Learning Outcomes-based Curriculum Framework (LOCF) for Post-graduate Programme

Post Graduate programmes: (M.Sc. (Computer Science), M.Sc. (Computer Science with specialization in Artificial Intelligence) and M.Tech (Computer Science with specialization in Digital Image Computing)

(**Syllabus effective from 2020 Admission**)

UNIVERSITY OF KERALA

DEPARTMENT OF COMPUTER SCIENCE

2020

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PREAMBLE

The role of higher education is vital in securing the gainful employment and providing further access to higher education comparable to the best available in the world-class institutions elsewhere. The improvement in the quality of higher education, therefore; deserves to be given top-most priority to enable the young generation of students to acquire skill, training and knowledge to enhance their thinking, comprehension and application abilities and prepare them to compete, succeed and excel globally. Sustained initiatives are required to reform the present higher education system for improving and upgrading the academic resources and learning environments by raising the quality of teaching and standards of achievements in learning outcomes across all graduate programs in science, humanities, commerce and professional streams of higher education.

One of the significant reforms in the graduate education is to introduce the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-centric, interactive and outcome-oriented with well-defined aims, objectives and goals to achieve. The University Grants Commission (UGC) took the initiative of implementing the LOCF in the Colleges and the Universities of the country. Accordingly, the University of Kerala has decided to implement the LOCF in all its departments under the auspices of Internal Quality Assurance Cell (IQAC). A series of teacher training workshops were organized by IQAC and the office of the Credit and Semester System (CSS), and the departments have revised the syllabus accordingly, through workshops and in consultation with academic experts in the field.

GRADUATE ATTRIBUTES (GAs)

The Graduate Attributes (GAs) reflect particular qualities and abilities of an individual learner including knowledge, application of knowledge, professional and life skills, attitudes and human values that are required to be acquired by the graduates of University of Kerala. The graduate attributes include capabilities to strengthen one's professional abilities for widening current knowledge and industry-ready skills, undertaking future studies for global and local application, performing creatively and professionally, in a chosen career and ultimately playing a constructive role as a socially responsible global citizen. The Graduate Attributes define the characteristics of learners and describe a set of competencies that are beyond the study of a particular area and programme.

The GAs of University of Kerala

- Continue life-long learning as an autonomous learner
- Continuously strive for excellence in education
- Apply and nurture critical and creative thinking
- Promote sustainable development practices
- Promote co-operation over competition
- Balance rights with responsibilities
- Understand and respect diversity & difference
- Not be prejudiced by gender, age, caste, religion, or nationality.
- Use education as a tool for emancipation and empowerment of humanity

BRIEF HISTORY OF THE DEPARTMENT

The Department of Computer Science, University of Kerala, was established in 1985. It offers M.Sc. in Computer Science, M.Sc. in Computer Science (with specialization in Artificial Intelligence), M.Tech. in Computer Science (with specialization in Digital Image Computing), M.Phil., and Ph.D. in Computer Science. The Department gives at most importance on Research and Development besides regular teaching. Over the past few years the department has acquired national and international importance. The department has a track record of producing highly skilled professionals in the field of Computer Science. Many of the alumni are well placed in Institutes of National Importance, Central/State universities, R&D organizations like ISRO, CDAC, Educational Institutions and different MNCs. The department has produced more than 30 Ph.D.s so far. The students and faculty members have published a good number of research papers in reputed International Journals/Conference Proceedings published by IEEE, Springer, Elsevier, Wiley etc. Many of our students and faculty members have received national and international recognitions. Department of Computer Science is the only department in Kerala to bag the National Award for Best M.Tech. thesis, three times from Indian National Academy of Engineering (INAE), New Delhi. The faculty members of the department have received prestigious awards such as AICTE Career Award for Young Teachers, IEI Young Engineer Award, SSI Young System Scientist Award etc. to name a few.

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

UNIVERSITY OF KERALA

Syllabus for M. Sc in Computer Science

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	Data structures and 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 Systems 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 with not less than 60% marks (or equivalent grade) 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	Describe the principles and concept of distributed system
CO2	Identify the challenges and opportunities faced by distributed systems
CO3	Explain the middleware technologies that support distributed applications such as RPC, RMI and object based middleware.
CO4	Apply remote method invocation and objects.
CO5	Identify 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	Describe 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	Explain 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	Identify 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 – Issues in IPC by Message Passing - Synchronization - Buffering - Multi datagram Messages – Encoding and Decoding of Message Data - Process Addressing - Failure Handling - Group Communication.

MODULE III: Distributed Shared Memory: General Architecture of DSM Systems - Design and Implementation: Issues of DSM - Granularity - Structure of Shared Memory Space – Consistency Models - 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 – File Models - 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

DATA STRUCTURES AND 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	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 skill set 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 skill set 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	Describe 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	Identify 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	Implement 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	Describe 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	Identify 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	Implement 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 follows 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 follows 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	PSO11	A	P

	software requirements engineering, analysis, design, and testing processes.			

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: Micro service Architectures for Software Development- Characteristics of Micro services- Challenges- Advantages and Disadvantages- Micro services and SOA- Implementation of a simple micro service 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, Lakshmikanth Raghavan ;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 spatial 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 spatial 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 transforms – 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 - Tag set - 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 tree banks - 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 Labeling 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 Block chain	PSO2	U	C
CO2	Analyze the significance of crypto currencies in the digital world	PSO3, PSO7, PSO9	An	C, P
CO3	Identify the functional/operational aspects of crypto currency eco system	PSO8	U	F, C
CO4	Explain emerging abstract models for Block chain Technology	PSO3, PSO7, PSO9	U	F, C
CO5	Illustrate the working of Ethereum Virtual Machine	PSO7, PSO8	A	C, P
CO6	Assess Block chain 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 BLOCK CHAIN - 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 Block chain - Succinct non interactive argument for Knowledge (SNARK) - pairing on Elliptic curves - Zcash.

REFERENCES

- R.Pass et al, Fruitchain, a fair Block chain, 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 Block chain 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.
- Block chain 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 Block chain - 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 in Microbial 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 in Microbial 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, ChIP-seq 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 Maximization (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 and Expression 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" Mc Graw Hill Furnell, "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, hadoopeCSCsystem 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 SYSTEMS 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 vacuum 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, Types of 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	Discuss about management of smart devices in virtual environments, human user-centered environments and physical environments.
CO4	Articulate the concepts of Autonomous systems and artificial life.
CO5	Assess common 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 connectivity Smart 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 environments Smart 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 centred 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

Department of Computer Science

Learning Outcomes-based Curriculum Framework (LOCF)

For Post-Graduate Programme

M.Sc. Computer Science

With Specialization in Artificial Intelligence

(Syllabus effective from 2020 Admission onwards)

UNIVERSITY OF KERALA

2020

UNIVERSITY OF KERALA

Syllabus for M.Sc in Computer Science
(With specialization in Artificial Intelligence)

PROGRAMME OUTCOMES

PO1	Ability to apply theoretical and advanced knowledge to solve the real world problems.
PO2	Develop the skill to do 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 Artificial intelligence, Intelligent Agents, Advanced Machine Learning, Artificial Intelligence algorithms, applications of Artificial Intelligence Management Systems and Information Security related courses.
PSO2	Provide students mathematical and technical skill set of Machine Learning, Data Analytics, 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 Artificial Intelligence.
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 computersand 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**

*(With Specialization in **Artificial Intelligence**)*

Semester	Course Code	Name of the course	Credits
I	**Core courses (CC)**		
	CSA-CC-511	Mathematics of Artificial Intelligence	4
	CSA-CC-512	Autonomous Systems and Knowledge Representation	4
	CSA-CC-513	Algorithms- Complexity and Optimization	4
	CSA-CC-514	Artificial Intelligence Lab	3
	Skill Enhancement Elective (SE)		
	CSA-SE-501	Entrepreneurial Skills and Scientific Writing	2
	Generic Course (GC)		
	CSA-GC-501	Introduction to Machine Learning and Applications	2
II	**Core courses (CC)**		
	CSA-CC-521	Theoretical Foundations of Machine Learning	4
	CSA-CC-522	Analytics and Data Science	4
	CSA-CC-523	Database Systems for Big Data	4
	CSA-CC-524	Machine Learning Lab	3
	Discipline Specific Electives (DE)		
	CSA-DE-525(i)	Digital Image Processing	4
	CSA-DE-525(ii)	Natural Language Processing	4
	CSA-DE-525(iii)	Block chain Technology	4
	CSA-DE-525(iv)	Computational Biology	4
	CSA-DE-525(v)	Cyber Security and Cyber Law	4
III	**Core courses (CC)**		
	CSA-CC-531	Advanced Learning Models	4
	CSA-CC-532	Machine Intelligence Lab	3
	CSA-CC-533	Case Study	2
	CSA-CC-534	Seminar	2
	Discipline Specific Electives (DE)		
	CSA-DE-535(i)	Foundations of Robotics	4
	CSA-DE-535(ii)	Internet of Things	4
	CSA-DE-535(iii)	Cloud Computing	4
	CSA-DE-535(iv)	Intelligent Agent based computing	4
	CSA-DE-535(v)	High Performance Computing	4

	CSA-DE-536(i)	Optimization Techniques	4
	CSA-DE-536(ii)	Social Network Analysis	4
	CSA-DE-536(iii)	Artificial Intelligence in Cyber Security	4
	CSA-DE-536(iv)	Smart Applications	4
	CSA-DE-536(v)	Nature Inspired Computing	4
	Generic Course (GC)		
	CSA-GC-502	Artificial Intelligence and Daily Life	2
IV	**Core courses (CC)**		
	CSA-CC-541	Dissertation and Viva - Voce	18

Eligibility:

Candidates shall be required to possess First class Bachelor's Degree with not less than 60% marks (or equivalent grade) 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: CSA-CC-511	Credits: 4

MATHEMATICS FOR ARTIFICIAL INTELLIGENCE

	COURSE OUTCOMES
CO1	Find the relationship between the vectors by the help of vector algebra
CO2	Prioritize the components of a matrix with the help of Eigenvalues & eigenvectors
CO3	Articulate the concept and derivation of gradients
CO4	Describe the role of local-global maxima & minima Gradient algorithms optimization
CO5	State the basics conditional probability and its applications
CO6	Illustrate the use of Information theory in machine learning algorithms

TAGGING OF COURSE OUTCOMES

	COURSE OUTCOMES	PSO	CL	KC
CO1	Find the relationship between the vectors by the help of vector algebra	PSO2	U, A	C, P
CO2	Prioritize the components of a matrix with the help of Eigenvalues & eigenvectors	PSO12	U, An, C	C, P
CO3	Articulate the concept and derivation of gradients	PSO9	U	C
CO4	Describe the role of local-global maxima & minima Gradient algorithms optimization	PSO2	U, An	C, P
CO5	State the basics conditional probability and its applications	PSO12	U	C, P
CO6	Illustrate the use of Information theory in machine learning algorithms	PSO1	An	C, P

COURSECONTENT

MODULE I: Linear Algebra –Review of basic ideas of Vectors and its operations, cosine similarity, orthogonal vectors. Review of vector norms, Vector space and basis, Spanning sets, Linear independence, Bases and Dimension.

MODULE II: Matrices, Hadamard product, linear transformation, identity matrix, invertible matrix and inverse, rank, Type of matrices- symmetric, diagonal, orthogonal, orthonormal, positive definite matrix.

MODULE III: Calculus – review of Functions, rules of differentiation, partial derivatives, Gradient concept, intuition properties, directional derivative.

MODULE IV: Vector and matrix calculus, Eigenvalues & eigenvectors, Jacobian Gradient algorithms,local-global maxima and minima, saddle point, convex functions, gradient descent algorithms- batch, mini-batch, stochastic.

MODULE V: Probability - Basic rules and axioms, events, sample space, frequentist approach, dependent and independent events, conditional probability, Random variables- continuous and discrete, expectation, variance.

MODULE VI: Distributions- joint and conditional, Bayes' Theorem, Distributions- binomial, bernoulli, gaussian. Basics of Information theory- entropy, cross-entropy, mutual information.

SUGGESTED CLASS ROOM ACTIVITIES

- Written/ Lab assignments for each modules will be made available in between the lectures.
- Seminar on different application areas of course contents in AI.
- Rapid Computing Context – who will solve the mathematical problem first in class?

LEARNING RESOURCES

References

- Axler, Sheldon. *Linear Algebra Done Right*. Springer, 2014.
- Deisenroth, Marc Peter, et al. *Mathematics for Machine Learning*. Cambridge University Press, 2020.
- Härdle, Wolfgang Karl, and Léopold Simar. *Applied Multivariate Statistical Analysis*. Springer, 2015.
- Morin, David. *Probability*. Createspace Independent Publishing Platform, 2016.

On-line Sources

- https://mml-book.github.io/book/mml-book.pdf
- https://rubikscode.net/2019/05/13/mathematics-for-artificial-intelligence-calculus-optimization/
- https://www.mobt3ath.com/uplode/book/book-33342.pdf

ASSESSMENT

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

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

AUTONOMOUS SYSTEMS AND KNOWLEDGE REPRESENTATION

	COURSE OUTCOMES:
CO1	Discuss Artificial Intelligence including topics, branches, and applications.
CO2	Explain the significance of intelligent agents in the Artificial Intelligence.
CO3	Discuss about knowledge representation and its structures.
CO4	Compare different reasoning methods and Bayesian networks.
CO5	Compare different association rule mining algorithms.
CO6	Illustrate how Artificial Intelligence works in Gaming applications (basics only).
CO7	Explain the principles, components, operations and other technological advancements in Robotics.
CO8	Evaluate a selected robotic expert system and discuss its working principle.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Discuss Artificial Intelligence including topics, branches, and applications.	PSO1	U	F
CO2	Explain the significance of intelligent agents in the Artificial Intelligence.	PSO2	U	C, F, P
CO3	Discuss about knowledge representation and its structures.	PSO4	U	C, P
CO4	Compare different reasoning methods and Bayesian networks.	PSO9	An	C, P
CO5	Compare different association rule mining algorithms.	PSO8	U	C, P
CO6	Illustrate how Artificial Intelligence works in Gaming applications (basics only).	PSO10	A	P
CO7	Explain the principles, components, operations and other technological advancements in Robotics.	PSO9	U	C, P
CO8	Evaluate a selected robotic expert system and discuss its working principle.	PSO13	E	P

COURSE CONTENT

MODULE I: Topics of Artificial Intelligence, Timelines of Artificial Intelligence, Branches of Artificial Intelligence, Applications of Artificial Intelligence. - Intelligent agents - structure, types of agents, environment, autonomous agents.
Problem Solving - Production Systems, State space representation.

MODULE II: Knowledge Representation - Knowledge Management, Types of Knowledge, Knowledge representation-bases and structures - First Order logic, Unification algorithm, Frames, Conceptual Dependency, Scripts, Semantic network

MODULE III: Reasoning - Types of reasoning, Non-monotonic reasoning, reasoning with Fuzzy logic, Rule Based reasoning, Case Based reasoning, Model based reasoning systems. - Bayes rule, Bayesian networks, probabilistic inference, sample applications

MODULE IV: Game playing - Minimax procedure, Alpha-Beta pruning, combined approach, Iterative Deepening.

MODULEV: Expert systems - characteristics, components. Expert system development, knowledge engineering, application of expert systems. Case studies in expert systems.

MODULE VI: Robotics – principles and components, operations, mathematics of robotics, line flow robot, applications of robots, case studies in robotics.

LEARNING RESOURCES

References

- Kevin Knight, Elaine Rich – "Artificial Intelligence" ,3rd Edn, Pearson, Chennai
- Stuart Russell and Peter Norvig – "Artificial Intelligence: A Modern Approach", 3rd Edition Prentice Hall of India, New Delhi, 2009
- Vinod Chandra S S, Anand H S- "Artificial Intelligence: Principles and Applications", Prentice Hall of India, New Delhi, 2020

ASSESSMENT

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

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

ALGORITHMS- COMPLEXITY AND OPTIMIZATION

	COURSE OUTCOMES:
CO1	Write the performance of algorithms in mathematical terms.
CO2	Analyze the performance of algorithms.
CO3	Explain the algorithm design techniques including Divide and Conquer, Dynamic programming and Backtracking methods.
CO4	Prioritize the knowledge of advanced search and heuristic search techniques.
CO5	Identify the concepts of decision making theory.
CO6	Articulate optimization procedures handled in artificial intelligence.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Write the performance of algorithms in mathematical terms.	PSO12	C	C, P
CO2	Analyze the performance of algorithms.	PSO8	An	C, P
CO3	Explain the algorithm design techniques including Divide and Conquer, Dynamic programming and Backtracking methods.	PSO6	U	C, P
CO4	Prioritize the knowledge of advanced search and heuristic search techniques.	PSO7	E	C, P
CO5	Identify the concepts of decision making theory.	PSO4	U	C, P
CO6	Articulate optimization procedures handled in artificial intelligence.	PSO1, PSO4	U	C, P

COURSE CONTENT

MODULE I: Concepts in algorithm analysis – the efficiency of algorithms, average and worst – case analysis, asymptotic notation, time and space complexity.
Convergence and Regression - Learning via uniform convergence, uniform convergent series, linear regression, correlation, regression analysis

MODULE II: Techniques -brute force, divide and conquer, decrease and conquer, dynamic programming, shortest paths, backtracking

MODULE III: Heuristic search techniques - Generate and test, Hill climbing, Simulated annealing, Problem reduction, AO* algorithm, Constraints satisfaction, Means - Ends analysis

MODULE IV: Search Techniques - Graph search, Depth First Search, Breadth First Search, Iterative Deepening search, Uniform cost search, Greedy method, Best first search, Beam search, Branch and Bound search, A* algorithm.

MODULE V: Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications.

MODULE VI: Stochastic optimization – Markov chains, Random search, Fuzzy optimization, Reactive search optimization, Tabu search, combinatorial optimization.

LEARNING RESOURCES

References

- Kalyanmoy Deb, "Optimization for Engineering Design, Algorithms and Examples" - Prentice Hall of India, New Delhi, 2012
- Stuart Russell and Peter Norvig - "Artificial Intelligence: A Modern Approach", 3rd Edition Pearson, Chennai, 2015
- Thomas H. Corman, Charles E. Leiserson and Ronald L. Rivest - "Introduction to Algorithms", 3rd Eed., Prentice Hall of India, New Delhi , 2009
- Vinod Chandra S S, Anand H S - "Artificial Intelligence: Principles and Applications", Prentice Hall of India, New Delhi, 2020

ASSESSMENT

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

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

ARTIFICIAL INTELLIGENCE LAB

	COURSE OUTCOMES:
CO1	Implement basic python programs.
CO2	Implement programs in problem solving and state space search in AI.
CO3	Implement algorithms in Divide and conquer Decrease and Conquer, Dynamic Programming, Shortest paths, Backtracking techniques.
CO4	Implement algorithms in Graph Search, Depth First Search, Breadth First Search, Iterative Deepening Search, Uniform Cost Search, Greedy Method, Best First Search, Beam Search, Branch and Bound Search, A* Algorithm.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Implement basic python programs.	PSO3	C	C, P
CO2	Implement programs in problem solving and state space search in AI.	PSO3, PSO4	A	C, P
CO3	Implement algorithms in Divide and conquer Decrease and Conquer, Dynamic Programming, Shortest paths, Backtracking techniques.	PSO6, PSO8	C	C, P
CO4	Implement algorithms in Graph Search, Depth First Search, Breadth First Search, Iterative Deepening Search, Uniform Cost Search, Greedy Method, Best First Search, Beam Search, Branch and Bound Search, A* Algorithm.	PSO1, PSO3	A	C, P

COURSE CONTENT

Students should practice python programming and implement different algorithms applicable in the field of Artificial Intelligence.

List of Experiments

Implement the following algorithms and methods

1. Divide and Conquer.
2. Dynamic programming.

3. Shortest path algorithm.
4. Backtracking techniques.
5. Depth-First searchand Breadth First Search.
6. Iterative Deepening Search.
7. Uniform Cost Search.
8. Greedy Method.
9. Best First Search.
10. Beam Search.
11. Branch and Bound Search.
12. A* Algorithm.

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

ENTREPRENEURIAL SKILLS & 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 skill set 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 Outcome	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 skill set 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	C, 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 - Preparation of CV- Emotional Intelligence Skills - Life Skills.

MODULE IV: Self awareness- SWOT Analysis- Planning & Goal setting -Leadership skills- Stress Management Skills- Life 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.

LEARNING RESOURCES

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: CSA-GC-501	Credits: 2

INTRODUCTION TO MACHINE LEARNING AND APPLICATIONS

	COURSE OUTCOMES:
CO1	Explain the basic concepts and applications of Machine learning.
CO2	Compare and contrast different supervised machine learning algorithms.
CO3	Explain the approaches of machine learning.
CO4	Compare predictive analysis and descriptive analysis.
CO5	Apply machine learning algorithms to solve real world problems.
CO6	Illustrate the training process in machine learning.
CO7	Identify and categorize the types of machine learning.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Explain the basic concepts and applications of Machine learning.	PSO10	U	F, C
CO2	Compare and contrast different supervised machine learning algorithms.	PSO3	U	C, P
CO3	Explain the approaches of machine learning.	PSO7	U	C
CO4	Compare predictive analysis and descriptive analysis.	PSO10	U	C, P
CO5	Apply machine learning algorithms to solve real world problems.	PSO8	A	C, P
CO6	Illustrate the training process in machine learning.	PSO10	A	P
CO7	Identify and categorize the types of machine learning.	PSO7	U	C

COURSE CONTENT

MODULE I: Understanding Machine Learning -What Is Machine Learning? - Defining Big Data- Big Data in Context with Machine Learning - Leveraging the Power of Machine Learning- Descriptive analytics - Predictive analytics

MODULE II: The Roles of Statistics and Data Mining with Machine Learning - Approaches to Machine Learning -Supervised learning -Unsupervised learning - Reinforcement learning - Neural networks

MODULE III: Applying Machine Learning - Understanding Machine Learning Techniques- Tying Machine Learning Methods to Outcomes - Applying Machine Learning to Business Needs

MODULE IV: Looking inside Machine Learning - The role of algorithms - Types of machine learning algorithms - Training machine learning systems - Data Preparation - Identify relevant data -The Machine Learning Cycle

MODULE V: Understanding How Machine Learning Can Help - Focus on the Business Problem- Executing a Pilot Project- Determining the Best Learning Model- Learning Machine learning skills that you need.

MODULE VI: Using Machine Learning to Provide Solutions to Business Problems - Applying Machine Learning to Patient Health - Proactively Responding to IT - Issues - Protecting Against Fraud

LEARNING RESOURCES

References

- Aurélien Géron "Hands-On Machine Learning with Scikt-Learn & TensorFlow", O'Reilly Media, Inc.,2019.
- Ethem Alpaydın "Introduction to Machine Learning Second Edition", The MIT Press Cambridge, Massachusetts, London, England.
- Judith Hurwitz and Daniel Kirsch, Machine Learning For Dummies, IBM Limited Edition, Wiley, 2018.

ASSESSMENT

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

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

THEORETICAL FOUNDATIONS OF MACHINE LEARNING

	COURSE OUTCOMES
CO1	Explain the basics of machine learning and applications.
CO2	Compare different quantification methods of classification.
CO3	Compare different supervised, semi supervised, and unsupervised algorithms.
CO4	Explain about reinforcement learning and its different learning methods.
CO5	Compare different association rule mining algorithms.
CO6	Differentiate different clustering techniques and algorithms**.**
CO7	Implement Support Vector Machine algorithm and its variants.
CO8	Explain different learning algorithms based on decision tree.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Explain the basics of machine learning and applications.	PSO1	U	C
CO2	Compare different quantification methods of classification.	PSO2	An	C, P
CO3	Compare different supervised, semi supervised, and unsupervised algorithms.	PSO4	An	C, P
CO4	Explain about reinforcement learning and its different learning methods.	PSO3	U	C
CO5	Compare different association rule mining algorithms.	PSO8	U	C
CO6	Differentiate different clustering techniques and algorithms**.**	PSO6	An	C, P
CO7	Implement Support Vector Machine algorithm and its variants.	PSO6, PSO7	An, A	C, P
CO8	Explain different learning algorithms based on decision tree.	PSO9	U, A	C

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.

LEARNING RESOURCES

References

- C. Bishop - "Pattern Recognition and Machine Learning", Springer, 2007.
- 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
- Vinod Chandra S S, Anand H S- "Artificial Intelligence and Machine Learning", Prentice Hall of India, New Delhi, 2014

ASSESSMENT

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

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

ANALYTICS AND DATA SCIENCE

	COURSE OUTCOMES
CO1	Define data science, its scope and applications.
CO2	Differentiate data science and data analytics.
CO3	Illustrate the statistical and visualization techniques in data science.
CO4	Compare different statistical learning models and classifiers.
CO5	Compare different machine learning algorithms for data science.
CO6	Explain single value decomposition techniques in data science and analysis**.**
CO7	Implement different data science and analysis problems using R programming language.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Define data science, its scope and applications.	PSO2	U	F, C
CO2	Differentiate data science and data analytics.	PSO2, PSO3	U	F, C
CO3	Illustrate the statistical and visualization techniques in data science.	PSO4	A	C, P
CO4	Compare different statistical learning models and classifiers.	PSO8	An	C, P
CO5	Compare different machine learning algorithms for data science.	PSO9	U	C, P
CO6	Explain single value decomposition techniques in data science and analysis**.**	PSO8	U	C
CO7	Implement different data science and analysis problems using R programming language.	PSO3, PSO6, PSO12	A	C, P

COURSE CONTENT

MODULE I: Introduction: Data Science –Basic concepts, definition and architecture, business analytics and visualization techniques, Different industrial application of Data Science technique.

MODULE II: Statistics and Probability: Statistical measures, probability– conditional probability, Baye's theorem, Probability distributions and standard distributions, density functions, Mathematical expectations and moments, covariance and correlation.

MODULE III: Statistical learning - Stochastic processes, Markov process, HMM, Forward - Backward procedure, Viterbi algorithm, Baum-Welch algorithm, Applications of HMM.- Statistical classifiers - Linear classifiers, Fisher linear discriminant, Quadratic classifiers, Naive Bayes classifier, Bayesian networks.

MODULE IV: Dimensionality Reduction, Clustering, Association Rules – Apriori algorithm, Anomaly Detection, Spam Filtering, Network Analysis and Recommender Systems.

MODULE V: Singular value decomposition - Handwritten digits and simple algorithm - Classification of handwritten digits using SVD bases - Tangent distance - Text Mining.

MODULE VI: Familiarization of R-Studio Integrated Development Environment (IDE) – Understanding different data types working with R – Reading/storing data from/in different file types, data manipulation, Loading and saving data, Control flow, Functions, Data analysis using R.

LEARNING RESOURCES

References

- Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly. 2014.
- Bendat J S, and Piersol A G (2011), Random Data Analysis and Measurement procedures (vol. 729) John Wiley & Sons.
- D.A.Simovici, Linear algebra tools for data mining, World Scientific Publishing, 2012.
- E. Davis, Linear algebra and probability for computer science applications, CRC Press, 2012.
- EldénLars, Matrix methods in datamining and pattern recognition,Society for Industrial and Applied Mathematics, 2007.

ASSESSMENT

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

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

DATABASE SYSTEMS FOR BIG DATA

	COURSE OUTCOMES:
CO1	Describe the basic concepts of Database systems and Transactions including ACID properties and Concurrency Control techniques.
CO2	Explain in detail about Big Data, its types, characteristics, handling techniques and Big Data databases.
CO3	Describe about the architecture, challenges and the applications of Big Data.
CO4	Discuss about Hadoop technology, hadoop ecosystem components and its features.
CO5	Explain in detail about Hadoop file system- HDFS and MapReduce framework.
CO6	Discuss about the NoSQL data store, architecture and its advantages.
CO7	Explain the use of MongoDB and implement its basic commands- CRUD operations.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Describe the basic concepts of Database systems and Transactions including ACID properties and Concurrency Control techniques.	PSO7	U	F, C
CO2	Explain in detail about Big Data, its types, characteristics, handling techniques and Big Data databases.	PSO3	U	F, C
CO3	Describe about the architecture, challenges and the applications of Big Data.	PSO8	U	C
CO4	Discuss about Hadoop technology, hadoop ecosystem components and its features.	PSO9	U	C
CO5	Explain in detail about Hadoop file system- HDFS and MapReduce framework.	PSO7, PSO8	U, A	C, P
CO6	Discuss about the NoSQL data store, architecture and its advantages.	PSO3	U, A	P
CO7	Explain the use of MongoDB and implement its basic commands- CRUD operations.	PSO10	U, A	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, Big Data concepts, classification of data - structured, semi-structured and unstructured, Big Data - definition, characteristics, types, Big Data handling techniques, Big Data databases.

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

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

MODULE IV : Hadoop file system – HDFS, Data storage and file system, MapReduce framework and programming model, hadoop ecosystem 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.

LEARNING RESOURCES

References

- Chris Eaton, Dirk deroos et al. "Understanding Big data ", McGraw Hill, 2012.
- Connolly, Thomas M; Begg, Carolyn E, Database systems: a practical approach to Design, Implementation, and Management.6th ed., Pearson Education, 2015 ISBN: 978-0132943260.
- Martin Fowler "NoSQL distilled".
- Vignesh Prajapati,Big Data Analytics with R and Hadoop, Packt Publishing, 2013, ISBN: 978-1-78216-328-2.

On-line Sources

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

ASSESSMENT

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

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

MACHINE LEARNING LAB

	COURSE OUTCOMES
CO1	Implement 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 Outcome	PSO	CL	KC
CO1	Implement 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, PSO13	U, 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.

7. Support Vectors Machine.
8. Association rule mining.
9. Reinforcement learning.
10. Clustering.
11. Decision Trees.
12. Classification.

SEMESTER II	Course Code: CSA-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 spatial 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 Outcome	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
CO3	Discuss about various spatial domain image transformations and filtering.	PSO3, PSO4	U	C
CO4	Discuss about various frequency domain image transformations and filtering.	PSO3, PSO7	U	C
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 transforms – Thresholding - Region based segmentation – Region growing – Region splitting and merging –Watershed segmentation algorithm.

LEARNING RESOURCES

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, 1999.
- 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: CSA-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	Describe 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 Outcome	PSO	CL	KC
CO1	Apply the n-gram & Language models in various NLP applications.	PSO8	A	C, P
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
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	Describe 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 &	PSO8	E	C, P

	relation extraction methods.			

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.

MODULE III: 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.

MODULE V: Speech **-** Phonetics, Hidden Markov Model, Morphology, Graphical Models for Sequence Labeling 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.

LEARNING RESOURCES

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 Press2003.
- 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.
- Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), The Handbook of Computational Linguistics and Natural Language Processing (Blackwell Handbooks in Linguistics) 1st Edition, Kindle Edition.

ASSESSMENT

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

SEMESTER II	Course Code: CSA-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 crptocurrencies in the digital world
CO3	Identify the functional/operational aspects of cryptocurrency ecosystem
CO4	Compare 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 Block chain	PSO2	U	C
CO2	Analyze the significance of crptocurrencies in the digital world	PSO3, PSO7, PSO9	An	P
CO3	Identify the functional/operational aspects of cryptocurrency ecosystem	PSO8	U	F, C
CO4	Compare emerging abstract models for Block chain Technology	PSO3, PSO7, PSO9	U	C, P
CO5	Illustrate the working of Ethereum Virtual Machine	PSO7, PSO8	A	P
CO6	Assess Block chain 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,M

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 BLOCK CHAIN - 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 Block chain - Succinct non interactive argument for Knowledge (SNARK) - pairing on Elliptic curves - Zcash.

LEARNING RESOURCES

References

- Mastering Bitcoin: Unlocking Digital Cryptocurrencies, Andreas M. Antonopoulos O'Reilly 2010.
- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.
- 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}.

- 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 Block chain protocol in Asynchronous networks , EUROCRYPT 2017, (eprint.iacr.org/2016/454) . A significant progress and consolidation of several principles).

On-line Sources

- Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
- Zero to Block chain - An IBM Redbooks course, by Bob Dill, David Smits- https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html

ASSESSMENT

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

SEMESTER II	Course Code: CSA-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 in Microbial informatics, Biomedical Images and Microarray.

TAGGING OF COURSE OUTCOMES

	Course Outcome	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.	SO9	An	C, P
CO3	Explain the properties of DNA, RNA, and proteins, the relationships among these molecules.	PSO8	U	C
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 in Microbial 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, tRNA, miRNA 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, pairwise, multiple, 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 Maximization (EM) with forward and backward algorithms, discriminative learning; Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, 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

LEARNING RESOURCES

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", MIT 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: CSA-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 Outcome	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
CO3	Evaluate different methods in cryptography.	PSO8	E	P
CO4	Discuss network security issues and Virtual Private Networks.	PSO1	U	C, P
CO5	Relate Cyber laws with security incidents.	PSO10	A	C, P
CO6	Analyze fundamentals of Cyber Law.	PSO13	An	C, P
CO7	Discuss IT Act & its Amendments.	PSO1	U	C
C08	Relate Cyber laws with security incidents.	PSO10	A	P

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, Finger Prints, 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 and Expression 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.

LEARNING RESOURCES

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", Mc Graw HillFurnell, "Computer Insecurity", Springer.

ASSESSMENT

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

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

ADVANCED LEARNING MODELS

	COURSE OUTCOMES
CO1	Explain about fuzzy systems and networks.
CO2	Use fuzzy set theory for solving problems.
CO3	Familiar with Neuro-fuzzy systems and EM models.
CO4	Describe basic programming structure and control statements in scilab.
CO5	Implement KNN, ensemble and adaBoost classifiers for Machine learning.
CO6	Compare different ANN networks and working structure.
CO7	Compare different Deep architectures and their learning models.
C08	Familiarize with different deep frameworks like Tensorflow, Keras, Caffe, GAN.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Explain about fuzzy systems and networks.	PSO1	U	C
CO2	Use fuzzy set theory for solving problems.	PSO2, PSO12	A	P
CO3	Familiar with Neuro-fuzzy systems and EM models.	PSO4	U	C
CO4	Describe basic programming structure and control statements in scilab.	PSO3, PSO6	U	C
CO5	Implement KNN, ensemble and adaBoost classifiers for Machine learning.	PSO1	A	C, P
CO6	Compare different ANN networks and working structure.	PSO8	An	C, P
CO7	Compare different Deep architectures and their learning models.	PSO4	An	C, P
C08	Familiarize with different deep frameworks like Tensorflow, Keras, Caffe, GAN.	PSO6	U	C

COURSE CONTENT

MODULE I: Fuzzy Network-Fuzzy systems, Info Fuzzy networks, Fuzzy neural systems, Fuzzy logic and fuzzy set, Fuzzy control, defining fuzzy operation, Making Fuzzy decision, Fuzzy reasoning, De-fuzzification, Neuro-fuzzy systems, ANFIS, Types of Neuro-fuzzy Systems, Applications and advantages of Fuzzy systems. Expectation Maximization, General EM, EM algorithm, Features of EM, Mathematics of EM

MODULE II: Nearest neighborhood - Distance measure, Hamming distance, Euclidean distance, City Block Distance, Square distance, KNN algorithm, KNN algorithm implications, Nearest Neighborhood applications

MODULE III: Ensemble classifier, Types of ensemble, Simple ensemble models, advanced ensemble models, AdaBoost, Bayes Optimal classifier, Bayesian model averaging, Gradient boosting

MODULE IV: ANN basics, Types of networks, The perceptron, RBF networks, Self-organising maps, Adaptive resonance theory, Recurrent neural network, Hopfield networks, Boltzmann machines, Probabilistic neural network

MODULE V: Deep architecture -Recurrent and Recursive networks, Bidirectional RNNs, Deep Recurrent Networks, Recursive Neural Networks, LSTM, GRU. Image captioning, word prediction. Deep Belief networks, Convolutional neural networks, Deep reinforcement learning, Geometric stability, Applications of deep learning.

MODULE VI: TensorFlow - Implementing object classification and detection using CNN networks using any of deep libraries like Tensorflow, Keras, Caffe. Generative Networks: Auto encoders, Generative Models, GANs framework, GANs application, Variation auto encoders, DCGANS. Instance recognition, Category recognition, Context and scene understanding.

LEARNING RESOURCES

References

- Aggarwal Charu – "Neural Networks and Deep Learning", Springer, 2015.
- Aurélien Géron's, "Hands-On Machine Learning with Scikit-Learn and TensorFlow", O'Reilly Media, Inc.,2017.
- Ian Goodfellow, Yoshua Bengio, Aaron Courville – "Deep Learning", MIT Press, 2016.
- Mike Krebbs - "Deep Learning with Python", CreateSpace Independent Publishing Platform, 2018.
- 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: CSA-CC-532	Credits: 3

MACHINE INTELLIGENCE LAB

	COURSE OUTCOMES
CO1	Implement the basic image processing operations like Histogram equalization, thresholding, edge detection, data, data augmentation, morphological operations.
CO2	Implement SVM/Softmax classifier for CIFAR-10 dataset: (i) using KNN, (ii) using 3 layer neural network.
CO3	Study the effect of batch normalization and dropout in neural network classifier Familiarization of image labelling tools for object detection, segmentation Image segmentation using Mask RCNN, UNet, SegNet.
CO4	Implement Image Captioning with LSTMs, Network Visualization: Saliency maps, Class Visualization, Generative Adversarial Networks, Chatbot using bi-directional LSTMs.
CO5	Familiarization of cloud based computing like Google colab.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Implement the basic image processing operations like Histogram equalization, thresholding, edge detection, data, data augmentation, morphological operations.	PSO8	C, A	C, P
CO2	Implement SVM/Softmax classifier for CIFAR-10 dataset: (i) using KNN, (ii) using 3 layer neural network.	PSO9	C, A	C, P
CO3	Study the effect of batch normalization and dropout in neural network classifier Familiarization of image labelling tools for object detection, segmentation Image segmentation using Mask RCNN, UNet, SegNet.	PSO4	U, C	C, P
CO4	Image Captioning with LSTMs, Network Visualization: Saliency maps, Class Visualization, Generative Adversarial Networks, Chatbot using bi-directional LSTMs.	PSO7	C	C, P
CO5	Familiarization of cloud based computing like Google colab.	PSO3, PSO6	U, C	C

SEMESTER III	Course Code: CSA-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	P
CO6	Suggest modifications and improvement of the system.	PSO3	C	P

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 allows students with real expertise and understanding, how and why an innovation has worked in a specific case. The students 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.

SEMESTER III	Course Code: CSA-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
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

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.

SEMESTER III	Course Code: CSA-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	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

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, vacuum 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 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.

LEARNING RESOURCES

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

ASSESSMENT

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

SEMESTER III	Course Code: CSA-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 Big Data 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
CO3	Compare IoT and machine to machine technologies.	PSO7	An	C,P
CO4	Analyze Smart devices and IoT Systems.	PSO8	An	C,P
CO5	Describe operating systems that support IoT.	PSO4	An	C, P
CO6	Explain how IoT and Big Data get related.	PSO7	U, A	C
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 Network, M2M 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 - Arduino - 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: Big Data versus IoT, Big Data in flucement in IoT, A cyclic model of Big Data - Cloud and Internet of Things: Data Storage, Analysis and Communication, Classifications, Characteristics of Big Data, Types of Big Data - Analyzing of Data - Applications, Real time situations, Big Data tools - A combined application of Cloud and Big Data 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.

LEARNING RESOURCES

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.
- Arshdeep Bahga, Vijay Madisetti, , Internet of things: a hands-on approach, CreateSpace Independent Publishing Platform, 2013.
- Dieter Uckelmann, Mark Harrison, Michahelles Florian (Ed.), Architecting the internet of things, Springer, 2011.
- Dr. Ovidiu Vermesan, Dr Peter Friess, Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, River Publishers, 2013.
- Olivier Hersent, David Boswarthick, Omar Elloumi The internet of things: key applications and protocols, Wiley, 2012.

ASSESSMENT

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

SEMESTER III	Course Code: CSA-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 Outcome	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
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	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.

LEARNING RESOURCES

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
- Rajkumar Buyya, 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: CSA-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 Outcome	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	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 modeling 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 Modeling- An Example of Agent-Based Models- Tools for Agent-Based Modeling.

LEARNING RESOURCES

References

- M. Wooldridge: Reasoning about Rational Agents. MIT Press, 2000
- Michael Wooldridge: An Introduction to MultiAgent Systems (2nd ed.). Wiley, 2009. ISBN 978-0-570-51946-2.
- 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

On-line Sources

- Introduction to Agent-Based Modelling 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: CSA-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 Outcome	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	P
CO3	Discuss the nature and working of parallel algorithms.	PSO9	U	C
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	C, 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, OpenMP, MPI), I/O and File Systems, Parallel Matlabs (Parallel Matlab, Star-P, Matlab 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 ASSIGNMENTS 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.

LEARNING RESOURCES

References

- Bader, David A. Petascale Computing. CRC Press, 2007.
- David Culler Jaswinder Pal Singh,"Parallel Computer Architecture: A hardware/Software Approach", Morgan Kaufmann, 1999.
- 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.
- Grama, A. Gupta, G. Karypis, V. Kumar, An Introduction to Parallel Computing, Design and Analysis of Algorithms: 2/e, Addison-Wesley, 2003.

On-line Sources

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

ASSESSMENT

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

SEMESTER III	Course Code: CSA-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 Outcome	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
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	C, 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 I: Optimization: Introduction, Statement of an Optimization problem, formulation of Optimal Problem, Types of 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.

LEARNING RESOURCES

References

1. G. Hadley, Linear programming, Narosa Publishing House, New Delhi, ISBN 13: 9788185015910.
2. 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: CSA-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 Outcome	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
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
CO7	Implement an algorithm to solve social media mining and sentimental analysis.	PSO10	A	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.

LEARNING RESOURCES

References

- Borko Furht, "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.
- Guandong Xu ,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: CSA-DE-536(iii)	Credits: 4

ARTIFICIAL INTELLIGENCE IN CYBER SECURITY

	COURSE OUTCOMES
CO1	Explain the fundamentals of Artificial Intelligence and Cyber Security.. (Understand)
CO2	Identify the challenges in Cyber security with and without Artificial Intelligence.
CO3	Familiar with AI enabled cyber attacks and Threats.
CO4	Describe about 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 Outcome	PSO	CL	KC
CO1	Explain the fundamentals of Artificial Intelligence and Cyber Security.. (Understand)	PSO1	U	C
CO2	Identify the challenges in Cyber security with and without Artificial Intelligence.	PSO4	A	C, P
CO3	Familiar with AI enabled cyber attacks and Threats.	PSO7	U	C
CO4	Describe about 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.

MODULEII: 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.

MODULEV: 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).

LEARNING RESOURCES

References

- Alessandro Parisi, "Hands-On Artificial Intelligence for Cybersecurity", Packt publishing 2019, 978-1-789-80402-7.
- Emmanuel Tsukerman, " Machine Learning for Cybersecurity 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, " lobal Cyber Security Labor Shortage and International Business Risk", IGI global 2019, 978-1-552-55927-6.

ASSESSMENT

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

SEMESTER III	Course Code: CSA-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), wearables (smart watches, fitness trackers) and home automation devices.
CO3	Discuss about management of smart devices in virtual environments, human user-centered environments and physical environments.
CO4	Articulate the concepts of Autonomous systems and artificial life.
CO5	Assess common designs for smart applications.
CO6	Examine development platforms and cloud services for smart applications.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Describe methods and technologies for the development of smart connected applications.	PSO1	U, A	C
CO2	Explain about smart objects, mobile devices (smart phones, tablets), wearable (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, P
CO5	Assess common designs for smart applications.	PSO9	E	C, P
CO6	Examine development platforms and cloud services for smart applications.	PSO3	U, A	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 connectivity. Smart 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 environments. Smart Expert system - Building Smart systems using different learning techniques, smart system applications, 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 (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)

LEARNING RESOURCES

References

- Aurélien Géron's - "Hands-On Machine Learning with Scikit-Learn and TensorFlow", O'Reilly Media, Inc.,2017
- Jan Holler, Vlasios Tsiatsis, 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: CSA-DE-536(v)	Credits: 4

NATURE INSPIRED COMPUTING

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

TAGGING OF COURSE OUTCOMES

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

LEARNING RESOURCES

References

- Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
- Floreano, D. and C. Mattiussi -"Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT 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: CSA-GC-502	Credits: 2

ARTIFICIAL INTELLIGENCE AND DAILY LIFE

	COURSE OUTCOMES
CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
CO2	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, Natural language Processing - machine learning models.
CO3	Demonstrate an ability to share in discussions applications of AI, its current scope and limitations.
CO4	Apply basic principles of AI in solving daily life.

TAGGING OF COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.	PSO1	A	F, C
CO2	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, Natural language Processing - machine learning models.	PSO10	A	C, P
CO3	Demonstrate an ability to share in discussions applications of AI, its current scope and limitations.	PSO8	A	C, P
CO4	Apply basic principles of AI in solving daily life.	PSO7	A	P

COURSE CONTENT

MODULE I: Introduction to Artificial Intelligence- History of AI- Advantages and Disadvantages of AI- Applications- AI domains.

MODULE II: Search and Control Strategies- State- Space representation- Problem Solving - Heuristic Techniques – Hill Climbing – Simulated Annealing – Generate and Test, Problem reduction- Constraint Satisfaction- Means End Analysis.

MODULE III: Machine Learning- Supervised and Unsupervised Algorithms- Neural Networks- Classification and Predictions model – Applications.

MODULE IV: Natural Language Processing - Natural Language Processing Tasks - NLP Applications- Recommender System - Sentimental Analysis.

MODULE V: Introduction to Game Theory- Two player game - Mini- Max Procedure- Alpha Beta Cut off.

MODULE VI: AI in real life, Expert system - Expert system development- Modern expert systems.

LEARNING RESOURCES

References

- Stuart Russell and Peter Norvig, Artifcial Intelligence: A Modern Approach Third Edition Pearson Education 2010 Inc. ISBN: 978-0-13-604259-5.
- Dan W Patterson, Artificial Intelligence, Prentice Hall of India (1999)
- Nils J.Nilsson, Artificial Intelligence, ELSEVIER.
- E.Rich and K.Knight, Artificial Intelligence, - TMH

On-line Sources

- https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_overview.htm

ASSESSMENT

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

SEMESTER IV	Course Code: CSA-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 Outcome	PSO	CL	KC
CO1	Identify a problem statement for the final project.	PSO12	U	C
CO2	Perform literature review by analyzing the related works.	PSO8	U	C, P
CO3	Implement the existing work from the literature.	PSO9	A	P
CO4	Analyze the existing system capture the limitations.	PSO6	An	C, P
CO5	Propose a method improvement to overcome the limitations.	PSO4	C	C, P
CO6	Evaluate and interpret the design and experimental results.	PSO3	E	C, 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.

Department of Computer Science

Learning Outcomes-based Curriculum Framework (LOCF)

M. Tech. Computer Science

(With Specialization in Digital Image Computing)

(Syllabus effective from 2020 Admission Onwards)

UNIVERSITY OF KERALA

2020

UNIVERSITY OF KERALA
Department of Computer Science
2020
Syllabus for M. Tech Programme in Computer Science
(With Specialization Digital Image Computing)

Programme Outcomes (PO)for M. Tech Computer Science (with specialization Digital Image Computing)	
PO1	Develop the graduates to be successful professionals in industry, academia, research, entrepreneurship.
PO2	Develop the thinking skills and hence promoting innovation and research.
PO3	Provide support to the post graduates who can pursue life-long learning to chase their dreams.
PO4	Acquire skill set to solve the real life problems using team work
PO5	Enhance the presentation and communication skills
PO6	Gain self confidence by solving and implementing real life projects
PO7	Mould the graduates to develop a sense of social responsibility and social awareness
PO8	Understand the significance of academic integrity and research ethics

Programme Specific Outcomesfor M.Tech Computer Science (with specialization Digital Image Computing)	
PSO1	Provide the graduates flair of research by making them to do research-oriented projects.
PSO2	Possess the skill set to develop and implement the algorithms in computer science and the interdisciplinary areas.
PSO3	Provide advanced technical skills in the area of Image Processing and Machine Intelligence to graduates who can perform better as an individual or in a team; through their critical analytical and research skills.
PSO4	Develop the ability to apply mathematical and engineering skills in a pragmatic manner to solve problems.
PSO5	Develop an ability to identify, critically analyze, formulate and solve research problems in Digital Image Processing, Medical Image Processing.
PSO6	Develop the skills for writing technical and scientific research publications.
PSO7	Able to solve the real life problems with machine learning and deep learning techniques.
PSO8	Possess the ability to specialize in Image Processing, Intelligent systems
PSO9	Exposure to learn new tools and programming languages including MATLAB, Python, OpenCV, LaTeX, OpenGL

Department of Computer Science

University of Kerala

Programme structure of **M. Tech. in Computer Science**
(withSpecialization in **Digital Image Computing)**

Semester	Course Code	Name of the course	Credits
I	**Core Courses (CC)**		
	CSM-CC-611	Mathematics for Image Processing	4
	CSM-CC-612	Digital Image Processing	4
	CSM-CC-613	Machine Learning Techniques	4
	CSM-CC-614	Image Processing Laboratory	3
	Discipline-Specific Elective (DE)		
	CSM-DE-615(i)	High-Performance Computing	4
	CSM-DE-615(ii)	Computational Cognitive Neuroscience	4
	CSM-DE-615(iii)	Advanced Natural Language Processing	4
	CSM-DE-615(iv)	Cyber Security and Cyber law	4
	CSM-DE-615(v)	Digital Video Processing	4
	CSM-DE-615(vi)	Computational Geometry	4
	Generic Courses (GC)		
	CSM-GC-601	Basics of Digital Image Processing	2
	CSM-GC-602	Introduction to Scilab	2
II	**Core Courses (CC)**		
	CSM-CC-621	Advanced Computation Models	4
	CSM- CC -622	Data and Image Compression	4
	CSM- CC -623	Image Analysis and Computer Vision	4
	CSM- CC -624	Computer Vision Laboratory	3
	Discipline-Specific Elective (DE)		
	CSM-DE-625(i)	Robotics and Intelligent System Design	4
	CSM-DE-625(ii)	Biomedical Image Processing	4
	CSM-DE-625(iii)	Visual Cryptography	4
	CSM-DE-625(iv)	Nature Inspired Computing and Optimization	4
	CSM-DE-625(v)	Reinforcement Learning Techniques	4
III	**Core Courses (CC)**		
	CSM-CC-631	Research Methodology	4
	CSM-CC-632	Dissertation(Part-I)	10
	Skill Enhancement Elective (SE)		
	CSM-SE-601	Entrepreneurial Skills and Scientific Writing	2
	Generic Courses (GC)		
	CSM-GC-602	Artificial Intelligence and Applications	2
IV	**Core Courses (CC)**		
	CSM-CC-641	Dissertation(Part-II)	16

Eligibility:

Candidates shall be required to possess:

A Bachelor's Degree in Engineering / Technology with at least 55% marks in one of the following branches: Computer Science and Engineering. / Information Technology / Electronics Engineering / Electrical Engineering from the University of Kerala or equivalent recognized degree of a recognized University

OR

A First Class Master's degree in Computer Science / Computer Application from the University of Kerala or equivalent recognized degree of a recognized University.

SEMESTER I	Course Code:CSM-CC-611	Credits: 4

MATHEMATICS FOR IMAGE PROCESSING

	COURSE OUTCOMES
CO1	Solve linear algebra problems
CO2	Compute eigen values and eigen vectors of a matrix
CO3	Analyse the significance of linear algebra in computational problems
CO4	Solve the problems based on linear equations
CO5	Identify the relevance of probability distributions in solving real life problems
CO6	Apply dimensionality reduction techniques
CO7	Apply statistical parameters in image processing problems and write the inference
CO8	Use linear algebra to solve the image processing and computer vision applications

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Solve linear algebra problems	PSO 4 PSO7	U,A	C,P
CO2	Compute eigen values and eigen vectors of a matrix	PSO4	U,A	C,P
CO3	Analyse the significance of linear algebra in computation problems	PSO2	An	C,P
CO4	Solve the problems based on linear equations	PSO4	A	P
CO5	Identify the relevance of probability distributions in solving real life problems	PSO4	A	P,C
CO6	Apply dimensionality reduction techniques	PSO7	A	C,P
CO7	Apply statistical parameters in image processing problems and write the inference	PSO4	A	P, C
CO8	Use linear algebra to solve the image processing and computer vision applications	PSO3	A	P

COURSE CONTENT

Module-1: Linear Algebra: Solving Linear Equations, Vectors and Linear Equations, Idea of Elimination, Elimination Using Matrices, Rules for Matrix Operations, Inverse Matrices

Module -2: Eigenvalues and Eigenvectors:Introduction to Eigenvalues, Diagonalizing a Matrix, Systems of Differential Equations, Symmetric Matrices, Positive Definite Matrices

Module -3 : Linear Algebra in Probability & Statistics: Mean, Variance, and Probability, Covariance Matrices and Joint Probabilities, Multivariate Gaussian and Weighted Least Squares

Module -4 : Probability and Random Process: Probability Distributions, Random Signals , Stationary Process, Markov Process, Markov Chain

Module -5 : Singular Value Decomposition (SVD)- Image Processing by Linear Algebra, Bases and Matrices in the SVD, Principal Component Analysis (PCA by the SVD), Geometry of the SVD

Module -6 : Applications – Image Processing, Computer Vision, Graphs and Networks, , Matrices in Engineering, Computer Graphics

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Solve mathematical problems

LEARNING RESOURCES

References

- Gilbert Strang, Linear Algebra and Its Applications, Academic Press (1976) Fourth Edition : Brooks/Cole/Cengage (2006).
- Gilbert Strang, Introduction to Linear Algebra, Indian edition, Wellesley Publishers, May 2016
- Erwin Kreyszig; Herbert Kreyszig; E J Norminton, Advanced Engineering Mathematics. New York John Wiley 2011.
- Higher Engineering Mathematics, by B S Grewal, Khanna Publishers

SEMESTER I	Course Code:CSM-CC-612	Credits: 4

DIGITAL IMAGE PROCESSING

	COURSE OUTCOMES
CO1	Explain the elements of image processing
CO2	Analyse how 2D image signals are processed
CO3	Provide Hands-on experience in using computers to process digital images
CO4	Perform histogram equalization on an image
CO5	Illustrate the process of smoothening and sharpening in gray scale and color images
CO6	Compare Otsu thresholding and Binary Thresholding techniques
CO7	Explain the restoration filters in image processing
CO8	Implement an algorithm for noise removal in spatial and in frequency domain
CO9	Implement three Edge detection filters including Canny, Prewitt, Sobel
CO10	Analyse the significance of region based segmentation algorithm in processing images.
CO11	Discuss about the current technologies and issues specific to Digital Image Processing.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain the elements of image processing	PSO 2 PSO7	U	C
CO2	Analyse how 2D image signals are processed	PSO2	An	C,P
CO3	Provide Hands-on experience in using computers to process digital images	PSO3 PSO2	A, E	P
CO4	Perform histogram equalization on an image	PSO4	A	P
CO5	Illustratethe process of smoothening and sharpening in gray scale and color images	PSO4	A	P,C
CO6	Compare Otsu thresholding and Binary Thresholding techniques	PSO7	An	C
CO7	Explain the restoration filters in image processing	PSO2	U	C
CO8	Implement an algorithm for noise removal in spatial and in frequency domain	PSO3 PSO8	A	P
CO9	Implement three Edge detection filters including Canny, Prewitt, Sobel	PSO2	A	P
CO10	Analyse the significance of region based segmentation algorithm in processing images.	PSO2	An	C,P
CO11	Discuss about the current technologies and issues specific to Digital Image Processing.	PO8	U	C

COURSE CONTENT

Module 1 : Signals and System: Signals, Impulse Sequence, Exponential Sequence, Periodic Sequence, Linear Systems, Shift-Invariant systems, Linear Shift Invariant (LSI) systems

Module 2 : Convolution and Correlation, Inverse Convolution or Deconvolution, Finite Impulse Response System, Infinite Impulse Response System, Transforms- Fourier Transform, Z Transform, DST, DCT, KL Transform

Module 3 : Steps in Digital Image Processing Sampling and Quantization- Applications of Image Processing, Intensity Transformation and Spatial Filtering, Intensity Transformation Functions, Piecewise Linear Transformation Functions, Histogram Processing, Histogram Equalization, Histogram Matching, Local Enhancement, Enhancement using Arithmetic and Logic operations, Image Subtraction, Image Averaging

Module 4: Spatial Filtering, Smoothening Spatial Filters, Sharpening Spatial Filters, Laplacian Filter, Unsharp masking and High Boost Filter, Gradient operators – Edge detection filters, Filtering in Frequency domain, Frequency Domain Smoothening Filters: Ideal Filter, Butterworth Filter, Gaussian Filter, Frequency Domain Sharpening Filters, Laplacian in Frequency domain, Homomorphic Filtering.

Module 5 : Image degradation/Restoration process model, Noise probability density functions, Spatial Filtering: Mean Filters, Order-statistics filter, Adaptive Filters, Periodic Noise Reduction – Frequency domain filters: Band-reject filters, Band-pass filters, Notch filters. Estimating the degradation function, Inverse filtering, Wiener filtering, Performance measures.

Module 6 : Color image processing: Color fundamentals, Color models – RGB, CMYK, HSI, YCbCr, La*b* color spaces. Full color image processing, Color image smoothening and sharpening, color edge detection. Point and line detection. Image segmentation: Fundamentals, Thresholding, Optimum global thresholding – Otsu's method. Region based segmentation

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Implementation of image processing programs

LEARNING RESOURCES

References

● Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson, 1st Ed., 1988.

● AzrielRosenfield, Avinash C. Kak, "Digital Picture Processing", Morgan Kaufmann, 2nd Ed., 1982.

● Bernd Jahne, "Digital Image Processing", Springer, 6th Ed., 2005.

● Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 4th Ed., Pearson, March 2017.

● William K. Pratt, "Digital Image Processing: PIKS Scientific Inside", John Wiley & Sons, 4th Ed., 2007.

SEMESTER 1	CSM-CC-613	Credits: 4

MACHINE LEARNING TECHNIQUES

	COURSE OUTCOMES:
CO1	Demonstrate the capability to articulate the basic concepts of Machine learning
CO2	Compare and contrast different supervised machine learning algorithms
CO3	Evaluate unsupervised machine learning algorithms with examples
CO4	Explain the elements in Reinforcement learning techniques
CO5	Apply machine learning algorithms to solve real world problems
CO6	Illustrate the dimensionality reduction techniques with practical aspects
CO7	Compare the statistical Machine learning Techniques.
CO8	Identify the techniques to evaluate the performance of a classifier

TAGGING COURSE OUTCOMES

	Course Outcomes:	PO/PSO	CL	KC
CO1	Demonstrate the capability to articulate the basic concepts of Machine learning	PSO1	A	C,P
CO2	Compare and contrast different supervised machine learning algorithms	PSO5	E	C.P
CO3	Evaluate unsupervised machine learning algorithms with examples	PSO2	E	P
CO4	Explain the elements in Reinforcement learning techniques	PSO2	An	C
CO5	Apply machine learning algorithms to solve real world problems	PSO7	A	P
CO6	Illustrate the dimensionality reduction techniques with practical aspects	PSO9	A	C,P
CO7	Compare the statistical Machine learning Techniques.	PSO4	E	C,P
CO8	Identify the techniques to evaluate the performance of a classifier	PSO5	U,A	C

COURSE CONTENT

Module 1: Introduction to Machine Learning, Applications: Learning Associations, Classification ,Regression, Unsupervised Learning, Reinforcement Learning , Batch learning and online learning, Instance based learning Versus Model Based learning, Challenges of Machine Learning.

Module 2 : Supervised Learning algorithms-Classification: Linear Discriminant Classifier, Decision Trees, Random Forest, Support Vector Machines, kernel Functions, linear SVM, Non-linear SVM, ,KNN algorithm-Distance measures, Naïve Bayes classifier, Regression : Linear Regression, Logistic Regression

Module 3 : Unsupervised Learning algorithms**:** Clustering: Similarity measures, Clustering criteria, Distance functions, Hierarchical clustering, Single Linkage, Average Linkage and Complete Linkage algorithms, Ward's Method. Partitional Clustering, Forgy's Algorithm, K-means algorithm, Fuzzy C means algorithm,

Module 4 : Reinforcement Learning: Introduction, Elements of Reinforcement Learning, Limitations and scope, Markov Decision Process, Temporal Difference learning, Q-learning, On-policy TD control, Off-policy TD control.

Module 5 : Dimensionality Reduction: Problems of dimensionality, Need, The Curse of Dimensionality, Main approaches of Dimensionality reduction, Subset selection, Principle Component Analysis, Factor Analysis, Linear Discriminant Analysis

Module 6 : Statistical Learning- stochastic process, Markov process, HMM, Cross-Validation and Resampling Methods- *K*-Fold Cross-Validation, 5×2 Cross-Validation, Bootstrapping, Measuring Classifier Performance :Accuracy, Precision, Recall, F1 Score, Sensitivity, Specificity, ROC, AUC, Confusion matrix

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Implementation of machine learning programs

LEARNING RESOURCES

References

- Aurélien Géron "Hands-On Machine Learning with Scikt-Learn &TensorFlow", O'Reilly Media, Inc.,2019
- Bishop, C. M. "Neural Networks for Pattern Recognition". New York: Oxford University Press (1995).
- Duda, R., Hart, P., and Stork, D. (2001). "Pattern Classification". New York: Wiley.
- EthemAlpaydın "Introduction to Machine Learning Second Edition" , The MIT Press Cambridge, Massachusetts, London, England
- LaureneFauseett: "Fundamentals of Neural Networks", Prentice Hall India, New Delhi,1994.
- Mitchell, T. (1997). "Machine Learning". New York: Mc Graw-Hill.

SEMESTER I	CSM-CC-614	Credits:4

IMAGE PROCESSING LABORATORY

	COURSE OUTCOMES
CO1	Implement basic image processing and machine learning algorithms
CO2	Perform image restoration using wiener filtering
CO3	Implement a mini project in image processing using machine learning techniques
CO4	Perform convolution and correlation on images
CO5	Implement filtering algorithms in spatial and frequency domain
CO6	Solve real life problems using image processing and machine learning
CO7	Apply and evaluate the feature extraction and dimensionality techniques on images.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Implement basic image processing and machine learning algorithms	PSO2, PSO4	A	P
CO2	Perform image restoration using wiener filtering	PSO2	A	P
CO3	Implement a mini project in image processing research area	PSO1 PSO2, PSO4	A	P
CO4	Compare the working of convolution and correlation	PSO2 PSO9	An	P
CO5	Implement filtering algorithms in spatial and frequency domain	PSO2	A	P
CO6	Solve real life problems using image processing algorithms	PSO2, PSO7, PSO8	A	P
CO7	Apply and evaluate the feature extraction and dimensionality reduction techniques on images	PSO2, PSO8 PSO9	A, E	P

Students should undertake a research-oriented mini project to get an exposure to the recent research developments in the domain of Digital Image Processing. A detailed project report should be submitted and its evaluation should be conducted at the end of the semester.

List of Experiments

Implement the following algorithms and methods

- Hough Transform,
- Feature Extraction: Entropy, GLCM
- Dimensionality Reduction: PCA, LDA

- Classifiers:
- FCM, SVM, Perceptron, MLP, K-NN,
- Bayes Classifiers, Random Forest
- Adaboost, Decision Tree
- Histogram Equalization
- Color Image processing
- Image Deblurring using Wiener Filter
- Homomorphic filtering
- Contrast Stretching
- Unsharp masking
- Image Subtraction
- Local Enhancement and Global Enhancement
- Edge Detection – Laplacian and Canny

ELECTIVE- I

SEMESTER 1	CSM-DE-615(i)	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	Explain the randomization techniques in parallel programming
CO5	Illustrate the use SPMD Programming
CO6	Assess the performance of the parallel programming

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Illustrate the computational complexity of modern problem methodology	PSO9	A	C
CO2	Demonstrate the working of parallel computing	PSO2	A	P
CO3	Discuss the nature and working of parallel algorithms	PSO4	U	C
CO4	Explain the randomization techniques in parallel programming	PSO2	A	P
CO5	Illustrate the use SPMD Programming	PSO2	U	C
CO6	Assess the performance of the parallel programming	PSO2	E	C,P

COURSE CONTENT

Module 1: 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 2 : 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 3 : 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 4 : 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 5 :SPMD Programming (threads, OpenMP, MPI), I/O and File Systems, Parallel Matlabs (Parallel Matlab, Star-P, Matlab MPI), Partitioning Global Address Space (PGAS) languages (UPC, Titanium, Global Arrays)

Module 6 : 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

- Assignments 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.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Implementation of programs

LEARNING RESOURCES

References

● Bader, David A. Petascale Computing. CRC Press, 2007

● David Culler Jaswinder Pal Singh,"Parallel Computer Architecture: A hardware/Software Approach", Morgan Kaufmann, 1999.

● 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

SEMESTER 1	CSM-DE-615(ii)	Credits:4

COMPUTATIONAL COGNITIVE NEUROSCIENCE

	COURSE OUTCOMES
CO1	Correlate machine learning and human learning in the context of computational cognitive neuroscience
CO2	Ability to identify the important issues in cognitive scienceand comprehend the empirical data
CO3	Articulate the basics of psychological ideas and translate psychological theories to computational or mathematical models.
CO4	Apply computational models and algorithms to cognitive science data
CO5	Illustrate how computational and mathematical theories can be applied to real-world problems, and effectively find solutions.
CO6	Categorize the characteristics of neurological brain disorders including Epilepsy, Alzheimer disease and Dementia
CO7	Compare fMRI and MRI

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Correlate machine learning and human learning in the context of computational cognitive neuroscience	PSO2	U	C
CO2	Ability to identify the important issues in cognitive science and comprehend the empirical data	PSO2, PSO7	U, A	C, P
CO3	Articulate the basics of psychological ideas and translate psychological theories to computational or mathematical models.	PSO4	U	C,F
CO4	Apply computational models and algorithms to cognitive science data	PSO4, PSO7	A	P
CO5	Illustrate how computational and mathematical theories can be applied to real-world problems, and effectively find solutions.	PSO7, PSO2	A	C,P
CO6	Categorize the characteristics of neurological brain disorders including Epilepsy, Alzheimer disease and Dementia	PSO7	An	P
CO7	Compare fMRI and MRI	PSO5	An	P

COURSE CONTENT

Module 1 : Introduction to Neuroscience - Computational Neuroscience: Descriptive Models- Computational Neuroscience: Mechanistic and Interpretive Models- The Electrical Personality of Neurons- Making Connections: Synapses- Time to Network: Brain Areas and their Function

Module 2 : Structural Neuroanatomy of the Human Brain- Structure and Anatomy- Development and Vascular Organization of the Brain- Terminology of Brain Organization-

Module 3 : Functional Anatomy of the Brain- Methods of Communication in the Brain Organization of Cognitive Domains- Neuropsychological Assessment of Cognition -Principles and Methods of Neuroimaging

Module 4 : Approaches to Neuroimaging- Basics of MRI - Basics of fMRI- Structural MRI Studies- Functional MRI Studies- Experimental design and special applications in neuroimaging- Experimental Design- Functional Connectivity MRI Studies- Diffusion Tensor Imaging

Module 5 : Brain Imaging and Spectroscopy- Structural Brain Imaging – MRI (T1 and FLAIR) and CT- – MRI T1 processing- Structural MRI - Diffusion Weighted Imaging- – Functional MRI – BOLD – Block and Event-related design- – fMRI Processing -

Module 6 : Magnetic Resonance Spectroscopy –overview- How does MR Spectroscopy work? Positron Emission Tomography (PET)- overview- How does PET work ? - Neurological Brain Disorders : Epilepsy, Alzheimer disease and Dementia

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Implementation of programs

References

O'Reilly, R. C., Munakata, Y., Frank, M.J., Hazy, T.E. and Contributors (2014). Computational Cognitive Neuroscience. Wiki Book, 2nd Edition,

Online Source : Computational Neuroscience by University of Washington offered by Coursera

Online source :Fundamental Neuroscience for Neuroimaging by Johns Hopkins University by offered by Coursera

SEMESTER 1	CSM-DE-615(iii)	Credits:4

ADVANCED NATURAL LANGUAGE PROCESSING

	COURSE OUTCOMES
CO1	Demonstrate the NLP- Text & Speech understanding system
CO2	Generalize the knowledge representation system in Language processing
CO3	Differentiate: Active & Passive constructions in lexical analysis
CO4	Constitute the wh-movements and its evaluation
CO5	Illustrate the process of morphological analysis in NLP
CO6	Implement the Finite State Model for morphological processing
CO7	Differentiate between top-down parsing& bottom-up parsing
CO8	Recall the Phonetics & Phonology in speech forms
CO9	Examine the place and manner of articulation in speech processing
CO10	Apply the probability model for speech processing
CO11	Identify the different types of Parts-of- speech tagging
CO12	Develop a Baum Welch Algorithm for speech processing

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Demonstrate the NLP- Text & Speech understanding system	PSO2	A	P, C
CO2	Generalize the knowledge representation system in Language processing	PSO4	C	P
CO3	Differentiate: Active & Passive constructions in lexical analysis	PSO2	An	C
CO4	Constitute the wh-movements and its evaluation	PSO9	U	C
CO5	llustrate the process of morphological analysis in NLP	PSO2	U, A	C, P
CO6	Implement the Finite State Model for morphological processing	PSO8	A	P
CO7	Differentiate between top-down parsing& bottom-up parsing	PSO8	An	P
CO8	Recall the Phonetics & Phonology in speech forms	PSO2	U	C
CO9	Examine the place and manner of articulation in speech processing	PSO2	U	C
CO10	Apply the probability model for speech processing	PSO2, PSO9	A	P
CO11	Identify the different types of Parts-of- speech tagging	PSO2, PSO9	U, A	P
CO12	Develop a Baum Welch Algorithm for speech processing	PSO7,PSO8,PSO9	A	P

COURSE CONTENT

Module 1 : Introduction - Machine Learning and NLP, ArgMax Computation; Tree Adjoining Grammars: Dependency Grammars-Statistical Parsing; Introduction to Semantic Processing, Semantic Knowledge Representation, Deep Structure and Logical Form-Compositional Semantic Interpretation-Semantic Grammars-Case Frames and Case Frame based Parsing; Problems in NL Generation-Basic Generation Techniques Hard Problems in NLP-Speech Understanding and Translation-Discourse Processing.

Module 2 : Lexical Functional Grammar: Active-Passive and Dative Constructions-Wh-movement in Questions. Overview of LFG - LFG Formalism-Well-formedness Conditions-Handling Wh movement in Questions Computational Aspects.

Module 3 : Morphology and Finite State Transducers: Root and Stem, affixes - Inflectional Morphology-Derivational Morphology-Finite State Morphological Parsing-The Lexicon and Morphotactics Morphological Parsing with Finite State Transducers-Orthographic Rules and Finite-State Transducers-Combining an FST Lexicon and Rules-Lexicon-Free FSTs.

Module 4 : Word Sense Disambiguation: WordNet – Lexicography, Corpus. Wordnet; Application in Query Expansion, Measures of WordNet Similarity, Resnick's work on WordNet Similarity, Parsing Algorithms, Evidence for Deeper Structure; Top Down Parsing Algorithms, Noun Structure: Noun, verb, adjective and adverb structure. Top Down Parsing Algorithms, Non-noun Structure and Parsing Algorithms; Probabilistic parsing: Sequence labelling, PCFG; Probabilistic parsing: Training issues, Arguments and Adjuncts, Probabilistic parsing; inside-outside probabilities.

Module 5 : Speech : Phonetics, Hidden Markov Model, Graphical Models for Sequence Labelling in NLP, Consonants (place and manner of articulation) and Vowels; Forward Backward probability: Viterbi Algorithm, Phonology, Sentiment Analysis and Opinions on the Web, Machine Translation and MT Tools - GIZA++ and Moses, NLTK, Textblob – Python, Regular expression. Text Alignment, POS Tagging.

Module 6 : Phonology: ASR, Speech Synthesis, Hidden Markov Model and Viterbi, Precision, Recall , F-score, Map, Semantic Relations; UNL; Universal Networking Language: Introduction, Semantic Role Extraction, Baum Welch Algorithm; HMM training.

References:

1. Dash, NiladriSekhar (2005) Corpus Linguistics and Language Technology, New Delhi : Mittal Publications.
2. Introduction to Natural Language Processing, Jacob Eisenstein. 2019
3. Natural Language Processing with Python. Steven Bird, Ewan Klein and Edward Loper. 2016
4. Natural Language Understanding (2nd Edition) 2nd Edition- 2017. James Allen
5. RuslanMitkov, (2003), The Oxford Handbook of Computational Linguistics, Oxford University Press.
6. Speech and Language Processing (3rd ed. draft), Dan Jurafsky and James H. Martin. Draft chapters in progress, October 16, 2019
7. Statistical Machine Translation. Philipp Koehn. 2016
8. The Handbook of Computational Linguistics and Natural Language Processing (Blackwell Handbooks in Linguistics) 1st Edition, Kindle Edition by Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor),

SEMESTER 1	CSM-DE-615(iv)	Credits:4

CYBER SECURITY AND CYBER LAW

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

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify the issues and challenges in Networking	PSO1	U, A	C
CO2	Explain the concepts of Information security, Threats, Vulnerabilities, Impact and control measures.	PSO2	U	C, P
CO3	Analyze the efficiency of algorithms in cryptography.	PSO4	E	C
CO4	Discuss network security issues and Virtual Private Networks.	PSO2	U	C, P
CO5	Relate Cyber laws with security incidents**.**	PSO5, PSO7	A	C
CO6	Analyze Cyber Lawin the context of breach of cyber security.	PSO2	An	F, C
CO7	Discuss IT Act & its Amendments	PSO2	U	F, C

COURSE CONTENT

Module 1 : 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 2 : Model of Cryptographic Systems, Issues in Documents Security, System of Keys, Public Key Cryptography, Digital Signature, Requirement of Digital Signature System, Finger Prints, Firewalls, Design and Implementation Issues, Policies Network Security- Basic Concepts, Dimensions, Perimeter for Network.

Module 3 : 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, IPSecTunneling& Protocols. - VLAN: introduction, Links, Tagging, VLAN Trunk Protocol (VTP).

Module 4 : Constitutional & Human Rights Issues in Cyberspace Freedom of Speech and Expression in Cyberspace - Right to Access Cyberspace – Access to Internet- Right to Privacy - Right to Data Protection.
Module 5 : 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 6 :` 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”, Mc GrawHillFurnell, “Computer Insecurity”, Springer.
- Yadav, “Foundations of Information Technology”, New Age, Delhi.

SEMESTER 1	CSM-DE-615(v)	Credits:4

DIGITAL VIDEO PROCESSING

	COURSE OUTCOMES
CO1	Develop the capability of representing, analyzing, compressing and processing video
CO2	Apply the appropriate motion estimation technique for video processing applications
CO3	Illustrate the steps for processing of compressed video
CO4	Identify the steps for performing video summarization
CO5	Describe the video sampling mechanism
CO6	Evaluate the metrics for analyzing the efficiency of video processing algorithms
CO7	Describe the fundamentals of image and video processing and their applications
CO8	Develop familiarity and implement basic image and video processing algorithms.
CO9	Select and apply appropriate technique to real problems in image and video analysis.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Develop the capability of representing, analyzing, compressing and processing video	PSO3	U, A	C,P
CO2	Apply the appropriate motion estimation technique for a given video processing applications	PSO2	A	P
CO3	Illustrate the steps for processing of compressed video	PSO1	A	C, P
CO4	Identify the steps for processing video summarization	PSO2	U, A	C, P
CO5	Describe the video sampling mechanism	PSO8	U	C
CO6	Evaluate the metrics for analyzing the efficiency of video processing algorithms	PSO8	E	P
CO7	Describe the fundamentals of image and video processing and their applications	PSO2	U	C
CO8	Implement basic image and video processing algorithms.	PSO9	A	P
CO9	Apply appropriate technique to real problems in image and video analysis.	PSO7	A	P

COURSE CONTENT

Module 1 : Analog video and NTSC television- Spatio-temporal sampling; Sampling structure conversion (without using motion) - Motion Analysis- Real versus apparent motion- Spatial-temporal constraint methods (optical flow equation) –

Module 2 : Block-matching methods- Mesh-based methods - Region-based (parametric) motion modeling - Motion segmentation and layered video representations

Module 3 : Video Processing- Motion-compensated (MC) filtering- Noise reduction - Signal recovery and general inverse problems - Restoration (deblurring) - Superresolution, Mosaicing - Deinterlacing - Frame-rate conversion (MC-Interpolation)

Module 4 : Video Compression - Frame-based compression (principles behind MPEG-1, MPEG-2) Scalable or layered frame-based compression- Object-based compression (principles behind MPEG-4)

Module 5 : Video communication- Video streaming and error-resilience- Efficient processing of compressed video- Digital TV

Module 6 : Advanced Video Processing : Video indexing, summarization, and retrieval.-Video meta-data extraction and representation.- video semantic analysis - video quality evaluation techniques

REFERENCES

- Digital Video Processing" by M. Tekalp (Prentice Hall, 1995, ISBN 0-13-190075-7).
- H.264 and MPEG-4 Video Compression: Video Coding for Next Generation Multimedia – Iain E.G. Richardson, Wiley, 2003
- Handbook of Image and Video processing – Al Bovik (Alan C Bovik), Academic Press, Second Edition, 2005.
- Video Processing and Communications" by Yao Wang, JoernOstermann, and Ya-Qin Zhang, Prentice Hall, 2002, ISBN 0-13-017547-1.

SEMESTER 1	CSM-DE-615(vi)	Credits:4

COMPUTATIONAL GEOMETRY

	COURSE OUTCOMES
CO1	Explain fundamental geometry representations
CO2	Explain and apply basic concepts from Polygons and Triangulations
CO3	Analyze the 3D graphics programming and understand its limitations
CO4	Implement and evaluate basic geometry processing algorithms, such as smoothing, remeshing, deformation, and constructive solid geometry
CO5	Perform PCA based shape synthesis
CO6	Discuss surface reconstruction techniques
CO7	Explain the deformation types including Volume-based Deformation, Multi-Scale Deformation, Free-Form Deformation

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain fundamental geometry representations	PSO2	U	C
CO2	Apply basic concepts of Polygons and Triangulations for geometry processing	PSO4	U,A	P
CO3	Analyze the 3D graphics programming	PSO3	An	P
CO4	Describe basic geometry processing algorithms, such as smoothing, remeshing, deformation, and constructive solid geometry	PSO4, PSO9	A	P
CO5	Perform PCA based shape synthesis	PSO4	A	P
CO6	Discuss surface reconstruction techniques	PSO2	U	C
CO7	Explain the deformation types including Volume-based Deformation, Multi-Scale Deformation, Free-Form Deformation	PSO2	U	F

COURSE CONTENTS

Module 1 : Introduction- Digital Models- Geometry representation - Polygons and Triangulations - polygonal Jordan Curve - Art Gallery problem- Point Sets- Convex hull construction-Voronoi Diagrams

Module 2 : Mesh Data Structures- Face-Based Data Structures- Edge-Based Data Structures - Halfedge-Based Data Structure Directed-Edge Data Structure- 3D Graphics Programming- Introduction to open inventor tool- Mesh Comparison- Distance- Geodesic distance- Diffusion distance- Shape descriptors- Sampling - Shape correspondence

Module 3 :Surface reconstruction- Explicit representation- Implicit representation- Implicit function- Implicit reconstruction- Marching Squares algorithm- Marching cubes algorithm- Signed distance function- KD tree for NN- Scientific visualization - Direct scalar field visualization- Vector field visualization- Information visualization

Module 4 :Mesh Generation - Shape Synthesis- Part based shape synthesis- PCA based shape synthesis- PCA Computation - PCA application- eigen vector decomposition -Active shape model - Shape from Silhouette- Mesh Processing- Mesh smoothing- Remeshing- Subdivision surfaces- Subdivision curves

Module 5 :Mesh parameterization- Texture Mapping - Parameterization types- Linear Parameterization Methods- Disk Parameterization - Fixed-Boundary Parameterization - Free-Boundary Parameterization - MDS-based Parameterization - Parameterization Refinement- Parameterization of Closed Meshes - Spherical Parameterization- Sphere Generation Method - Parameterization Distortion

Module 6 :Shape Registration - Rigid vs. Non-rigid- Rigid Alignment via PCA- Eigen decomposition of Covariance Matrix- Rigid Alignment Transformations- Rigid Alignment via ICP- Rigid Alignment via RANSAC - Mesh Deformation- Deformation Types- Volume-based Deformation- Multi-Scale Deformation- Free-Form Deformation (FFD)- Interpolation- Skinning- Shell-based Deformation- Physically based deformation

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Poster Presentation
- Implementation of programs

REFERENCES:

- Polygon Mesh Processing, Mario Botsch, Leif Kobbelt, Mark Pauly, Pierre Alliez, Bruno Lévy , 2010

On-line Sources

- Computer Graphics: Geometric Modeling, course by L. Guibas (Stanford)
- Digital Geometry Processing, course by Hao Li
- Digital Geometry Processing, course by Mirela Ben-Chen
- Geometric Modeling course by TamalDey and the associated course notes (Ohio State University).
- http://staff.ustc.edu.cn/~fuxm/course/2017_Spring_DGP/index.html
- http://user.ceng.metu.edu.tr/~ys/ceng789-dgp/
- https://www.cs.ubc.ca/~sheffa/dgp/
- https://www.cse.iitb.ac.in/~cs749/spr2017/

SEMESTER 1	CSM-GC-601	Credits:2

BASICS OF DIGITAL IMAGE PROCESSING

	COURSE OUTCOMES
CO1	Explain the different tasks in digital image processing.
CO2	Illustrate the process of sampling and quantization in digtal images
CO3	Analyse the steps for removing the blur in an image
CO4	Explain various spatial and frequency domain filtering techniques.
CO5	Explore the image segmentation techniques

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain the different tasks in digital image processing.	PSO1	U	C, P
CO2	Illustrate the process of sampling and quantization in digtal images	PSO5	A	C,P
CO3	Analyse the steps for removing the blur in an image	PSO5	An	P
CO4	Explain various spatial and frequency domain filtering techniques.	PSO3	U	C
CO5	Explore the image segmentation techniques	PSO9	U	P

COURSE CONTENT

Module 1 : Images and Pictures- Image Processing- Image Acquisition and Sampling- Aspects of Image Processing- Types of digital images- Quantization and dithering- Histograms

Module 2 : Filtering- Low and High Pass filters- Guassian Filters- Edge Sharpening- Non linear filters- region of interest processing- Image Interpolation- Enhancement by Spatial Filtering

Module 3 : Fourier transforms of Images- Filtering in frequency domain- Ideal Filtering- Butterworth Filtering- Homomorphic filtering.

Module 4 : Image Restoration- Degradation model- Types of Noises- Median Filtering- Average Filtering- Adaptive Filtering- Wiener Filter.

Module 5 : Image Segmentation- Thresholding- Otsu's Thresholding- Adaptive Thresholding- Edge detection- Watershed algorithm- Hough Transform.

Module 6 : Mathematical Morphology- basic ideas- Dilation - Erosion- Opening- Closing- Hit or miss transforms- Gray Scale morphology- Processing of color images

LEARNING RESOURCES

REFERENCES

- Alasdair McAndrew , Introduction to Digital Image Processing with Matlab, Cengage Learning, 2004
- Anil K. Jain, “Fundamentals of Digital image Processing”, Prentice Hall, US Ed., 1989.
- Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 3rd Ed., PHI, 2007.
- William K. Pratt, “Digital Image Processing: PIKS Scientific Inside”, Wiley Interscience, 4th Ed., 2007

SEMESTER 1	CSM-GC-602	Credits:2

INTRODUCTION TO SCILAB

	COURSE OUTCOMES
CO1	Identify the significance of Scilab over other programming tools.
CO2	Demonstrate the procedures in downloading and accessing Scilab software.
CO3	Compare built-in operators and functions in scilab.
CO4	Discuss the working of arrays, matrices and other vectors in scilab programming.
CO5	Solve basic mathematical and relational problems using scilab programming.
CO6	Illustrate basic polynomial arithmetic using scilab programming.
CO7	Demonstrate 2D and 3D plotting using Scilab programming.
CO8	Create user defined functions in Scilab programming.
CO9	Apply statistical functions in Scilab programming.

TAGGING COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Identify the significance of Scilab over other programming tools.	PSO1	K	F
CO2	Demonstrate the procedures in downloading and accessing Scilab software.	PSO2	A	P
CO3	Compare built-in operators and functions in scilab.	PSO4	An	C,P
CO4	Discuss the working of arrays, matrices and other vectors in scilab programming.	PSO9	U	P
CO5	Solve basic mathematical and relational problems using scilab programming.	PSO4	A	P
CO6	Illustrate basic polynomial arithmetic using scilab programming.	PSO9	A	P
CO7	Demonstrate 2D and 3D plotting using Scilab programming.	PSO2	A	P
CO8	Create user defined functions in Scilab programming.	PSO7	C	P
CO9	Apply statistical functions in Scilab programming.	PSO4	A	P

COURSE CONTENT

Module 1 : Introduction to Scilab – Why Scilab, downloading & installing scilab, Scilab Environment – manipulating the command line, working directory, comments, variables in memory, the scilab menu bar, demos.

Module 2 :Scalars & Vectors - initializing vectors in scilab, mathematical operations on vectors, relational operations, logical operations on vectors, built-in logical functions- conditional statements, Mathematical functions on scalars, complex numbers, trigonometric functions

Module 3 :Matrices – introduction, arithmetic operators for matrices, basic matrix processing- Accessing and Addressing Matrix- Mathematical Operations with Matrix

Module 4 :Polynomials – introduction, creating polynomials, basic polynomial commands, finding roots of polynomial, polynomial arithmetic

Module 5 :Plotting- Plotting 2D graphs - Plotting 3D graphs- Functions in Scilab**-** Applications - Numerical Linear Algebra(Solving linear equations, Eigen values)

Module 6 :Statistics – 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

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

SEMESTER II	CSM-CC-621	Credits:4

ADVANCED COMPUTATION MODELS

	COURSE OUTCOME
CO1	Explain the basic theory and concepts of neural networks
CO2	Identify different neural network architectures, algorithms and applications.
CO3	Solve the neural network problems based on different learning rules.
CO4	Compare the crisp logic, the concept of fuzzy logic involved in various systems and fuzzy set theory.
CO5	Describe the fuzzy logic concepts including the use of fuzzy inference systems and approximate reasoning in solving complex tasks.
CO6	Implement, train, and evaluate neural networks
CO7	Different deep network architectures and how these are used in current applications
CO8	Design different type of classification methods suitable for the problems to be addressed.

TAGGING COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Explain the basic theory and concepts of neural networks	PSO2	U	C
CO2	Identify different neural network architectures, algorithms and applications.	PSO2	U	C
CO3	Solve the problems based on different learning rules.	PSO3	Ap	P
CO4	Compare the crisp logic, the concept of fuzzy logic involved in various systems and fuzzy set theory.	PSO3	U,A	P
CO5	Describe the fuzzy logic concepts including the use of fuzzy inference systems and approximate reasoning in solving complex tasks.	PSO3	U	C
CO6	Implement, train, and evaluate neural networks using existing software libraries	PSO3	U	C
CO7	Different deep network architectures and how these are used in current applications	PSO4	E	p
CO8	Design different type of classification methods suitable for the problems to be addressed.	PSO1, PSO5, PSO6 PSO7	C	P

COURSE CONTENT

Module 1 : Introduction to Fuzzy logic.Fuzzy sets and membership functions. Operations on Fuzzy sets. Fuzzy relations, rules, propositions, implications and inferences. Defuzzification techniques. Fuzzy logic controller design, Neuro Fuzzy systems, ANFIS, Applications of Fuzzy systems.

Module 2 :ANN Basics, Biological neuron,Models of neuron, Types of Neural network, learning, Activation Functions, The perceptron model, Backpropagation, stochastic gradient descent, Multi-layer Perceptrons.

Module 3 : Convolutional neural network :Architecture , Working of Convolutional Neural Network, ConvNet Layers, Convolutional Layer, Pooling Layer , Normalization Layer, Fully-Connected Layer, Converting Fully-Connected Layers to Convolutional Layers, ConvNet Architectures- Layer Patterns, Layer Sizing Patterns, AlexNet, VGGNet

Module 4 : Deep Learning Hardware and Software: CPUs, GPUs, TPUs, PyTorch, TensorFlow Dynamic vs Static computation graphs, Activation functions, data processing Batch Normalization, Transfer learning, Update rules, hyperparameter tuning, Learning rate scheduling, data augmentation.

Module 5 : Unsupervised Learning: Non-probabilistic Models: sparse coding, Autoencoders, stacked auto encoders, denoising auto encoders, deep auto encoders, Deep Belief Networks (DBNs), Generative Adversarial Networks (GANs).

Module 6 : Reurrent and Recursive networks, Bidirectional RNNS, Deep recurrent networks, Recursive Neural networks, The long short term memory,Deep Reinforcement Learning. Implementing object detection and classification using CNN with the help of any deep libraries like Tensorflow, Keras, Caffe.

LEARNING RESOURCES

References

- Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.
- CosmaRohillaShalizi, Advanced Data Analysis from an Elementary Point of View, 2015.
- Deng & Yu, Deep Learning: Methods and Applications, Now Publishers, 2013.
- Ian Goodfellow, YoshuaBengio, Aaron Courville, Deep Learning, MIT Press, 2016
- Kalchbrenner, Nal, Edward Grefenstette, and Phil Blunsom. "A convolutional neural network for modelling sentences." ACL (2014).

On line sources

http://www.cs.toronto.edu/~hinton/deeprefs.html

SEMESTER II	CSM-CC-621	Credits:4

DATA AND IMAGE COMPRESSION

	COURSE OUTCOMES
CO1	Model and code the redundancy in a data
CO2	Design a Huffman and Adaptive huffman codes for the data
CO3	Check whether a code is uniquely decidable or not.
CO4	Encode the data using adaptive dictionary based algorithms including LZ77, LZ78, LZW
CO5	Analyse the CALIC algorithm to do the image compression
CO6	Encode the data using BWT algorithm
CO7	Analyse the working of JPEG compression algorithm
CO8	Compare Static quantization and Adaptive quantization techniques
CO9	Discuss LBG algorithm
C10	Explain Vector Quantization Technique

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Model and code the redundancy in a data	PSO2	An	C
CO2	Design a Huffman and Adaptive huffman codes for the data	PSO3, PSO4	E	P
CO3	Check whether a code is uniquely decidable or not.	PO4	An	P
CO4	Encode the data using adaptive dictionary based algorithms including LZ77, LZ78, LZW	PSO2 PSO3	A	C, P
CO5	Analyse the CALIC algorithm to do the image compression	PSO2	An	C
CO6	Encode the data using BWT algorithm	PSO3	A	C, P
CO7	Analyse the working of JPEG compression algorithm	PSO2 PSO3	An	C
CO8	Compare Static quantization and Adaptive quantization techniques	PO5	An	C
CO9	Discuss LBG algorithm	PSO2	U	C
C10	Explain Vector Quantization Technique	PSO2	U	C

COURSE CONTENT

Module 1: Introduction: Compression Techniques, Modeling and Coding, Mathematical Preliminaries for Lossless compression: Information Theory, Uniquely decodable codes, Prefix codes, Kraft-McMillan Inequality.

Module 2: Huffman Coding, Adaptive Huffman Coding, Arithmetic Coding: Coding a sequence, Generating a binary code, Dictionary Techniques: Static Dictionary, Digram coding, Adaptive Dictionary, LZ77, LZ78, LZW algorithms

Module 3: Context-based Compression: Prediction with partial match (ppm), Burrows-Wheeler Transform (BWT), CALIC, JPEG standard, JPEG-LS, Run-Length Coding

Module 4 : Scalar and Vector Quantization: Quantization: Quantization problem, Uniform Quantizer, Lloyd- Max Quantizer, LBG Algorithm, Tree Structured and Structured Vector Quantizers

Module 5: Image data properties- Discrete image transforms in image data compression - Predictive compression methods - Vector quantization- Compression in transform domain- JPEG, Wavelets compression

Module 6: Hierarchical and progressive compression methods- Comparison of compression methods - Other techniques - Coding - JPEG and MPEG image compression.

REFERENCES

- Alistair Moffat, Andrew Turpin, "Compression and Coding Algorithms", Kluwer Academic Publishers, 1st Ed., 2002.
- David Salomon, "Data Compression – The Complete Reference", Springer, 4th Ed., 2006.
- John Miano, "Compressed Image File Formats", Addison Wesley Professional, 1st Ed., 1999.
- Khalid Sayood, "Introduction to Data Compression", Morgan Kaufmann Publishers, 4th Ed., 2012.
- Mark Nelson, Jean-Loup Gailly, "The Data Compression Book", John Wiley & Sons, 2nd Ed., 1995.
- Peter Wayner, "Compression Algorithms for Real Programmers", Morgan Kaufmann, 1st Ed., 1999.
- VasudevBhaskaran, Konstantinos Konstantinides, "Image and Video Compression Standards", Kluwer Academic Publishers, 2nd Ed., 2003.

SEMESTER II	CSM- CC -623	Credits:4

IMAGE ANALYSIS AND COMPUTER VISION

	COURSE OUTCOME
CO1	Explain the fundamental theories and techniques of human vision with computer vision.
CO2	Explain the process of image formation in the camera.
CO3	Explore the significance of morphological operations
CO4	Apply different region properties in an image
CO5	Summarize different texture, color-based feature extraction methods used for computer vision
CO6	Illustrate the working of Camera calibration system
CO7	Explain different methods to compute the motion of an object from 2D image sequences
CO8	Explain the process of the depth information from stereo images
CO9	Apply different types of morphological operations to an image
CO10	Develop a computer-based system with vision capabilities

TAGGING COURSE OUTCOMES

	Course Outcome	PSO	CL	KC
CO1	Explain the fundamental theories and techniques of human vision with computer vision.	PSO2	U	C
CO2	Explain the process of image formation in the camera.	PSO2	U	C
CO3	Explore the significance of morphological operations and apply different type of morphological operations in order to get the perfect object from the given image	PSO3	AP	P
CO4	Apply different region properties in an image	PSO3	AP	C,P
CO5	Summarize different texture, color-based feature extraction methods used for computer vision	PSO4	U	C,P
CO6	Illustrate the working of Camera calibration system	PSO2	U	C
CO7	Explain different methods to compute the motion of an object from 2D image sequences	PSO2, PSO6	U	C
CO8	Explain the process of the depth information from stereo images	PSO2	U	C
CO9	Apply different types of morphological operations to an image	PSO3	AP	C,P
CO10	Develop a computer-based system with vision capabilities	PSO1, PSO5, PSO7	Cr	P

COURSE CONTENT

Module 1 : Imaging and Image Representation: Imaging Devices, 3D structure from 2D images, Five frames of reference. Binary Image Analysis: Pixels and Neighborhoods, Applying masks to images, Counting the objects in an image, Connected components labeling. Binary image morphology, Region properties, Region adjacency graphs,

Module 2 : Feature detection and matching: Points and patches, SIFT, Edges-Edge detection and linking, Lines-Hough transforms. Color and Shading: Color bases, Color histograms, Color segmentation, Shading. Texture: Texture, Texels and Statistics, Texel based Texture Descriptions, Quantitative Texture Measures, Texture Segmentation.

Module 3 : Content based image retrieval: Image distance measures: Colorsimilarity,Texture similarity, Shape similarity, Database organization. Motion from 2D image sequences: Computing Motion Vectors, Computing paths of moving points, Detecting significant changes in video.

Module 4 : Matching in 2D: Registration of 2D data, Representation of points, Affine mapping functions, 2D object recognition via Affine Mapping: Local Feature Focus method, Pose clustering, Geometric hashing, 2D object recognition via Relational Matching.

Module 5 : Perceiving 3D from 2D images: Labeling of line drawings from blocks world, 3D cues available in 2D images, Perspective imaging model, Depth perception from Stereo- Establishing correspondences.

Module 6 :3D sensing and Object pose Computation: 3D Affine transformations, Camera Model, Affine calibration matrix, Improved Camera calibration method, Pose estimation, 3D object reconstruction.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

- Assignments
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

- Linda G. Shapiro, George C. Stockman, “Computer Vision”, Prentice Hall, 1st Ed., 2001.
- Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer, 1st Ed., 2010.
- David A. Forsyth, Jean Ponce, “Computer Vision: A Modern Approach”, 2nd Ed., 2011.
- Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 1st Ed., 2012.
- Ramesh Jain, RangacharKasturi, Brian G. Schunck, “Machine Vision”, McGraw-Hill, 1st Ed., 1995
- Ranjay Krishna “Computer Vision :Foundatons and Applications “Stanford University

SEMESTER II	CSM- CC -624	Credits:3

COMPUTER VISION LABORATORY

	COURSE OUTCOMES
CO1	Implement basic data compression algorithms including Huffman Coding and adaptive huffman coding
CO2	Implement dictionary based data compression algorithms including JPEG.
CO3	Implement a mini project in image compression domain.
CO4	Implement the programs for Testing Uniquely Decodable Codes and check whether the code word is prefix code or not
CO5	Implement image compression using JPEG and LBG
CO6	Implement the programs for Texture classification
CO7	Implement Object detection using computer vision algorithms

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO/PO	CL	KC
CO1	Implement basic data compression algorithms including Huffman Coding, Golumb Coding	PO4 PO5	A	C,P
CO2	Implement advanced data compression algorithms including JPEG, .	PO4 PO5	A	P
CO3	Implement a mini project in image compression domain.	PO4 PO5	A	P
CO4	Implement the programs for Testing Uniquely Decodable Codes and check whether the code word is prefix code or not	PO4 PO5	A	P
CO5	Analyse the JPEG compression algorithm	PO4 PO5	An	C,P
CO6	Implement LBG algorithm	PO5 PO4	A	P

COURSE CONTENT

Following experiments, related to Data Compression and Computer Vision need to be implemented:

Data Compression

- Entropy, Testing Uniquely Decodable Codes
- Huffman algorithm, Adaptive Huffman algorithm
- LZ77 , LZ78, LZW
- Image compression using LBG, JPEG and Vector Quantization

Computer Vision

- Connected Component Labelling
- Morphological Operations
- Region based Segmentation
- Texture Classification
- Object detection
- Object Tracking
- Stereo imaging

Students should undertake a research-oriented mini project to get an exposure to the recent research developments in the domain of Image -Video processing or Computer Vision. A detailed project report should be submitted and its evaluation should be conducted at the end of the semester.

SEMESTER II	CSM-DE-625(i)	Credits: 4

ROBOTICS AND INTELLIGENT SYSTEM DESIGN

	COURSE OUTCOMES
CO1	Demonstrate the skillset to program and control a robotics system
CO2	Explain the management and analysis of robotics systems
CO3	Illustrate the working of a robot understanding the concepts of electronics, programming and robotics
CO4	Acquire basic Knowledge on Robots
CO5	Ability to process end effectors and robotic controls.
CO6	Analyze Robot Transformations and Sensors
CO7	Able to understand Robot cell design and applications

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Demonstrate the skillset to program and control a robotics system	PSO1	A	P
CO2	Explain the management and analysis of robotics systems	PSO2	U	C
CO3	Illustrate the working of a robot understanding the concepts of electronics, programming and robotics	PSO3	A	P
CO4	Acquire basic Knowledge on Robots	PSO1	U	C
CO5	Ability to process end effectors and robotic controls.	PSO7	A	P
CO6	Analyze Robot Transformations and Sensors	PSO2	An	P
CO7	Able to understand Robot cell design and applications	PSO2, PSO8	A	P

COURSE CONTENTS

Module 1 : Introduction - What is robotics? - Robotics and AI - Embedded Systems -Agent-Task-Environment model - Embodied Systems - Synthetic approaches to science

Module 2 : Mobile Robots, Position, and Orientation -Translational and Dynamics - lying and Swimming Robots - Articulated Robots - Transformations, Path Planning, and Trajectories

Module 3 :Sensors and signal processing- Common sensors and their properties- 1D signal processing-VisionPlanning approaches to robot control- STRIPS and SHAKEY - Robot manipulator kinematicsLimitations of planning approaches

Module 4 :Control Theory - Feedback, feedforward and open loop control- Linear first order lag processesLimitations of control theory -Probability Based Approaches -Markov Decision Processes (MDPs) Navigation

Module 5 :Behaviour-Based Control -The subsumption architecture- Hybrid architectures Formalising behaviour based control (SMDPs)- Adaptive approaches to robot control - Reinforcement learning for control

Module 6 :Model Based learning approaches to control -Learning maps - Evolutionary approaches - Parameter Estimation and Adaptive Control - Task Planning and Multi-Agent Systems

LEARNING RESOURCES

References

- Albus, J. I., and Meystel, A. M., *Engineering of Mind*, J. Wiley & Sons, 2001.
- C. Asfahl, *Robots and Manufacturing Automation*, J. Wiley & Sons, 1992.
- D. Auslander, J. Ridgely, and J. Ringgenberg, *Control Software for Mechanical Systems*, Prentice-Hall, 2002.
- G. Bekey, *Autonomous Robots*, MIT Press, 2005.
- H. Asada and J.-J. Slotine, *Robot Analysis and Control*, J. Wiley & Sons, 1986.
- H. Choset, *Principles of Robot Motion*, MIT Press, 2005.
- M. Brady, J. Hollerbach, T. Johnson, T. Lozano-Perez, and M. Mason, *Robot Motion: Planning and Control*, MIT Press, 1984.
- P. Antsaklis and K. Passino, *An Introduction to Intelligent and Autonomous Control*, Kluwer, 1993.
- R. Arkin, *Behavior-Based Robotics*, Bradford, 1998.

Online sources
http://www.stengel.mycpanel.princeton.edu/MAE345Lectures.html

SEMESTER II	CSM-DE-625(ii)	Credits:4

BIOMEDICAL IMAGE PROCESSING

	COURSE OUTCOME
CO1	Explain the use of the biological signals in diagnosis, patient monitoring and physiological investigation.
CO2	Describe the physical basis and engineering principles underlying common approaches in acquiring 2D and 3D images for biomedical applications, including x-ray imaging, tomographic techniques.
CO3	Analyse the performance used to automatically process and analyze these images, including different image representations, image enhancement, restoration, edge detection, automatic image segmentation and registration.
CO4	Explain the biomedical applications including Image Guided Surgery, Image Guided Therapy, Computer Aided Diagnosis/Diagnostic Support Systems.
CO5	Analyze the various methods of face recognition system.
CO6	Explain the Iris recognition methods
CO7	Summarise the different steps in Fingerprint recognition
CO8	Design and implement an application based on image processing and some pattern recognition techniques

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Explain the use of the biological signals in diagnosis, patient monitoring and physiological investigation.	PSO2	U	C
CO2	Describe the physical basis and engineering principles underlying common approaches in acquiring 2D and 3D images for biomedical applications, including x-ray imaging, tomographic techniques.	PSO2	U,An	P
CO3	Analyse the performance used to automatically process and analyze these images, including different image representations, image enhancement, restoration, edge detection, automatic image segmentation and registration.	PSO3	An	P
CO4	Explain the biomedical applications including Image Guided Surgery, Image Guided Therapy, Computer Aided Diagnosis/Diagnostic Support Systems.	PSO2	U	C
CO5	Analyze the various methods of face recognition system.	PSO4	U,An	C,P
CO6	Explain the Iris recognition methods	PSO3	U	C
CO7	Summarise the different steps in Fingerprint recognition	PSO4	U	P
CO8	Design and implement an application based on image processing and some pattern recognition techniques	PSO1 PSO5 PSO6	C	P

		PSO7		

COURSE CONTENT

Module 1 : Medical Image Processing: Introduction to medical imaging, brief history, importance, applications, trends, challenges; Medical Image Formation Principles: X-Ray and Computed Tomography(CT) imaging , Basic principles of CT, 2D Image reconstructionFourier space and filtered backprojection methods, Iterative reconstruction.

Module 2 : Imaging Modalities: Magnetic Resonance Imaging (MRI) Mathematics of MR, spin physics, NMR spectroscopy, imaging principles, Nuclear Imaging- positron emission tomography (PET) , single photon emission Tomography (SPECT)

Module 3 : Ultrasound Imaging , Overview, Generation and Detection of Ultrasound Waves, Physical and Physiological Principles of Ultrasound, Fundamental Ultrasound Concepts Wave Equation, Attenuation, Reflection, Ultrasound Imaging Modalities, Applications of Ultrasound Imaging, Microscope, The simple Microscope- principles, The compound Microscope, Optics, Image Formation.

Module 4 : Edge Detection and Segmentation of Images: Edge Detection-Sobel Edge detection, Laplacian of Gaussian edge Detection, Canny Edge Detection. Image Segmentation: Region Segmentation using Luminance Thresholding, Region Growing, Quad-Trees.

Module 5 : Analysis of Shape: Representation of shapes and contours-Signatures of contours, chain coding, segmentation of contours, Thinning and skeletenoization, Shape Factors- Compactness, moments, chord length statistics, Fourier descriptors, Fractional concavity, Analysis of spicularity, Application: Shape Analysis of Calcifications.

Module 6 : Texture in Biomedical Images : Models for the Generation of Texture: Random texture, Ordered texture , Oriented texture , Statistical Analysis of Texture: GLCM measures of texture, Laws_ Measures of Texture Energy.

ACTIVITIES, LEARNING RESOURCES & ASSESSMENT

Suggested Class Room Activities:

- Assignments
- Quiz
- Demonstration of simple experiments

LEARNING RESOURCES

References

- Bankman I.N. “Hand book of Medical Imaging-Processing and Analysis” , Academic Press
- Bovik A.I. “Handbook of Image and Video processing”, Academic Press.
- Jiri Jan, “Medical Image Processing, Reconstruction and Restoration- Concepts and
- KayyanNaarian, Robert Splinter, “Biomedical Signal and Image Processing” CRC Tayler & Francis,2012
- L. Landini, V. Positano, M.L. Santarelli, “Advanced Image Processing in Magnetic Methods”, CRC Tayler & Francis, 2006.
- Paul Suetens, “Fundamentals of Medical Imaging”, Cambridge University Press, Second Edition
- Rangaraj M. Rangayyan, “Biomedical Image Analysis”, CRC Tayler & Francis, 2004 Resonance Imaging”, CRC Tayler & Francis, 2005.

Online sources

https://www.britannica.com/technology/microscope/Stereoscopic-microscopes

SEMESTER II	CSM-DE-625(iii)	Credits:4

VISUAL CRYPTOGRAPHY

	COURSE OUTCOME
CO1	Explain the network security problems and cryptographic techniques.
CO2	Identify the need and importance of visual cryptography.
CO3	Demonstrate steganography and digital watermarking.
CO4	Demonstrate basic visual cryptographic models using halftone techniques.
CO5	Discuss the procedures for constructing visual secret shares.
CO6	Discuss about visual cryptography and share generation using color images.
CO7	Compare Basic Visual Secret Sharing schemes (Naor and Shamir's, Wu and Chen's scheme, Wu and Chang's scheme, etc.)
CO8	Compare Multiple secret sharing schemes in Visual Cryptography (Shyuet.al's scheme and Fenget.al's scheme).
CO9	Design ideas on visual cryptography and secret sharing methods.

TAGGING COURSE OUTCOMES

No.	Course Outcome	PSO	CL	KC
CO1	Explain the network security problems and cryptographic techniques.	PSO8	U	C
CO2	Identify the need and importance of visual cryptography.	PSO8	U	C
CO3	Illustrate steganography and digital watermarking algorithms.	PSO9	A	C,P
CO4	Demonstrate basic visual cryptographic models using halftone techniques.	PSO9	A	C,P
CO5	Discuss the procedures for constructing visual secret shares.	PSO9	U	C
CO6	Discuss about visual cryptography and share generation using color images.	PSO9	U	P
CO7	Compare Basic Visual Secret Sharing schemes (Naor and Shamir's, Wu and Chen's scheme, Wu and Chang's scheme, etc.)	PSO9	An	C,P
CO8	Compare Multiple secret sharing schemes in Visual Cryptography(Shyuet.al's scheme and Fenget.al's scheme).	PSO9	E	C,P
CO9	Design ideas on visual cryptography and secret sharing methods.	PSO3	C	M

COURSE CONTENTS

Module 1 :Basics of cryptography - Images for secure communication - Steganography: introduction, LSB Steganography - Digital Watermarking: Reversible Data Hiding technique, significant share generation.

Module 2 : Visual cryptography: introduction, history, visual cryptography Vs traditional cryptography, common issues in Visual Cryptography - Visual Secret Sharing scheme: Construction of Visual Secret Shares, Halftone VSS Construction Using Error Diffusion, Share structure. - Distribution of SIP and ABP: Generation of Halftone shares via Error Diffusion.

Module 3 : Schemes for general model - Naor and Shamir's Basic Visual Secret Sharing Scheme - (n, n) threshold schemes - (k, n) threshold schemes, Moiré Cryptography scheme, Size-adjustable visual secret sharing schemes.

Module 4 : Visual Cryptography for Color Images - Color Superposition and Darkening Problem - Formal Models for Colored VCS - Models for B&W VC and Color VC - Visual Cryptography Schemes for SC model.

Module 5 : Visual Cryptography Schemes for ND model - General schemes for Colored VC - (2, 2) threshold schemes - (t, n) threshold AS models. - Probabilistic Visual Cryptography Schemes: Probabilistic Schemes with No Pixel Expansion, Probabilistic Schemes with Pixel Expansion.

Module 6 : Visual Cryptography for Multiple Secrets- Introduction - Visual Two-Secret Sharing Schemes: Wu and Chen's scheme, Wu and Chang's scheme - Visual Multiple Secret Sharing Schemes: Shyu et al.'s scheme, Feng et al.'s scheme.

LEARNING RESOURCES

REFERENCES

- BorkoFurht, EdinMuharemagic and Daniel Socek, Multimedia Encryption and Watermarking, Springer, 2005 , 978-0-387-24425-9.
- Jen- Shyang Pan, Hsiang- Cheh Huang and Lakhi C. Jain, Intelligent Watermarking Techniques, World Scientific., 2004, 978-981-238-757-8 (hardcover).
- Josef Pieprzyk, Thomas hardjino and Jennifer Sebberry, Fundamentals of computer security, Springer International Edition 2003, 978-3-540-43101-5.
- Naor, Moni, and Adi Shamir. "Visual cryptography." In Workshop on the Theory and Application of of Cryptographic Techniques, pp. 1-12. Springer Berlin Heidelberg, 1994.
- Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson Education, Fourth Edition, 978-0133356724, 2017.
- Shen Ying," Visual Cryptography based Multiparty Copyright Protect Scheme", 978-1-4244-5848-6/10/ ©2010 IEEE.
- Shruti M. Rakhunde, Archana A. Nikose," New Approach for Reversible Data Hiding Using Visual Cryptography", 2014 Sixth International Conference on Computational Intelligence and Communication Networks.
- StelvioCimato, "Visual Cryptography and Secret Image Sharing", CRC Press 2017, 9781138076044.

- T. Hofmeister, M. Krause, and H.U.Simon. Contrast-optimal k out of n secret sharing schemes in visual cryptography. In COCCON '97, Lecture Notes in Computer Science, volume 1276, pages 176–185, Berlin, 1997. Springer.
- Zhi Zhou, Member,Gonzalo R. Arce, Giovanni Di Crescenzo, "Halftone Visual Cryptography", IEEE Transactions On Image Processing, Vol. 15, No. 8, August 2006.

SEMESTER II	CSM-DE-625(iv)	Credits:4

NATURE INSPIRED COMPUTING AND OPTIMIZATION

	COURSE OUTCOMES
CO1	Algorithms that can be used for autonomous design and adaptation of intelligent systems.
CO2	Insight in biologically inspired as well as traditional machine learning methods for search, optimization and classification.
CO3	Analyse the benefits and drawbacks of the nature inspired computing techniques
CO4	Apply bioinspired algorithms for solving real life problems
CO5	Illustrate the working of Ant Colony Algorithms
CO6	Compare firefly algorithm with Cuckoo search algorithm

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Algorithms that can be used for autonomous design and adaptation of intelligent systems.	PSO1	C	P
CO2	Insight in biologically inspired as well as traditional machine learning methods for search, optimization and classification.	PSO2	U	C
CO3	Analyse the benefits and drawbacks of the nature inspired computing techniques	PSO2	An	P
CO4	Apply bioinspired algorithms for solving real life problems	PSO7	A	P
CO5	Illustrate the working of Ant Colony Algorithms	PSO8	A	P
CO6	Compare firefly algorithm with Cuckoo search algorithm	PSO3, PSO9	An	P

COURSE CONTENT

Module 1 : 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 2 : Genetic algorithms - Mathematical foundation, Genetic problem solving, cross over and mutation. genetic algorithms and Markov process, applications of genetic algorithms

Module 3 : Ant Colony Algorithms - Ant colony basics, hybrid ant system, ACO in combinatorial optimisation, variations of ACO, case studies. Particle Swam algorithms - particles moves, particle swarm optimisation, variable length PSO, applications of PSO, case studies.

Module 4 :
Artificial Bee Colony algorithms - ABC basics, ABC in optimisation, Multi-dimensional bee colony algorithms, applications of bee algorithms, Selected nature inspired techniques - Hill climbing, simulated annealing, Gaussian adaptation, Cuckoo search, Fire fly algorithm, SDA algorithm, bat algorithm, case studies.

Module 5 : 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 6 : 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.

LEARNING RESOURCES

REFERENCES

- Albert Y.Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006
- Floreano, D. and C. Mattiussi -"Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT 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

SEMESTER II	CSM-DE-625(v)	Credits:4

REINFORCEMENT LEARNING TECHNIQUES

	COURSE OUTCOMES
CO1	Describe the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning
CO2	Exemplify an application problem (e.g. from computer vision, robotics, etc), decide if it should be formulated as a RL problem
CO3	Implement in code common RL algorithms
CO4	Explain the multiple criteria for analyzing RL algorithms and evaluate algorithms on these metrics
CO5	Illustrate the working of policy gradients in Reinforcement Learning
CO6	Identify the significance of importance sampling in Monte Carlo Methods

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Describe the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning	PSO1	K	C
CO2	Exemplify an application problem (e.g. from computer vision, robotics, etc), decide if it should be formulated as a RL problem	PSO3	A	P
CO3	Implement in code common RL algorithms	PSO9	A	P
CO4	Explain the multiple criteria for analyzing RL algorithms and evaluate algorithms on these metrics	PSO7	U	C
CO5	Illustrate the working of policy gradients in Reinforcement Learning	PSO4	A	P
CO6	Identify the significance of importance sampling in Monte Carlo Methods	PSO4	K	C

COURSE CONTENT

Module 1 : Origin and history of Reinforcement Learning research. : Reinforcement learning framework- Its connections with other related fields and with different branches of machine learning. Applications of Reinforcement learning.

Module 2 : Brush up of Probability concepts - Axioms of probability, concepts of random variables, PMF, PDFs, CDFs, Expectation. Concepts of joint and multiple random variables, joint, conditional and marginal distributions. Correlation and independence.

Module 3 : Markov Decision Process -Introduction to RL terminology, Markov property, Markov chains, Markov reward process (MRP). Introduction to Markov decision process (MDP), state and action value functions, Bellman expectation equations, optimality of value functions and policies, Bellman optimality equations

Module 4 : Overiew of dynamic programing for MDP, definition and formulation of planning in MDPs, principle of optimality, iterative policy evaluation, policy iteration, value iteration,

Module 5 : Monte Carlo Methods for Model Free Prediction and Control-Overiew of Monte Carlo methods for model free RL, First visit and every visit Monte Carlo, Monte Carlo control, On policy and off policy learning, Importance sampling.

Module 6 : Policy Gradients -Getting started with policy gradient methods, Log-derivative trick, Naive REINFORCE algorithm, bias and variance in Reinforcement Learning, Reducing variance in policy gradient estimates, baselines, advantage function, actor-critic methods.

LEARNING RESOURCES

References

- "Reinforcement Learning: An Introduction", Richard S. Sutton and Andrew G. Barto, 2nd Edition
- "Probability, Statistics, and Random Processes for Electrical Engineering", 3rd Edition, Alberto Leon-Garcia
- MLAPP "Machine Learning: A Probabilistic Perspective", Kevin P. Murphy

SEMESTER II	CSM-GC-602	Credits:2

ARTIFICIAL INTELLIGENCE AND APPLICATIONS

	COURSE OUTCOMES
CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.
CO2	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, Natural language Processing - machine learning models.
CO3	Demonstrate an ability to share in discussions applications of AI, its current scope and limitations
CO4	Apply basic principles of AI in solving daily life

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations.	PSO1	A	P
CO2	Demonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, Natural language Processing - machine learning models.	PSO2	A	P
CO3	Demonstrate an ability to share in discussions applications of AI, its current scope and limitations	PSO5	A	P
CO4	Apply basic principles of AI in solving daily life	PSO4, PSO7	A	P

COURSE CONTENT

Module 1 : Introduction to Artificial Intelligence- History of AI- Advantages and Disadvantages of AI- Applications- AI domains

Module 2 : Search and Control Strategies- State- Space representation- Problem Solving - Heuristic Techniques – Hill Climbing – Simulated Annealing – Generate and Test, Problem reduction- Constraint Satisfaction- Means End Analysis

Module 3 : Machine Learning- Supervised and Unsupervised Algorithms- Neural Networks- Classification and Predictions model – Applications

Module 4 : Natural Language Processing - Natural Language Processing Tasks - NLP Applications- Recommender System - Sentimental Analysis

Module 5 : Introduction to Game Theory- Two player game - Mini- Max Procedure- Alpha Beta Cut off .

Module 6 :AI in real life , Expert system - Expert system development- Modern expert systems.

LEARNING RESOURCES

References

- Artifcial Intelligence: A Modern Approach Third Edition Stuart Russell and Peter Norvig, 2010. Pearson Education, Inc. ISBN: 978-0-13-604259-4
- Artificial Intelligence, Dan W Patterson, Prentice Hall of India (1999)
- Artificial Intelligence, Nils J.Nilsson, ELSEVIER.
- E.Rich and K.Knight, Artificial Intelligence, - TMH

Online Sources
https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_overview.htm

SEMESTER III	CSM-CC-631	Credits:4

RESEARCH METHODOLOGY

	COURSE OUTCOMES
CO1	Demonstrate the capability to prepare M. Tech dissertation with a research bias.
CO2	Formulate a viable research problems.
CO3	Critically Analyse the research articles and reports.
CO4	Illustrate the categories of research methodologies with examples.
CO5	Develop the skill to write a technical paper based on research findings.
CO6	Analyze the benefits and drawbacks of
CO7	Illustrate the basic outline of research process with an example.
CO8	Critically analyze and prepare a literature review.
CO9	Develop professional ethics and code of ethics in research. .
CO10	Develop a skill to prepare and execute a research project.
CO11	Prepare technical report and research papers
CO12	Assess the research performance using the metric including impact factor, H-index, i-index

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Demonstrate the capability to prepare M. Tech dissertation with a research bias.	PSO1	A	C,P
CO2	Formulate a viable research problems.	PSO1	A	C
CO3	Critically Analyse the research articles and reports.	PSO5, PO8	An	C
CO4	Illustrate the categories of research methodologies with examples.	PO2	A	P
CO5	Develop the skill to write a technical paper based on research findings.	PO8	A	P
CO6	Analyze the benefits and drawbacks of	PO1	E	C, P
CO7	Illustrate the basic outline of research process with an example.	PO6	C	M
CO8	Critically analyze and prepare a literature review.	PSO1	An	C,P
CO9	Develop professional ethics and code of ethics in research. .	PO8	C	C,P
CO10	Develop a skill to prepare and execute a research project.	PO4, PO6	A	C,P
CO11	Prepare technical report and research papers	PO5, PO8	A	C,P
CO12	Assess the research performance using the metric including impact factor, H-index, i-index	PO8	A,E	C,P

COURSE CONTENT

Module 1 : Introduction to Research Methodology: Motivation towards research. Types of research: Quantitative research approach and Qualitative research approach. Steps in research process - Problem definition, setting out a plan, literature review, analysis and hypothesis formulation, presentation and interpretation, decision making. Criteria of good research.

Module 2 : Professional ethics in research - Ethical issues-ethical committees. Copy right - royalty - Intellectual property rights and patent law - Copy left- Open access-reproduction of published material - Plagiarism - Citation and acknowledgement. Creative commons license. Impact factor, H-index, Identifying major conferences and important journals in the concerned area. Collection of at least 4 papers in the area.
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Module 3 : Research formulation and literature review - Problem definition and formulation, literature review, characteristics of a good research question, literature review process. Analyze the chosen papers and understand how the authors have undertaken literature review, identified the research gaps, arrived at their objectives, formulated their problem and developed a hypothesis.
Data Collection - Primary and secondary data primary and secondary data sources, data collection methods data processing, types of data processing, data processing stages classification of data.

Module 4 : Data analysis - Regression analysis, Correlation analysis, PCA, sampling. Analyse the chosen papers and study the methods of data collection used. - Data processing and analysis strategies used– Study the tools used for analysing the data.

Module 5 : Research design - Need for research design, Features of a good design, Types of research designs, induction and deduction. Hypothesis formulation and testing - Hypothesis, important terms, Types of research hypothesis, hypothesis testing, Z-test, t-test, f-test, making a decision, types of errors, ROC graphics.

Module 6 : Presentation of the Research Work - technical writing, structure and components, contents of a typical technical paper, business report, technical report, research report, general tips for writing report. Presentation of data- oral presentation. Identification of a simple research problem – Literature survey- research design- methodology –paper writing based on a hypothetical result.

REFERENCES

- C. R. Kothari – " Research Methodology", New Age International, 2004
- 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

SEMESTER III	CSM-SE-601	Credits:2

ENTREPRENEURIAL SKILLS AND SCIENTIFIC WRITING

	COURSE OUTCOMES (CO)
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	Analyse and Prepare research papers and literature review
CO5	**Assess the commercial viability of new technologies, business opportunities**

TAGGING COURSE OUTCOMES

	Course Outcomes (CO)	PSO/PO	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**	**PO1**	**A**	**P**
CO2	**Develop skillset to carry out scientific research in the field of entrepreneurship**	**PO2**	**C**	**P**
CO3	**Prepare scientific reports and communicate the results in journal/conferences**	**PO8**	**C**	**P,M**
CO4	Analyse and Prepare research papers and literature review	**P08, PO5**	An	P
CO5	**Assess the commercial viability of new technologies, business opportunities**	**PO1, PO7**	**E**	**P**

COURSE CONTENT

Module 1 : 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 2 : 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 3 : Introduction to Soft Skills- Communication Skills - Presentation Skills -Time Management Skills- Group Discussion & Interview Skills - Emotional Intelligence Skills –

Module 4 : Life Skills - Self awareness- Identifying one's strengths and weakness Planning & Goal setting- Leadership skills- Stress Management Skills

Module 5 : 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 6 : Google Scholar, Web of Science, Scopus, Impact Factor, h-Index, g- index, Copyrights andPatents, IPR Laws. Citation, Plagiarism, Creative commons licenses

Learning Resources

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

SEMESTER III	CSM-CC-632	Credits:10

DISSERTATION – PART – 1

	COURSE OUTCOMES
CO1	Identify a specific topic for dissertation in the area of Digital Image Processing.
CO2	Prepare Preliminary study on the topic and give a presentation on it.
CO3	Implement the initial phase of the work as the first part of the dissertation.
CO4	Present the progress of the research work based on the results and analysis.
CO5	Prepare and submit a well written report in the department.
CO6	Analyse and a thorough understanding of problem solving in a research project.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Identify a specific topic for dissertation in the area of Digital Image Processing.	PSO1	A	C
CO2	Prepare Preliminary study on the topic and give a presentation on it.	PO4	A, An	P
CO3	Implement the initial phase of the work as the first part of the dissertation.	PO5	A	P
CO4	Present the progress of the research work based on the results and analysis.	PO5	A	C
CO5	Prepare and submit a well written report in the department.	PO6	C, An	C,P
CO6	Analyse and a thorough understanding of problem solving in a research project.	PO6	An	C, P

COURSE CONTENT

The dissertation work shall be carried out in the department under the guidance of an internal guide. However any specific request from the student to work in a National Level Institute/ R&D company in the industry can also be considered with specific conditions.

SEMESTER IV	CSM-CC-641	Credits:16

DISSERTATION(PART-II)

	COURSE OUTCOMES
CO1	Investigate the related and recent works in the area of dissertation.
CO2	Apply critical thinking and design new strategies for the work
CO3	Implement and analyse the performance of the new method.
CO4	Propose a new algorithm in the area of study.
CO5	Prepare a dissertation on the work done in the prescribed format.
CO6	Presentation on the entire work done as part of the course.

TAGGING COURSE OUTCOMES

	Course Outcomes	PSO	CL	KC
CO1	Investigate the related and recent works in the area of dissertation.	PO4	A	P
CO2	Apply critical thinking and design new strategies for the work.	PO5	An	C
CO3	Implement and analyse the performance of the new method.	PSO3	A	C, P
CO4	Propose a new algorithm in the area of study.	PSO1 PSO2	C	M
CO5	Prepare a dissertation on the work done in the prescribed format.	PO6	An	C
CO6	Presentation on the entire work done as part of the course.	PO7	A, E	

COURSE CONTENT

The second phase of the dissertation work shall be carried out as the extension of the first work. At the end of the course, all the students should submit a dissertation with the details of the work done, findings and suggestions. There will be internal and external evaluations of the work. Student should have atleast one research publication (communicated / accepted) or presentation in International Conference / Seminar for the final submission of dissertation. The publication should be in reputed International Journals (UGC –CARE List) or International Conferences. The conference proceedings should be recognized by Department Council.