progress and consolidation of several principles).
- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
- Blockchain by Melanie Swa, O'Reilly
- Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and Privacy, 2015 (article available for free download) { curtain raiser kind of generic article, written by seasoned experts and pioneers}.

- Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas Antonopoulos
- Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits –

On-line Sources

- https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html
- https://www.hyperledger.org/projects/fabric

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER II	Course Code: CSC-DE-525(iv)	Credits: 4

COMPUTATIONAL BIOLOGY

	COURSE OUTCOMES
CO1	Describe the basic concepts of molecular biology and biological data including DNA and RNA.
CO2	Analyze DNA, RNA, and protein sequences.
CO3	Explain the properties of DNA, RNA, and proteins, the relationships among these molecules.
CO4	Describe about in algorithms computational biology including Gene Finding Approaches and Bayesian via Hidden Marko.
CO5	Articulate the basic concepts of Genetic algorithm and its applications inMicrobial informatics, Biomedical Images and Microarray.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Describe the basic concepts of molecular biology and biological data including DNA and RNA.	PSO10	U	C
CO2	Analyze DNA, RNA, and protein sequences.	PSO9	An	C, P
CO3	Explain the properties of DNA, RNA, and proteins, the relationships among these molecules.	PSO8	U	C, P
CO4	Describe about in algorithms computational biology including Gene Finding Approaches and Bayesian via Hidden Marko.	PSO12	U	C, P
CO5	Articulate the basic concepts of Genetic algorithm and its applications inMicrobial informatics, Biomedical Images and Microarray.	PSO10	U	C, P

COURSE CONTENT

MODULE I: Central dogma of Molecular biology, Concepts in Biological data – DNA, RNA, Protein sequences, RNA classification – coding and non-coding RNA- mRNA, tRNAiRNA etc. Genomics and Proteomics.

MODULE II: Sequencing of biological samples, Sequencing Methods – Sanger sequencing, NGS, WGS, Chipseq RNA seq etc., Sequence Formats – FASTA, SRA, BED etc., Databases- NCBI SRA, Genebank, refseq, uniport, PDB etc.

MODULE III: Sequence alignment – local, global, pairwiseultiple, sequence alignment, scoring methods. Needleman and Wunsch algorithm, global and local alignments. Protein and RNA structure prediction, polypeptic composition, secondary and tertiary structure, algorithms for modelling RNA and protein folding.

MODULE IV: Algorithms in computational biology.Gene Finding Approaches: statistical, homology-based, Bayesian via Hidden Marko. Viterbi and forward/backward algorithms Phylogeny,Jukes-Cantor model, Maximum-likelihood method, distance-based methods, neighbour-joining, HMMs. Genome rearrangements

MODULE V: RNA Secondary Structure: Definitions, scoring schemes, dynamic programming approaches.Motif finding: Repeat finding. Promoter and enhancer recognition. Signal peptide recognition.Genotyping: Basic genetics, haplotype determination, haplotype blocks, forensic identification.Genome Sequence Assembly: Technology overview. Overlap-layout-consensus paradigm. Approaches.

MODULE VI: Combinatorial Pattern Matching- Hash Tables, Repeat Finding, Exact Pattern Matching; Expectation and Maximation (EM) with forward and backward algorithms, discriminative learning; Genetic Algorithm: Basic Concepts, Reproduction, Cross overutation, Fitness Value, Optimization using GAs; Applications in Microbial informatics, Biomedical Images, Microarray etc. Image acquisition Region of interest (RoI), Segmentation, Labelling of images, Image artefacts, Image analysis

REFERENCES

- Andreas Baxevanisand Francis Ouellette - "Bioinformatics- A practical guide to the Analysis of Genes and proteins", Wiley India, 2010
- P. Baldi and S. Brunak - "Bioinformatics: The Machine Learning Approach"IT Press, 2001
- R. Durbin, S. Eddy, A. Krogh and G. Mitchison–" Biological Sequence Analysis", Wiley, 1999
- Rastogi et. al. – "Bioinformatics: Methods and Applications Genomics, Proteomics and Drug Discovery", Prentice Hall of India, New Delhi, 2013
- Vinod Chandra S S, Amjesh R - "Bioinformatics for Beginers", Lambert Academic Publishers, UK, 2019

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER II	Course Code: CSC-DE-525(v)	Credits: 4

CYBER SECURITY AND CYBER LAW

	COURSE OUTCOMES
CO1	Identify Networking and its issues.
CO2	Explain the concepts of Information security, Threats, Vulnerabilities, Impact and control measures.
CO3	Evaluate different methods in cryptography.
CO4	Discuss network security issues and Virtual Private Networks.
CO5	Relate Cyber laws with security incidents**.**
CO6	Analyze fundamentals of Cyber Law.
CO7	Discuss IT Act & its Amendments.
CO8	Relate Cyber laws with security incidents**.**

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify Networking and its issues.	PSO10	U, A	C
CO2	Explain the concepts of Information security, Threats, Vulnerabilities, Impact and control measures.	PSO1	U	C, P
CO3	Evaluate different methods in cryptography.	PSO8	E	C
CO4	Discuss network security issues and Virtual Private Networks.	PSO1	U	C, P
CO5	Relate Cyber laws with security incidents**.**	PSO10	A	C
CO6	Analyze fundamentals of Cyber Law.	PSO13	An	F, C
CO7	Discuss IT Act & its Amendments.	PSO1	U	F, C
CO8	Relate Cyber laws with security incidents**.**	PSO10	A	C

COURSE CONTENT

MODULE I: Information System Threats and attacks, Classification of Threats and Assessing Damages, Security in Mobile and Wireless Computing- Security Challenges in Mobile Devices, authentication Service Security, Security Implication for organizations, Laptops Security, confidentiality, Integrity Availability, Access Control-Biometrics.

MODULE II: Model of Cryptographic Systems, Issues in Documents Security, System of Keys,Public Key Cryptography, Digital Signature, Requirement of Digital Signature System, FingerPrints, Firewalls, Design and Implementation Issues, Policies Network Security- Basic Concepts,Dimensions, Perimeter for Network.

MODULE III: Network Perimeter Security Fundamentals: Introduction, layers of Network
Security, Security by Router – Firewall: Basics, Types - Network Address Translation Issues.
Virtual Private Networks: VPN Basics, Types of VPN, IPSec Tunneling & Protocols. –VLAN, introduction, Links, Tagging, VLAN Trunk Protocol (VTP).

MODULE IV: Constitutional & Human Rights Issues in Cyberspace Freedom of Speech andExpression in Cyberspace - Right to Access Cyberspace – Access to Internet-Right to Privacy -Right to Data Protection.

MODULE V: Cyber Crimes & Legal Framework Cyber Crimes against Individuals – Institution and State - Hacking - Digital Forgery - Cyber Stalking/Harassment - Cyber Pornography -Identity Theft & Fraud Cyber terrorism - Cyber Defamation - Different offences under IT Act,2000.

MODULE VI: Intellectual Property Issues in Cyber Space Interface with Copyright Law -
Interface with Patent Law- trademarks & Domain Names Related issues. Indian Context of Jurisdiction and IT-Act, 2000. , International Law and Jurisdictional Issues in Cyberspace.

REFERENCES

- Forouzan, B.A., Cryptography & Network Security. Tata McGraw-Hill Education, 2010.
- Godbole,“ Information Systems Security”, Willey.
- IT Act 2000 Jeffrey M. Bradshaw, Software Agents (Editor). MIT Press.
- Kahate, A. Cryptography and Network Security. McGraw-Hill Higher Ed., 2009.
- Luger., Artificial Intelligence. 4 ed.- Pearson Education.
- Merkov, Breithaupt,“ Information Security”, Pearson Education
- Schou, Shoemaker, “Information Assurance for the Enterprise”, Tata McGraw Hill,“Cyber Laws Simplified”c GrawHillFurnell, “Computer Insecurity”, Springer.
- Yadav, “Foundations of Information Technology”, New Age, Delhi.

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-CC-531	Credits: 4

DATABASE SYSTEMS FOR BIG DATA

	COURSE OUTCOMES
CO1	Explain in detail about bigdata, its types, characteristics, handling techniques and big data databases.
CO2	Describe about the architecture, challenges and the applications of bigdata.
CO3	Discuss about Hadoop technology, hadoop ecosystem components and its features.
CO4	Explain in detail about Hadoop file system- HDFS and Mapreduce framework.
CO5	Discuss about the NoSQL data store, architecture and its advantages.
CO6	Explain the use of MongoDB and implement its basic commands- CRUD operations.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain in detail about bigdata, its types, characteristics, handling techniques and bigdata databases.	PSO3	U	F, C
CO2	Describe about the architecture, challenges and the applications of bigdata.	PSO8	U	C, P
CO3	Discuss about Hadoop technology, hadoop ecosystem components and its features.	PSO9	U	C, P
CO4	Explain in detail about Hadoop file system- HDFS and Mapreduce framework.	PSO7, PSO8	U, A	C, P
CO5	Discuss about the NoSQL data store, architecture and its advantages.	PSO3	U, A	C, P
CO6	Explain the use of MongoDB and implement its basic commands- CRUD operations.	PSO10	U, A	C, P

COURSE CONTENT

MODULE I : Review of basic concepts, Transaction processing concepts, ACID properties, Schedules, Serializability, Concurrency Control – timestamp and validation concurrency control

MODULE II: Introduction, need of bigdata, classification of data - structured, semi-structured and unstructured, bigdata - definition, characteristics, types, bigdata handling techniques, bigdata databases.

Introduction Spark, Bigdata architecture and Spark, challenges of bigdata, bigdata applications and case studies- big data and credit risk management,bigdata in healthcare and medicine, bigdata and advertising, Limitations of bigdata.

MODULE III: Hadoop Technology- Introduction to hadoop, hadoop and its eCSCystem – core components, features of hadoop, hadoopeCSCystem components, hadoop streaming and pipes.

MODULE IV: Hadoop file system – HDFS, Data storage and file system apreduce framework and programming model, hadoop eCSCystem tools.

MODULE V: NoSQL datastore – Introduction and motivation, Schema less models, Need of NoSQL, Architecture patterns, Features - CAP theorem, Advantages of NoSQL.

MODULE VI: MongoDB – Definition, Characteristics, SQL and MongoDB, Data modeling, datatypes, Commands in MongoDB, CRUD operations.

REFERENCES

- Big Data Analytics with R and Hadoop_ Set up an integrated infrastructure of R and Hadoop to turn your data analytics into Big Data analytics (PDFDrive.com)
- Chris Eaton, Dirk deroos et al. "Understanding Big data "cGraw Hill, 2012.
- NoSQL distilledartin Fowler.

On-line Sources

- https://hostingdata.co.uk/nosql-database/
- http://www.ccs.neu.edu/home/kathleen/classes/cs3200/20-NoSQLMongoDB.pdf

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-CC-532	Credits: 4

DATABASE SYSTEM LAB

	COURSE OUTCOMES
CO1	Develop an idea on file management tasks in Hadoop including creation of directory, list and see the contents of file.
CO2	Implement Programs to understand Map Reduce paradigm
CO3	Create queries for implementing Create, Read, Update and Delete (CRUD) operations.
CO4	Design programs to understand the usage of MongoDB

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Develop an idea on file management tasks in Hadoop including creation of directory, list and see the contents of file.	PSO3, PSO6, PSO7	C	C
CO2	Implement Programs to understand Map Reduce paradigm	PSO6, PSO7, PSO8	A	C, P
CO3	Create queries for implementing Create, Read, Update and Delete (CRUD) operations.	PSO7, PSO8	C	C
CO4	Design programs to understand the usage of MongoDB	PSO6, PSO7	A,C	C, P

COURSECONTENT

Lab exercises related with the following should be implemented in this course.

1. Familiarize hadoop to process and analyze data.
2. Structure semi-structured and unstructured data.
3. Familiarize basic commands in MongoDB.
4. Queries for Create, Read, Update and Delete operations.

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments.

SEMESTER III	Course Code: CSC-CC-533	Credits: 2

CASE STUDY

	COURSE OUTCOMES
CO1	Identify a research problem which is significant in the area of computer science
CO2	Analyze the literature survey in the selected topic as an individual
CO3	Design the experiment with proper hypothesis
CO4	Evaluate and interpret the experimental results.
CO5	Analyze effectiveness of the method implemented.
CO6	Suggest modifications and improvement of the system.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify a research problem which is significant in the area of computer science	PSO12	C	C, P
CO2	Analyze the literature survey in the selected topic as an individual	PSO1, PSO9, PSO13	An	C, P
CO3	Design the experiment with proper hypothesis	PSO5, PSO6, PSO13	C	C, P
CO4	Evaluate and interpret the experimental results.	PSO5, PSO6	An	C, P
CO5	Analyze effectiveness of the method implemented.	PSO8	An	C, P
CO6	Suggest modifications and improvement of the system.	PSO3	C	M

COURSE CONTENT

A case study is a detailed investigation done by a student on a specific topic in the courses studied till third semester. It is a milestone and precursor to the final presentation of the Project. The objective of doing Case Study allow students with real expertise and understanding how and why an innovation has worked in a specific case. The student have to implement a published article from the Research and Development area. The presentation will be oral. The report of the case study should contain Background of the case, Analysis, Alternatives and recommendations and Implementation plan.

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-CC-534	Credits: 2

SEMINAR

	COURSE OUTCOMES
CO1	Acquire in-depth knowledge in specific area of study.
CO2	Develop presentation skill and communication skill
CO3	Apply Professional skills for preparing presentation slides
CO4	Develop defending ability

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Acquire in-depth knowledge in specific area of study.	PSO2, PSO5, PSO6	U,E	C, P
CO2	Develop presentation skill and communication skill	PSO9	C	C, P
CO3	Apply Professional skills for preparing presentation slides	PSO3, PSO11	A	C, P
CO4	Develop defending ability	PSO13	C	C, P

COURSE CONTENT

A Seminar is an outstanding work, published in an international journal in the field that covered in the course need to be presented. The in depth knowledge of the underlying technology/method of the work is evaluated through this course. Students can make use of the presentation aids to deliver the theoretical aspects of the work. The interaction with the audience, Students and faculty is beneficial for the student to strengthen the different aspects of the presentation such as presentation skill, depth of knowledge, Language and rendering, defending the questions.

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments.

SEMESTER III	Course Code: CSC-DE-535(i)	Credits: 4

FOUNDATIONS OF ROBOTICS

	COURSE OUTCOMES
CO1	Illustrate the evolution and technological advancements in Robotics
CO2	Demonstrate the working principle of robots
CO3	Articulate the working of sensors for the success of a robot
CO4	Describe the role of grippers in industrial robots
CO5	Sketch the Kinematics of robots
CO6	Outline the challenges and importance of robot programming

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Illustrate the evolution and technological advancements in Robotics	PSO7	A	C, P
CO2	Demonstrate the working principle of robots	PSO8, PSO9	A	C, P
CO3	Articulate the working of sensors for the success of a robot	PSO5, PSO10	An	C, P
CO4	Describe the role of grippers in industrial robots	PSO4	U	C
CO5	Sketch the Kinematics of robots	PSO3, PSO7, PSO9	C	C, P
CO6	Outline the challenges and importance of robot programming	PSO13	U	C, P

COURSECONTENT

MODULE I: Robotics history through research of the industry, applications of automation and robotics, technologies and their implications on the field of robotics, Robotics classification with respect to geometrical configuration (Anatomy), Controlled system & chain type: Serial manipulator & Parallel Manipulator.

MODULE II: Components of Industrial robotics-precession of movement-resolution, accuracy &repeatability-Dynamic characteristics- speed of motion, load carrying capacity & speed of response

MODULE III: Sensors- types of sensors and ways in which they can be categorized, internal sensors: Position sensors, Velocity sensors. External sensors: Proximity sensors, Tactile Sensors, & Force or Torque sensors.

MODULE IV: Grippers – Mechanical Gripper-Grasping force-Engelberger-g-factors-mechanisms for actuation, Magnetic gripper vaccume cup gripper-considerations in gripper selection & design. Industrial robots: specifications. Selection based on the Application.

MODULE V: Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, D-H transformation matrix, D-H method of assignment of frames. Direct and Inverse Kinematics for industrial robots.

MODULE VI: Robot programming languages and systems – Levels of Robot Programming, Sample Application, Requirements of a Robot Programming Language, Problems peculiar to Robot Programming Language.Off-line programming systems

SUGGESTED CLASS ROOM ACTIVITIES

- Written Assignments for each module will be made available in between the lectures.
- Presentation (Video) of different robots and its working.
- Model Your Idea Context – Illustrate and model a robot for your own idea.

REFERENCES

- Craig, John J. *Introduction to Robotics*. Prentice Hall, 2017.
- *Industrial Robotics (Special Indian Edition)*. Tata McGraw-Hill Education, 2012.
- Jazar, Reza N. *Theory of Applied Robotics*. Springer Science & Business Media, 2010.
- Yang, Richard (Chunhui), et al. *Robotics and Mechatronics*. Springer, 2019.

On-Line Sources

- http://www.mech.sharif.ir/c/document_library/get_file?uuid=5a4bb247-1430-5e46-942c-d692dead831f&groupId=14040
- http://engineering.nyu.edu/mechatronics/smart/Archive/intro_to_rob/Intro2Robotics.pdf

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-DE-535(ii)	Credits: 4

INTERNET OF THINGS

	COURSE OUTCOMES
CO1	Explain the significance of IoT technology in the modern digital world.
CO2	Explain the awareness of technologies behind IoT.
CO3	Compare IoT and machine to machine technologies.
CO4	Analyze Smart devices and IoT Systems.
CO5	Describe operating systems that support IoT.
CO6	Explain how IoT and bigdata get related.
CO7	Implement IoT concepts in python

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain the significance of IoT technology in the modern digital world.	PSO2	U	C
CO2	Explain the awareness of technologies behind IoT.	PSO3	U	C, P
CO3	Compare IoT and machine to machine technologies.	PSO7	An	C
CO4	Analyze Smart devices and IoT Systems.	PSO8	An	C
CO5	Describe operating systems that support IoT.	PSO4	An	C, P
CO6	Explain how IoT and bigdata get related.	PSO7	U, A	C, P
CO7	Implement IoT concepts in python	PSO6	C, A	C, P

COURSE CONTENT

MODULE I: Introduction, to Internet Technology - Internet of Things and Related Future Internet Technologies - Internet of everything - Internet of Things : Definition, Vision, Characteristics, Physical design, Logical design, Functional blocks - Communication models & APIs.

MODULE II: Internet Communication Technologies: Networks and Communication, Processes, Data Management - IoT Related Standardization: Communication protocols, Addressing Schemes - Machine to Machine (M2M): Difference between

IoT and M2M, Software define Network2M Service Layer Standardization - OGC Sensor Web for IoT.

MODULE III: Smart Technology: Introduction, Smart devices, Smart environment, IoT Components, Basic Principles - Embedded technology Vs IoT - Sensors, Wireless sensor networks - Aurdino - Raspberry Pi.

MODULE IV: Prototyping in IoT: Basics of prototypes, Communication in IoT, Prototyping model, Data handling in IoT, fabryq, Bluetooth Low Energy, µfabryq, Operating Systems for Low-End IoT Devices - Open Source OS: introduction, Contiki, RIOT, FreeRTOS, TinyOS, OpenWSN - Closed Source OS :ThreadX, QNX, VxWorks, Nucleus RTOS.

MODULE V: Big Data: BigData versus IoT, BigDatainflucement in IoT, A cyclic model of BigData - Cloud and Internet of Things: Data Storage, Analysis and Communication, Classifications, Characteristics of BigData, Types of BigData - Analysing of Data - Applications, Real time situations, BigData tools - A combined application of Cloud and BigData in IoT.

MODULE VI: Introduction to Python, Introduction to different IoT tools - developing applications through IoT tools - developing sensor based application through embedded system platform - Implementing IoT concepts with python.

REFERENCES

- Adrian McEwen, Hakim Cassimally, Designing internet of things, John Wiley & Sons, 2013.
- Anthony Townsend., Smart cities: big data, civic hackers, and the quest for a new utopia, WW Norton & Company, 2013
- Anthony Townsend., Smart cities: big data, civic hackers, and the quest for a new utopia, WW Norton & Company, 2013
- ArshdeepBahga, Vijay Madisetti, , Internet of things: a hands-on approach, CreateSpace Independent Publishing Platform, 2013
- Dieter Uckelmannark Harrisonichahelles Florian (Ed.), Architecting the internet of things, Springer, 2011
- Dr. OvidiuVermesan, Dr Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-DE-535(iii)	Credits: 4

CLOUD COMPUTING

	COURSE OUTCOMES
CO1	Discuss about Cloud Computing, its types and applications
CO2	Illustrate the application of Cloud Computing on technology, infra structure, and globalize workspace.
CO3	Discuss the issues and challenges related to cloud computing.
CO4	Analyze the security and authentication management in cloud.
CO5	Design a private cloud and integration of different types of cloud
CO6	Summarize the steps of developing AWS instances, volumes and understanding AWS services

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Discuss about Cloud Computing, its types and applications	PSO2	U	C
CO2	Illustrate the application of Cloud Computing on technology, infra structure, and globalize workspace.	PSO7	A	C, P
CO3	Discuss the issues and challenges related to cloud computing.	PSO8	U	C
CO4	Analyze the security and authentication management in cloud.	PSO4	An	C, P
CO5	Design a private cloud and integration of different types of cloud	PSO9	An	C, P
CO6	Summarize the steps of developing AWS instances, volumes and understanding AWS services	PSO10	E	C, P

COURSE CONTENT

MODULE I: Cloud computing-Definition, Characteristics, Cloud Architecture, Deployment models, merits and demerits of cloud computing, Application areas

MODULE II: Cloud Services **-** Infrastructure as a Service (IaaS)- Resource Virtualization (Server, Storage, Network), Platform as a Service (PaaS) - Cloud platform & Management (Computation, Storage), Software as a Service (SaaS) - Web services, Web 2.0, Web OS.

MODULE III: Cloud Security - Cloud issues and challenges, Cloud provider Lock-in, Infrastructure Security, Data and Storage security.

MODULE IV: Cloud Management **-** Authentication Management, Access Control, Trust, Reputation, Cloud contracting Model, Availability and disaster recovery strategies in Cloud.

MODULE V: Understanding Services and Applications - Cloud SOA, Basics of developing a private cloud, Moving applications to the cloud, Integration of clouds.

MODULE VI: AWS – Introduction to Amazon web services, AWS architecture and terminology, managing and creating Amazon EC2 instances and EBS volumes, Understanding Simple Storage Service(S3).

REFERENCES

- Barrie Sosinsky ,"Cloud Computing Bible", 2011, Wiley-India ,ISBN: 978-0-570-90356-
- Nick Antonopoulos ,Lee Gillam ,"Cloud Computing: Principles, Systems and Applications" 2012, Springer, ISBN-13: 978-1849962407
- RajkumarBuyya, James Broberg, Andrzej M. Goscinski," Cloud Computing: Principles and Paradigms", 2011,Wiley,ISBN 978-0-570-88799-8

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-DE-535(iv)	Credits: 4

INTELLIGENT AGENT BASED COMPUTING

	COURSE OUTCOMES
CO1	Explain the significance of intelligent agents in the computing world.
CO2	Describe the basic concepts, methods, techniques, and tools for the use of intelligent agents in computer-based systems.
CO3	Identify the components and functions of intelligent agents.
CO4	Apply the principles and methods of intelligent agents to a small-scale application problem
CO5	Critically evaluate Agent Oriented methodologies
CO6	Explain the problem solving and planning among agents
CO7	Apply agent based modeling techniques for solving real life problems
CO8	Illustrate Agent oriented methodologies including Gaia Methodology, MASE, OPEN process framework, Tropos with neat diagram

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain the significance of intelligent agents in the computing world.	PSO2, PSO4	An	C
CO2	Describe the basic concepts, methods, techniques, and tools for the use of intelligent agents in computer-based systems.	PSO7, PSO10	U	F
CO3	Identify the components and functions of intelligent agents.	PSO4, PSO7	U	F, C
CO4	Apply the principles and methods of intelligent agents to a small-scale application problem	PSO12	A	C, P
CO5	Critically evaluate Agent Oriented methodologies	PSO2, PSO7, PSO12	E	C, P
CO6	Explain the problem solving and planning among agents	PSO7, PSO12	An	C
CO7	Apply agent based modeling techniques for solving real life problems	PSO5, PSO7, PSO12	A	C, P
CO8	Illustrate Agent oriented methodologies including Gaia Methodology, MASE, OPEN process framework, Tropos with neat diagram	PSO2, PSO7, PSO12	A	C, P

COURSE CONTENT

MODULE I: Introduction What are agents Abstract architectures for intelligent agents Concrete architecture for intelligent agents Agent Programming languages Multi-agent Systems and Societies of Agents Introduction Agent Communications Agent Interaction Protocols Societies of Agents.

MODULE II: Distributed Problem Solving and Planning Introduction Task Sharing Result Sharing Distributed Planning Distributed Plan Representations- Distributed Planning and Execution

MODULE III: Distributed Rational Decision making- Introduction Evaluation Criteria Voting Auctions Bargaining _ General Equilibrium market mechanisms Contract nets coalition formation learning in multi-agent systems general characterization Learning and activity coordination Learning about and from other agents

MODULE IV: Computational Organization Theory Introduction Organizational Concepts useful in modelling organizations Formal Methods in DAI Logic based representation and reasoning.

MODULE V: Agents Development frameworks and languages- Development tools applications of agents. Agent Oriented methodologies - Agent oriented analysis and design,

MODULE VI: Agent Oriented Methodologies: Gaia Methodology, MASE, OPEN process framework, Tropos, Agent UML. Agent-based modeling - Entities in Agent-Based Modelling- An Example of Agent-Based Models- Tools for Agent-Based Modelling.

REFERENCES

- Michael Wooldridge: An Introduction to Multi-Agent Systems (2nd ed.). Wiley, 2009. ISBN 978-0-570-51946-
- Stuart Russell and Peter Norvig: Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall, 2009. ISBN 978-G. Weiss (ed.): Multi-Agent Systems - A Modern Approach to Distributed Artificial Intelligence (2nd ed.). MIT Press, 2013
- M. Wooldridge: Reasoning about Rational Agents. MIT Press, 2000

On-line Sources

- **https://dimensionless.in/introduction-to-agent-based-modelling/**

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-DE-535(v)	Credits: 4

HIGH PERFORMANCE COMPUTING

	COURSE OUTCOMES
CO1	Illustrate the computational complexity of modern problem methodology.
CO2	Demonstrate the working of parallel computing.
CO3	Discuss the nature and working of parallel algorithms.
CO4	Demonstrate the randomization techniques in parallel programming.
CO5	Illustrate the use SPMD Programming.
CO6	Assess the performance of the parallel programming.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Illustrate the computational complexity of modern problem methodology.	PSO4	A	C, P
CO2	Demonstrate the working of parallel computing.	PSO8	A	C
CO3	Discuss the nature and working of parallel algorithms.	PSO9	U	C, P
CO4	Demonstrate the randomization techniques in parallel programming.	PSO10	A	C, P
CO5	Illustrate the use SPMD Programming.	PSO7	A	C, P
CO6	Assess the performance of the parallel programming.	PSO4	E	P

COURSECONTENT

MODULE I: Review of Computational Complexity, Granularity and Partitioning, Locality: temporal, spatial, stream, kernel, Basic methods for parallel programming, Real-world case studies (drawn from multiscale, multi-discipline applications)

MODULE II: High-End Computer Systems: Memory Hierarchies, multi-core Processors: Homogeneous and Heterogeneous, Shared-memory Symmetric Multiprocessors, Vector Computers, Distributed Memory Computers, Supercomputers and Petascale Systems, Application Accelerators / Reconfigurable Computing, Novel computers: Stream, multithreaded, and purpose-built

MODULE III: Parallel Algorithms: Parallel models: ideal and real frameworks, Basic Techniques: Balanced Trees, Pointer Jumping, Divide and Conquer, Partitioning, Regular Algorithms: Matrix operations and Linear Algebra, Irregular Algorithms: Lists, Trees, Graphs.

MODULE IV: Randomization: Parallel Pseudo-Random Number Generators, Sorting, Monte Carlo techniques. Parallel Programming: Revealing concurrency in

applications, Task and Functional Parallelism, Task Scheduling, Synchronization Methods, Parallel Primitives (collective operations).

MODULE V: SPMD Programming (threads, OpenMPI), I/O and File Systems, Parallel Matlabs (Parallel Matlab, Star-Patlab MPI), Partitioning Global Address Space (PGAS) languages (UPC, Titanium, Global Arrays)

MODULE VI: Achieving Performance: Measuring performance, Identifying performance bottlenecks, restructuring applications for deep memory hierarchies, Partitioning applications for heterogeneous resources, using existing libraries, tools, and frameworks.

SUGGESTED CLASS ROOM ACTIVITIES

- Written for each modules will be made available in between the lectures.
- Presentation (Video) of different robots and its working.
- Model Your Idea Context – Illustrate and model a robot for your own idea.

REFERENCES

- Bader, David A. Petascale Computing. CRC Press, 2007.
- David Culler Jaswinder Pal Singh, "Parallel Computer Architecture: A hardware/Software Approach "organ Kaufmann, 1999.
- Grama, A. Gupta, G. Karypis, V. Kumar, An Introduction to Parallel Computing, Design and Analysis of Algorithms: 2/e, Addison-Wesley, 2003.
- G.E. Karniadakis, R.M. Kirby II, Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and their Implementation, Cambridge University Press,2003.
- G.S. Almasi and A. Gottlieb, Highly Parallel Computing, 2/E, Addison-Wesley, 1994.
- Kai Hwang, "Scalable Parallel Computing", McGraw Hill 1998.
- M.J. Quinn, Parallel Programming in C with MPI and OpenMP, McGraw-Hill, 2004.
- Wilkinson and M. Allen, Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, 2/E, Prentice Hall, 2005.

On-line Sources

- http://srmcse.weebly.com/uploads/8/9/0/9/8909020/introduction_to_parallel_computing_second_edition-ananth_grama..pdf
- http://index-of.co.uk/Algorithms/Petascale%20Computing%20Algorithms%20and%20Applications.pdf

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-DE-536(i)	Credits: 4

OPTIMIZATION TECHNIQUES

	COURSE OUTCOMES
CO1	Identify the concepts of optimization techniques and its types
CO2	Discuss different optimum design concepts and methods
CO3	Solve the Linear Programming models using graphical and simplex methods
CO4	Evaluate different algorithmic methods for solving constrained and unconstrained optimization problems
CO5	Explain the need of optimization of engineering systems
CO6	Illustrate how dynamic programming used to solve multi stage decision problems

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify the concepts of optimization techniques and its types	PSO2, PSO7, PSO12	U	F,P
CO2	Discuss different optimum design concepts and methods	PSO2, PSO7, PSO12	U	C, P
CO3	Solve the Linear Programming models using graphical and simplex methods	PSO2, PSO7, PSO12	A	C, P
CO4	Evaluate different algorithmic methods for solving constrained and unconstrained optimization problems	PSO2, PSO7, PSO12	E	P
CO5	Explain the need of optimization of engineering systems	PSO2, PSO7, PSO12	An	C
CO6	Illustrate how dynamic programming used to solve multi stage decision problems	PSO2, PSO7, PSO12	A	C, P

COURSE CONTENT

MODULE 1: Optimization: Introduction, Statement of an Optimization problem, formulation of Optimal Problem, Typesof Optimization problem.

MODULE II: Optimum design concepts: Definition of Global and Local optima, Optimality criteria, Convexity and concavity of functions of one and two variables, Lagrangian function, Hessian matrix formulation.

MODULE III: Linear programming: Standard form of Linear Programming Problem, Canonical form,, Elementary operations, Graphical method for two variable optimization problem, Simplex method, Karmarkar's projective scaling method.

MODULE IV: Optimization algorithms for solving unconstrained optimization problems – Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method.

MODULE V: Optimization algorithms for solving constrained optimization problems – direct methods – penalty function methods – steepest descent method.

MODULE VI: Dynamic Programming**:** Representation of multistage decision process, Types of multistage decision problems, Computational procedure in dynamic programming.

REFERENCES

- G. Hadley ;Linear programming, , Narosa Publishing House, New Delhi, ISBN 13: 9788185015910
- Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley and Sons ,(5th edition),ISBN: 978-1-119-55479-3

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-DE-536(ii)	Credits: 4

SOCIAL NETWORK ANALYSIS

	COURSE OUTCOMES
CO1	Identify the basic concepts semantic web and social networks.
CO2	Explain how semantic web and ontology related.
CO3	Describe about the basic concepts and measures of Social Network Analysis including ego networks, tie strength, key players and cohesion.
CO4	Discuss about the basic metrics used in Social network analysis degree distribution, clustering coefficient, clique, k-core, k-plex and network motifs.
CO5	Explain the centralities and find the relevance of web pages using page ranking algorithms.
CO6	Discuss about the affiliation networks, graphs and its partitioning techniques.
CO7	Implement an algorithm to solve social media mining and sentimental analysis.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify the basic concepts semantic web and social networks.	PSO4	U	F, C
CO2	Explain how semantic web and ontology related.	PSO8	U	C, P
CO3	Describe about the basic concepts and measures of Social Network Analysis including ego networks, tie strength, key players and cohesion.	PSO10	U	F, C
CO4	Discuss about the basic metrics used in Social network analysis degree distribution, clustering coefficient, clique, k-core, k-plex and network motifs.	PSO9	U	C, P
CO5	Explain the centralities and find the relevance of web pages using page ranking algorithms.	PSO9	U	C, P
CO6	Discuss about the affiliation networks, graphs and its partitioning techniques.	PSO8	U	C, P
CO7	Implement an algorithm to solve social media mining and sentimental analysis.	PSO10	A	C, P

COURSE CONTENT

MODULE I: Introduction to Semantic Web and social networks, limitations of current web, emergence of social web, Ontology and Semantic Web-Ontology based knowledge Representation; Resource Description Framework;

MODULE II: Network analysis - Social Network analysis, Key concepts and measures- Networks- structure- Nodes and edges, network diameter ,ego networks, tie strength- homophily, transitivity, key players- centrality measures, Cohesion- reciprocity, density, clustering, average and longest distance, small worlds, preferential attachment, Applications of SNA.

MODULE III: Basic metrics for social network analysis - Degree distribution, clustering coefficient, Cliques, k- cores, k-clans, k-plexes, F-groups, Frequent patterns - Network motifs.

MODULE IV: Centralities and ranking on network- Node centrality metrics: degree , closeness and betweenness, eigenvector centrality, Katz centrality, Page Ranking Algorithm, HITS.

MODULE V: Network communities- Divisive methods, Graph partitioning and cut metrics. Edge betweenness. Modularity clustering. Affiliation network and bipartite graphs.

MODULE VI: Information and influence propagation on networks, Social Diffusion, Basic cascade model, Influence maximization, Social media mining-sentiment mining.

REFERENCES

- BorkoFurht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010.
- Dion Goh and Schubert Foo, "Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008.
- GuandongXu ,Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", First Edition Springer, 2011.
- Maksim Tsvetovat, Alexander Kouznetsov; "Social Network Analysis for Startups: Finding Connections on the Social Web"; O'Reilly Media, Inc., ISBN 1449306462, 9781449306465
- Peter J. Carrington, John Scott, Stanley Wasserman; "Models and Methods in Social Network Analysis"; Cambridge University Press; ISBN 1139443437, 9781139443432
- Peter Mika, "Social Networks and the Semantic Web", , First Edition, Springer 2007.
- Song Yang, Franziska B. Keller, Lu Zheng; "Social Network Analysis: Methods and Examples"; SAGE Publications; ISBN 1506362125, 9781506362120

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER III	Course Code: CSC-DE-536(iii)	Credits: 4

ARTIFICIAL INTELLIGENCE IN CYBER SECURITY

	COURSE OUTCOMES
CO1	Explain the fundamentals of Artificial Intelligence and Cyber Security.
CO2	Identify the challenges in Cyber security with and without Artificial Intelligence.
CO3	Familiar with AI enabled cyber attacks and Threats.
CO4	Explain Artificial Intelligence enabled network and data security.
CO5	Compare different applications and software powered with Artificial Intelligence
CO6	Analyze machine learning algorithms in cyber security with examples**.**

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain the fundamentals of Artificial Intelligence and Cyber Security.	PSO1	U	C
CO2	Identify the challenges in Cyber security with and without Artificial Intelligence	PSO4	A	C
CO3	Familiar with AI enabled cyber attacks and Threats.	PSO7	U	C
CO4	Explain Artificial Intelligence enabled network and data security.	PSO1	U	C, P
CO5	Compare different applications and software powered with Artificial Intelligence	PSO8	U	C
CO6	Analyze machine learning algorithms in cyber security with examples**.**	PSO1, PSO2	An	C, P

COURSECONTENT

MODULE I: Artificial Intelligence: introduction, applications, challenges, machine learning and deep learning (basics only) – Cyber security: threats, cryptography, network security, authenticity, phishing, spamming and spoofing. Artificial Intelligence in cyber security: introduction, challenges, applications – AI powered attacks and threats - AI-powered Attacks and corresponding mitigations – AI vs. AI.

MODULE II: AI powered network security: network anomaly detection, botnet detection, insider test, DDoS detection and prevention. – Information security-Authentication abuse, account reputation scoring, user authentication security, biometric authentication.

MODULE III: AI powered cloud based security- fraud detection – credit card frauds – AI for social engineering- speech recognition, face recognition, deep fake detection, lie detection, Fake news and fake review detection.

MODULE IV: AI-based defense mechanism- CAPTCHA breaker, neural network assisted fuzzing, vulnerability scanner, malicious URL detector, software vulnerability detection. – Wireless indoor localization, Ad blocking.

MODULE V: Data security with AI- password cracking, deep steganography and steg-analysis, Encryption using AI. – Application analysis- introduction, Android applications, Gmail and YouTube – social media data security.

MODULE VI: AI powered Cyber security-case study analysis: Spam detection (NN perceptron, SVM) – Phishing detection (logistic regression and decision trees) – Malware threat detection (K-means clustering, HMM, Deep learning).

REFERENCES

- Alessandro Parisi, "Hands-On Artificial Intelligence for Cyber Security", Packt publishing 2019, 978-1-789-80402-7.
- Emmanuel Tsukerman, " Machine Learning for Cyber Security Cookbook", Packt publishing 2019, 978-1-789-80402-7.
- Leslie F. Sikos, " AI in Cybersecurity", Springer publishing 2019, 978-3-319-98842-9.
- Christiansen, Bryan, Piekarz, Agnieszka, " Global Cyber Security Labor Shortage and International Business Risk", IGI global 2019, 978-1-552-55927-6.

SEMESTER III	Course Code: CSC-DE-536(iv)	Credits: 4

SMART APPLICATIONS

	COURSE OUTCOMES
CO1	Describe methods and technologies for the development of smart connected applications.
CO2	Explain about smart objects, mobile devices (smart phones, tablets), wearable's (smart watches, fitness trackers) and home automation devices.
CO3	Discussabout management of smart devices in virtual environments, human user-centered environments and physical environments.
CO4	Articulatethe concepts of Autonomous systems and artificial life.
CO5	Assesscommon designs for smart applications.
CO6	Examine development platforms and cloud services for smart applications.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Describe methods and technologies for the development of smart connected applications.	PSO1	U, A	C, P
CO2	Explain about smart objects, mobile devices (smart phones, tablets), wearables (smart watches, fitness trackers) and home automation devices.	PSO8	U	F, C
CO3	Discuss about management of smart devices in virtual environments, human user-centered environments and physical environments.	PSO4	U	C
CO4	Articulate the concepts of Autonomous systems and artificial life.	PSO8	U	C
CO5	Assess common designs for smart applications.	PSO9	E	C, P
CO6	Examine development platforms and cloud services for smart applications.	PSO3	U, A	C, P

COURSE CONTENT

MODULE I: Smart devices and services: Service architecture models, service provision life-cycle, virtual machines and operating systems, Application and requirements, device technology and connectivitySmart mobiles, cards and device networks: Smart

mobile devices, users, resources and code, operating systems for mobile computers and communicator devices, smart card devices, device networks

MODULE II: Management of smart devices - Managing smart devices in virtual environments, managing smart devices in human user-centered environments, managing smart devices in physical environmentsSmart Expert system - Building Smart systems using different learning techniques, smart system applications, and agent based concurrent engineering

MODULE III: Human Computer Interaction: Explicit HCI, Implicit HCI, User Interface and Interaction for four hand-held widely used devices, Hidden UI via basic smart devices, Hidden UI via wearable and implanted devices, Human centered design, user models, iHCI Design.

MODULE IV: Autonomous systems and artificial life - Basic autonomous intra-acting systems, reflective and self-aware systems, self-management and autonomic computing, complex systems, artificial life

MODULE V: Common designs for smart applications (e.g. fuzzy logic in control systems or cloud analysis of field sensors data streams). Make or buy: selecting appropriate procurement strategies). Development platforms for smart objects (e.g.: Brillo (IoT devices) or Android TV (Smart TVs)), Development platforms for smart architectures (e.g. TensorFlow (server-side RNNs), or the Face Recognition API (mobile)). Cloud services for smart applications (e.g. Google Cloud Machine Learning API, Google Cloud Vision API, Google Cloud Speech API, or Deploying Deep Neural Networks on Microsoft Azure GPU VMs)

MODULE VI: Deployment and operations (e.g.: cloud hosting vs. device hosting, or harnessing user feedback to drive improvement). Measuring success: methods and metrics (e.g: defining user engagement and satisfaction metrics, or assessing the naturalness of smart interactions)

REFERENCES

- Aurélien Géron's - "Hands-On Machine Learning with Scikit-Learn and TensorFlow", O'Reilly Media, Inc.,2017
- Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle – "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", Elsevier Science Publishing, 2014.

- Stefan Poslad–"Ubiquitous Computing, Smart devices, environment and interaction", Wiley, 2011

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments.

SEMESTER III	Course Code: CSC-DE-536(v)	Credits: 4

NATURE INSPIRED COMPUTING

	COURSE OUTCOMES
CO1	Explain about bio inspired computing fundamentals.
CO2	Explain about optimization problems and its types.
CO3	Familiar with Genetic algorithm and its applications.
CO4	Compare different Ant Colony Optimization algorithmic models.
CO5	Compare different Artificial Bee Colony Optimization algorithmic models.
CO6	Illustrate Particle swam optimization algorithm with an example.
CO7	Explain different natural inspired computing algorithms.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain about bio inspired computing fundamentals.	PSO1	U	F, C
CO2	Explain about optimization problems and its types.	PSO4	U	C, P
CO3	Familiar with Genetic algorithm and its applications.	PSO7	U	C, P
CO4	Compare different Ant Colony Optimization algorithmic models.	PSO8	An	C, P
CO5	Compare different Artificial Bee Colony Optimization algorithmic models.	PSO9	An	C, P
CO6	Illustrate Particle swam optimization algorithm with an example.	PSO4	A	C, P
CO7	Explain different natural inspired computing algorithms.	PSO9	U	C, P

COURSE CONTENT

MODULE I: Models of Life and Intelligence - Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques, Swarm models and its self-organisation, swarm and evolutionary algorithms. Optimisation problems – single and multi-objective optimisation, heuristic, meta-heuristic and hyper heuristic functions.

MODULE II: Genetic algorithms - Mathematical foundation, Genetic problem solving, cross over and mutation. genetic algorithms and Markov process, applications of genetic algorithms

MODULE III: Ant Colony Algorithms - Ant colony basics, hybrid ant system, ACO in combinatorial optimisation, variations of ACO, case studies.

MODULE IV: Particle Swam algorithms - particles moves, particle swarm optimisation, variable length PSO, applications of PSO, case studies. Artificial Bee Colony algorithms - ABC basics, ABC in optimisation, multi-dimensional bee colony algorithms, applications of bee algorithms, case studies.

MODULE V: Selected nature inspired techniques - Hill climbing, simulated annealing, Gaussian adaptation, Cuckoo search, Firey algorithm, SDA algorithm, bat algorithm, case studies. Other nature inspired techniques - Social spider algorithm, Cultural algorithms, Harmony search algorithm, Intelligent water drops algorithm, Artificial immune system, Flower pollination algorithm, case studies.

MODULE VI: Selected nature inspired optimization techniques - Bacterial colony optimization, Glow-worm Swarm optimization, Plant growth adaptation in optimization, Termite colony optimization, African Buffalo optimization, case studies.

REFERENCES

- Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
- Floreano, D. and C. Mattiussi -"Bio-Inspired Artificial Intelligence: Theoriesethods, and Technologies"IT Press, 2008
- Leandro Nunes de Castro - " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007
- Marco Dorrigo, Thomas Stutzle -" Ant Colony Optimization", Prentice Hall of India, New Delhi, 2005
- Vinod Chandra S S, Anand H S - "Machine Learning: A Practitioners Approach", Prentice Hall of India, New Delhi, 2020

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments.

SEMESTER III	Course Code: CSC-GC-5A2	Credits: 2

COMPUTATIONAL SOCIAL SCIENCE

	COURSE OUTCOMES
CO1	Explain the basic idea of grouping according to social behavior
CO2	Identify the data sets in social science
CO3	Discuss the conversion of social science data sets into computational models
CO4	Use the basic concepts of graph and its properties
CO5	Explain basic principles of social network analysis
CO6	Discuss basic ideas to social media mining

TAGGING OF COURSE OUTCOMES

	Course outcomes	PSO	CL	KC
CO1	Explain the basic idea of grouping according to social behavior		**U**	F, C
CO2	Identify the data sets in social science		**U**	C, P
CO3	Discuss the conversion of social science data sets into computational models		**An**	C, P
CO4	Use the basic concepts of graph and its properties		**A**	P
CO5	Explain basic principles of social network analysis		**U**	C
CO6	Discuss basic ideas to social media mining		**U**	C, P

COURSE CONTENT

MODULE I: Social Behavior and its grouping. Introduction to the data sets in social science. Introduction to Semantic Web; Social Network analysis- concepts; Applications of Social Network Analysis.

MODULE II: Modeling Social Networks –Basic principles in graph theory, statistical properties of social networks.

MODULE III: Differences between vectors and Matrix, Basic matrix operations. Basic vector operations.

MODULE IV: Vector Space model, social media mining-sentiment mining.

REFERENCE

- Bruno Gonçalves, Nicola Perra, Social Phenomena: From Data Analysis to Models Computational Social Sciences, Springer, 2015,ISBN 3319140116, 9783319140117
- Claudio Cioffi-Revilla, Introduction to Computational Social Science: Principles and Applications Texts in Computer Science, Springer, 2017, ISBN 3319501313, 9783319501314
- David Easley and Jon Kleinberg; Networks, Crowds, and Markets: Reasoning About a Highly Connected World. available at http://www.cs.cornell.edu/home/kleinber/ networks-book/
- R. Michael Alvarez, Computational Social Science: Discovery and Prediction Analytical Methods for Social Research, Cambridge University Press, 2016, ISBN 1316531287, 9781316531280
- Riccardo Boero, Behavioral Computational Social Science, John Wiley & Sons, 2015 ISBN 1118657306, 9781118657300

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments

SEMESTER IV	Course Code:CSC-CC-541	Credits: 18

DISSERTATION AND VIVA VOCE

	COURSE OUTCOMES
CO1	Identify a problem statement for the final project.
CO2	Perform literature review by analyzing the related works.
CO3	Implement the existing work from the literature.
CO4	Analyze the existing system capture the limitations.
CO5	Propose a method improvement to overcome the limitations.
CO6	Evaluate and interpret the design and experimental results.
CO7	Develop the skill set to write research papers and project thesis.

TAGGING OF COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify a problem statement for the final project.	PSO12	U	C, P
CO2	Perform literature review by analyzing the related works.	PSO8	U	C
CO3	Implement the existing work from the literature.	PSO9	A	C, P
CO4	Analyze the existing system capture the limitations.	PSO6	An	C
CO5	Propose a method improvement to overcome the limitations.	PSO4	C	C, P
CO6	Evaluate and interpret the design and experimental results.	PSO3	E	P
CO7	Develop the skill set to write research papers and project thesis.	PSO12, PSO13	C	P

COURSE CONTENT

All the students have to do a project work on a problem which has industry or research potential as part of this course. The project work can be done in any of the following - R&D institutions, MNC - IT companies and Department. At the end of the course, all the students should submit a project report with the details of the work done, findings and suggestions for evaluation. There will be internal and external evaluation of the work.

All students need to attend a course viva of the programme at the end of project work. All students will be evaluated by a panel of experts on their knowledge on different courses in the program, case studies done and the final project work. There will be evaluation of their professional development acquired by the programme.

ASSESSMENT

As per the regulations of the University for the Teaching and Learning Departments