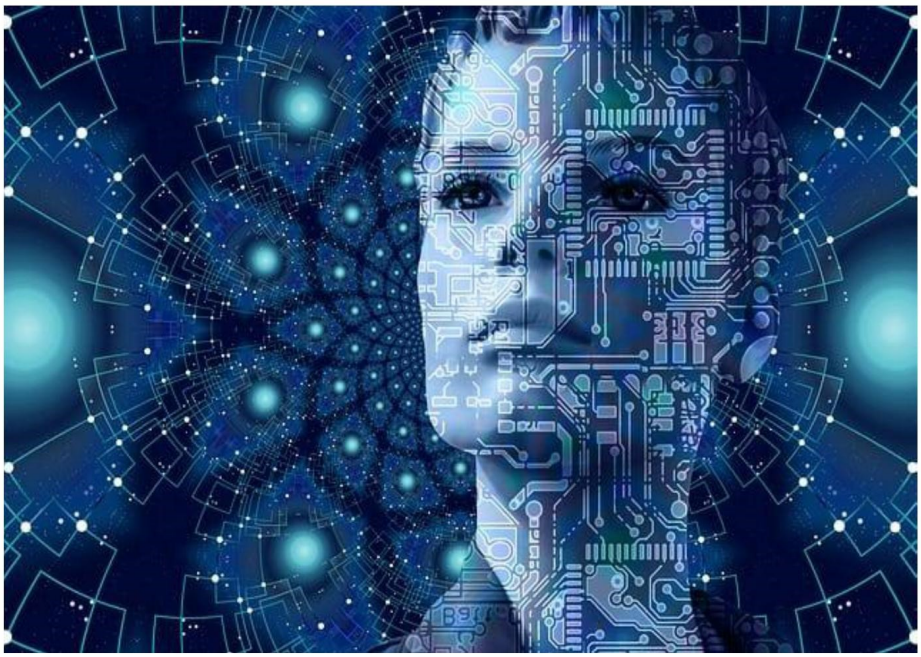
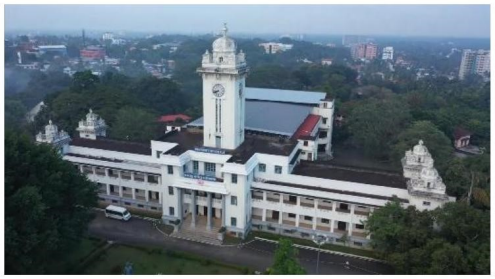
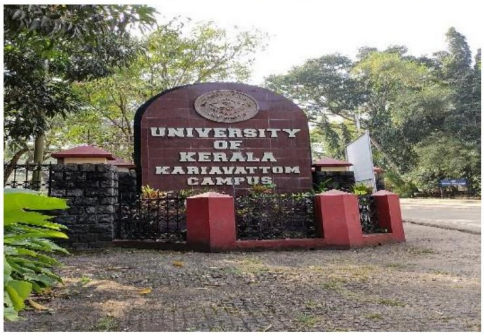
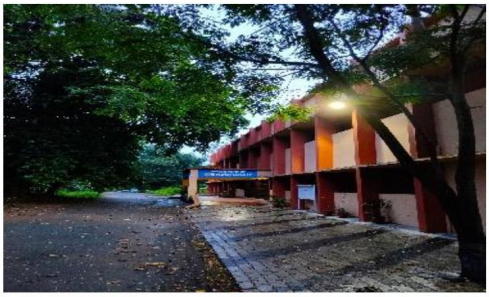
Learning Outcomes-based Curriculum Framework (LOCF) for

Post-Graduate Programme









M. Sc. Computer Science

Department of Computer Science
University of Kerala

www.keralauniversity.ac.in

Table of Contents

Preamble

The role of higher education is vital in securing gainful employment and providing further access to higher education comparable to the best available in world-class institutions elsewhere. Therefore, the improvement in the quality of higher education deserves to be given top-most priority to enable the young generation of students to acquire skills, 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 to improve and upgrade the academic resources and learning environments by raising the quality of teaching and standards of achievements in learning outcomes across all undergraduate programs in science, humanities, commerce, and professional streams of higher education.

One of the significant reforms in undergraduate education is introducing 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) implemented the LOCF in the country's Colleges and Universities. Accordingly, the University of Kerala has decided to implement the LOCF in all its departments under the auspices of the 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

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 the 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 Graduate Attributes of the 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 and differences. Do Not be prejudiced by gender, age, caste, religion, or nationality.
- Use education as a tool for the emancipation and empowerment of humanity.

1. About the Department of Computer Science

Department of Computer Science, University of Kerala, was established in 1985 under the School of Applied Science and Technology and conducted four Post Graduate programmes alongside with Ph D programme in different disciplines of Computer Science. The department offers an M Tech programme under the faculty of Engineering and Technology and three M Sc programmes under the Faculty of Applied Science and Technology. All the programmes are OBE mode and integrated with industry internships. The department gives at most importance to Research and Development besides regular teaching through knowledge dissemination globally. The department has a good track record of producing highly skilled professionals in Computer Science.

The thrust area of research focused on Image Processing, Pattern Recognition, Nature Inspired Computing, Cyber Security, Computer Vision, Machine Intelligence, High-Performance Computing, Data Mining, and Natural Language Processing. A good number of Ph Ds are awarded from this department in Computer Science, and Engineering. The department has achieved an h-index of 15 (Web of Science) with a consistent publication record. The fellows of the department received the highest impact factor, 13.751 (three times), and published their works in reputed journals. Achievement of an average impactor of 5.012 during the last five years. The alums are well-placed in National Institutes, Central/State Universities, R&D organisations and multi-national companies. Faculty and students received National and International recognition, including awards from Government organisations and best paper awards. The passed-out students are well placed in multi-national companies and other R&D Institutions.

2. About M Sc Computer Science

The curriculum of Computer Science gives an eye-opener into the theoretical concerns and their related disciplines. It also opens discussions on human-centric applications. For example, while designing a programme in Computer Science, formulate a theoretical blending scheme and create an entry point into its application domains. The performance of this programme allows the candidate to further domain expansions. Hence, while designing this programme, the curriculum should focus on theoretical and conceptual points in the subjects. This will help the students search for different Computer Science applied for domain job opportunity levels in the future. The application domains of Computer Science like Algorithms- Complexity and Optimization, Advanced Computer Networks, Database Systems with Bigdata, Software Engineering, Machine learning, Natural Language Processing, Smart Application Development etc., are some evolving areas that are useful for a job seeker. The growth and use of these domains are different from a job seeker's point of view. Today, Artificial Intelligence, Data

Science, Web Applications and IoT are tremendously evolved and fused in related subjects. Its practices are highly merged with real engineering applications. So, there are many scope for ready-to-serve professionals in this area of interest through focused curriculum-designed programmes.

The opportunity of M Sc programme in Computer Science is familiar to society, giving better domain applications available to the common people today. Some examples are modern digital applications in Industries, Finance, Banking, Agriculture, etc. The scope of this PG programme gives a building of industry-academy-ready professionals. University is responsible for marking and making curriculum design of such programmes. This is achieved by a joint venture of industry-academia during curriculum and syllabus design, through which the passed-out students are IT-ready, industry-ready, and society-ready. M Sc Computer Science is committed to:

- Impart rigorous training to generate knowledge through state-of-the-art concepts and technologies in Computer Science.
- Transform the programme offered department to impart Computer Science education and research.
- Analyse, design and implement solutions and adapt to changes in technology by self/ continuous learning.
- Engage in higher learning and contribute to technological innovations and Technology transfer.
- Work with professional ethics as an individual or team player to realise the project's goals or the organisation.
- Work with respect for societal values and environmental concerns in implementing engineering solutions.

3. General Information

3.1 Eligibility

Candidates shall be required to possess First class Bachelor's Degree in Computer Science/Computer Applications/Electronics/Any other degree in Science with Computer Science or Computer Applications as major components or an equivalent degree recognized by the University of Kerala or a degree recognised as equivalent thereto, and who have secured the following, shall be eligible for the admission:

a) CGPA of 2 or above on a 4-point scale or
b) 3.5 or above on a 7-point scale or
c) 5 or above on a 10-point scale or
d) 50% or above in the case of Bachelor Degrees, which award marks
e) Relaxation for candidates from SC/ST category shall be as follows:
f) CGPA of 1.8 or above on a 4-point scale
g) 3.15 or above on a 7-point scale
h) 4. 5 or above on a 10-point scale
i) 45% or above in the case of Bachelor Degrees, which award marks.

The CSS academic council shall be competent to recommend revisions to decide the equivalence of any other system that may come up in admissions. The percentile of marks shall be converted to a percentage and normalised according to the CGPA of the University of Kerala for admission procedures.

3.2 Programme Duration

M Sc Computer Science programme shall be a period of two academic years comprising four semesters; each academic year shall be organised into two semesters with a group of courses as given in the curriculum and scheme of examination. The postgraduate programmes shall be under a credit and semester system (CSS). The programme shall be offered with different courses, each with an assigned credit.

3.3 Expected Outcome

Programme Objectives

1. Comprehend fundamental concepts and hands-on knowledge of state-of-the-art Computer Application methodologies.
2. Design and Build Real-world Computer Application systems for complex planning, decision-making and learning, solving application-specific problems, and reasoning about them.
3. Conceive, Design and Develop Intelligent multi-modal multi-sensory Man-Machine interfaces.
4. Design, Develop and Deploy Computer Applications using structured and unstructured data (e.g., speech, text, images/videos).
5. Understand and Assess the reliability, dependability and trustworthiness of Computer Applications-based systems.
6. Design and develop Computer Applications for resource-constrained environments.
7. Adhere to evolving ethics and privacy laws across various domains and territories.
8. Plan, manage and execute technical projects in the field of Computer Applications.

Learning Outcome

1. Develop the skill set for R&D and industry-ready professionals to join the Information Technology field.
2. Prepare and motivate students to do research in Computer Science and interdisciplinary fields.
3. Demonstrate advanced skills in designing, developing and implementing software that communicates effectively.
4. Develop cutting-edge developments in computing technology and contemporary research for society.
5. Develop application skillset in algorithm design, optimisation, and improved performance in computing.
6. Develop advanced knowledge in Advanced Database Management Systems, Big data Systems, and Data Science techniques.

3.4 Evaluation

Candidates in each semester shall be evaluated by Continuous Assessment (CA) and End Semester Examinations (ESE). The maximum marks allotted for

continuous assessment and University examination for each subject are as prescribed by the scheme of study.

Continuous Assessment: An internal evaluation will be carried out during each semester's progress. The main purpose is to provide students with learning effectiveness and individual profoundness in their curriculum. The evaluation and award of CA marks differ for each course. Guidelines on conducting the continuous assessment of each course and comprehensive evaluation shall be approved by the Department Council and communicated effectively to the students.

End Semester Examinations: There will be University examinations at the end of the first academic year and the end of every semester onwards in courses as prescribed under the respective scheme of examinations. Every taught course shall be assessed through a written end-semester exam of a maximum of 3 hours' duration. As stated in the syllabus, the end-semester exams shall be summative and aimed at attesting to achieving course outcomes.

Letter Grades: Students' performance in individual courses shall be evaluated and assigned grades to indicate the achievement of objectives. The grading scale shall be the same as the national pattern recommended by the UGC. Each grade shall be indicated by a letter as in the table below:

Sl. No.	Weightage in Percentage	Grade Point (GP)	Letter Grade
1	90 to 100	10	**O** (Outstanding)
2	85 to less than 90	9	**A** + (Excellent)
3	80 to less than 85	8.5	**A** (Very Good)
4	70 to less than 80	8	**B**+ (Good)
5	60 to less than 70	7	**B** (Above Average)
6	55 to less than 60	6	**C** (Average)
7	50 to less than 55	5	**D** (Pass)
8	Less than 50	0	**F** (Fail)
9	Absent	0	**Ab** (Absent)
10	Course Incomplete	0	**CI** (Course Incomplete)

Each grade shall have a corresponding grade point which serves as a means of aggregating letter grades and is not marks or scores.

3.5 Induction Programme

There will be a three-week induction program for first-semester students. It is a unique three-week immersion Foundation Programme designed specifically for newly admitted students, which includes a wide range of activities, workshops, lectures and, seminars on social works, and much more. The programme is designed to mould students into well-rounded individuals, aware and sensitized to local and global conditions and foster their creativity, teach values and ethics, and help students to discover their passion. Foundation Programme also serves as a platform for the freshers to interact with their batch mates and seniors and start working as a team with them. The program is structured around the following five themes:

The programme is designed keeping in mind the following objectives:

- *Values and Ethics:* Focus on fostering a strong sense of ethical judgment and moral fortitude.
- *Creativity:* Provide channels to exhibit and develop individual creativity by expressing themselves through art, craft, music, singing, media, dramatics, and other creative activities.
- *Leadership, Communication and Teamwork*: Develop a teamwork and group communication culture.
- *Social Awareness:* Nurture a deeper understanding of the local and global world and our place in it as concerned citizens of the world.
- *Coding skills:* Students can develop programming skills to improve their values and standards.

4. Programme Structure

Every course of M Sc Computer Science Programmes shall be placed in the following categories.

Sl. No	Category	Code	Credits
1	Core Course (Theory)	CC	33
2	Core Course (Laboratory)	CC	9
3	Core Course (Case study)	CC	2
4	Core Course (Dissertation)	CC	18
5	Discipline Specific Electives	DE	12
6	Generic Course (offer to Students in other Department)	GC	2
7	Extra Departmental Electives	GC	4
Total Mandatory Credits			78
8	Skill Enhancement Electives	SE	10

Semester-wise credit distribution shall be as below:

Semester	1	2	3	4	Total
Credits	20	20	20	18	78

Programme Code: CCS

Core Course (CC): Course offered by a Department to the students in their Postgraduate programme, closely related to the area of specialisation. The assessment of the course will be per the regulations of the University for the Teaching and Learning Departments.

Laboratory Course (CC): The laboratory aims to develop and apply effective theory based on realistic practice; it is the primary way to train students properly in the rapidly advancing courses offered by the department. Each semester offers a laboratory course with at least 6 hours of weekly practicals. The laboratory has two levels of programming exercises- basic and advanced. The basic level gives an awareness of the course through programming exercises. At the advanced level, a mini project/case study/advanced programming exercises are given to understand

the application level of the course. Evaluation of Mini Project/Case Study/Advanced programming exercises and semester viva is performed by a panel of teachers in the department approved by the Department Council. Laboratory report submission is mandatory for each student and is to be submitted to the faculty in charge of the laboratory.

Skill Enhancement Course (SE): A course that provides value-based or skill-based knowledge should contain theory and laboratory/ hands-on/ training/ fieldwork. The main purpose of these courses is to provide students with life skills in the hands-on mode to increase their skill development and employability. The assessment of the course will be per the regulations of the University for the Teaching and Learning Departments.

Generic Course (GC): An elective course chosen from an unrelated discipline/subject to seek exposure beyond discipline/s. The Generic Course may also be interdisciplinary (to be offered collaboratively by more than one Department/discipline). The assessment of the course will be per the regulations of the University for the Teaching and Learning Departments.

Discipline-Specific Electives (DE): Courses offered under the main discipline/subject of study, primarily offered to the students of the same discipline each semester. The departments can modify such electives or add fresh electives from time to time based on the changing academic paradigms related to the course. The assessment of the course will be as per the regulations of the University for the Teaching and Learning Departments.

Extra Departmental Generic Course: An elective course chosen from an unrelated discipline/subject to seek exposure beyond discipline/s to be offered collaboratively by more than one Department/discipline.

Case Study: Each student is required to undertake the Case Study during the third semester under the guidance of a faculty member. The students are expected to select an emerging research area/industrial problem in Computer Science.

MOOC: Massive Open Online Courses (MOOCs) bring knowledge to students in selected disciplines through online platforms. Each student must compulsorily take a minimum of 30 hours' duration MOOC to complete Semester III successfully. The Department council will announce the source of MOOCs from time to time.

Dissertation: Dissertation (Project work) is intended to challenge students' intellectual and innovative abilities. It allows students to synthesise and apply the knowledge and analytical skills learned in the different disciplines. All the students must do a project on a problem with industry or research potential as part of this course. The project work can be done in any of the following - R&D institutions, MNCs - IT companies and departments. 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 evaluations of the work.

Industry Internship: During the fourth semester (it can be done during the vacation or semester break period), the students must complete the internship programme from the industry or R&D organisations. The students can identify industries and

undergo industry training or workshop. A minimum of one month of internship is compulsory to complete Semester IV successfully. Each student should submit an internship certificate along with a detailed study report. The Department council will select industry/ R&D organisations from the student's choice.

4.1 Programme Outcome (PO)

PO1	A Critical Thinker with a Research mind
PO2	A Communicator and Resilient Leader
PO3	A Receptive, Adaptive Person with an Inclusive mind
PO4	A Life-long Learner
PO5	A Creative and Global Professional
PO6	An Ethical and Socially Responsible Person

4.2 Programme-Specific Outcome (PSO)

PSO1	Students will be able to adapt the skills to implement effective solutions for need based problems by applying knowledge gained through different programming languages, tools and software covered in the curriculum of program.
PSO2	Pursue life-long learning in practice and contribution through socially relevant research.
PSO3	Proceed to the successful life with social concern, positive attitude and ethics.
PSO4	Demonstrate the ability provide solution for complex problems in making decisions based on big data and data science.
PSO5	Develop application skill set in algorithm design, optimization and improved performance in computing.
PSO6	Exposure to emerging trends and technologies in Computer Science to mould the students as industry ready professionals.
PSO7	Acquire concepts relating to the theory of computation and computational models including decidability and intractability.
PSO8	Apply software testing knowledge and engineering practices in real-time software project development using open-source programming environment or commercial environment to deliver quality product for the organization success.
PSO9	Explore research gaps, analyse and carry out research-oriented projects in the specialized/emerging areas and develop the skillset to work in an R&D institution.
PSO10	Implement basic algorithms and techniques of image and signal processing.
PSO11	Demonstrate technical competency to analyse, comprehend, design and develop solutions in the field of Natural Language Processing.
PSO12	Build expertise in advanced web technologies used in Software industry to develop interactive applications.

4.3 Mapping of PO to PSO

	PO1	PO2	PO3	PO4	PO5	PO6
PSO1	√	√		√		
PSO2				√		
PSO3			√			√
PSO4	√			√		
PSO5	√					
PSO6			√		√	
PSO7	√			√		
PSO8					√	
PSO9				√	√	
PSO10				√		
PSO11	√					
PSO12					√	

4.4 Scheme

Semester	Course Code	Name of the Course	Credits
I	**Core Courses (CC)**		
	CCS-CC-511	Mathematical Foundations in Computer Science	3
	CCS-CC-512	Algorithms- Complexity and Optimization	3
	CCS-CC-513	Web Technology	3
	CCS-CC-514	Principles of Computing	3
	CCS-CC-515	Advanced Computer Networks	3
	CCS-CC-516	Web Technology Laboratory	3
	Skill Enhancement Elective (SE)		
	CCS-SE-4B1	Entrepreneurship and Professional Development	2
	Generic Course (GC)		
	CCS-GC-4B1	Social Cyber Ethics	2
II	**Core Courses (CC)**		
	CCS-CC-521	Software Engineering for Industry	3
	CCS-CC-522	Database Systems for Big Data	3
	CCS-CC-523	Compiler Construction	3
	CCS-CC-524	Database Laboratory	3
	Discipline Specific Electives (DE)		
	CCS-DE-525(i)	Block Chain Technology	3
	CCS-DE-525(ii)	Internet of Everything	3
	CCS-DE-525(iii)	Cyber Security and Cyber Law	3
	CCS-DE-525(iv)	Soft Computing Techniques	3
	CCS-DE-525(v)	Cryptography and Network Security	3

	CCS-DE-526(i)	Computational Biology	3
	CCS-DE-526(ii)	Software Agents and Multiagent Systems	3
	CCS-DE-526(iii)	Machine Learning	3
	CCS-DE-526(iv)	Mobile Computing	3
	CCS-DE-526(v)	Social Network Analysis	3
	Skill Enhancement Elective (SE)		
	CCS-SE-4B2	IT Act and Constitution of India	2
III	**Core Courses (CC)**		
	CCS-CC-531	Analytics and Data Science	3
	CCS-CC-532	Smart Application Development	3
	CCS-CC-533	Natural Language Processing	3
	CCS-CC-534	Application Development Laboratory	3
	CCS-CC-535	Case Study	2
	Discipline Specific Electives (DE)		
	CCS-DE-536(i)	Human Computer Interaction	3
	CCS-DE-536(ii)	High Performance Computing	3
	CCS-DE-536(iii)	Optimization Techniques	3
	CCS-DE-536(iv)	Nature Inspired Computing	3
	CCS-DE-536(v)	Software Testing	3
	CCS-DE- 537(i)	Image Processing	3
	CCS-DE-537(ii)	Applied Machine Learning	3
	CCS-DE-537(iii)	Brain Computer Interface	3
	CCS-DE-537(iv)	Augmented Reality in MetaVerse	3
	CCS-DE-537(v)	Cloud Computing	3
	Skill Enhancement Electives (SE)		
	CCS-SE-4B3	Publication Ethics and Research Practices	2
	CCS-SE-4B4	MOOC	2
IV	**Core Courses (CC)**		
	CCS-CC-541	Dissertation and Viva-Voce	18
	Skill Enhancement Elective (SE)		
	CCS-SE-4B5	Industry Internship	2
I	XXX-GC-41X	Extra Departmental Elective – I	2
II	XXX-GC-43X	Extra Departmental Elective – II	2

5. Syllabus

Semester: 1	Course Code: CCS-CC-511	Credits: 3

MATHEMATICAL FOUNDATIONS IN COMPUTER SCIENCE

Preamble: This course is an introduction to key mathematical concepts relevant to Computer Science. The main focus of the course is on matrix methods, statistical models and features, real-world applications ranging from classification and clustering to denoising and recommender systems. Mathematical topics covered include linear equations, matrix rank, regression, singular value decomposition, and iterative optimization algorithms, probability and principles of linear programming. Through this course students will be able to understand the basic importance of applied mathematics in Computer Science and further research.

Prerequisite: Linear algebra, discrete mathematics and have exposure to numerical analysis.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Find the relationship between the vectors by the help of vector algebra	PO1	PSO1	U, Ap	C,P
CO2	Solve the linear algebra problems including linear equations, matrix calculus, and basic vector operations	PO3	PSO1, PSO4	U, Ap	C,P
CO3	Prioritize the components of a matrix with the help of Eigenvalues & eigenvectors	PO2	PSO6	An, Ap	C,P
CO4	State the basics Probability, statistics and its applications	PO3	PSO4	Ap	P
CO5	Articulate the concept and derivation of gradients	PO5	PSO4	Ap	C, P
CO6	Describe the role of local-global maxima & minima Gradient algorithms Optimization	PO4	PSO6	An	C, P
CO7	Illustrate different decomposition methods used in linear system of equations	PO1	PSO4, PSO6	Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

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, Linear Equations, Linear Dependence and Independence, Bases and Dimension.

MODULE II

Matrices: Determinants, Hadamard product, linear transformation, Types of matrices, identity matrix, invertible matrix, rank, Covariance matrix, Eigen Value, Eigen Vector, Dimensionality Reduction with Principal Component Analysis, Diagonalization, Singular Value Decomposition.

MODULE III

Probability: Construction of a probability space, Discrete and Continuous Probabilities, Sum Rule, Product Rule , Conditional Probability, Bayes theorem, Probability distribution- Binomial, Poisson, Normal, Uniform, Exponential, Gaussian.

MODULE IV

Numeric Analysis: Introduction, solution of equations by iteration, numeric linear algebra-Linear Systems: Gauss Elimination, LU factorization, matrix inversion, Least squares method. Parameter estimations - hypothesis testing and inferences, Correlation, Regression.

MODULE V

Continuous Optimization: Optimization using Gradient Descent, Necessary and sufficient conditions for optimum of unconstrained functions-Numerical methods for unconstrained functions - One-dimensional search - Gradient-free search with fixed step size.

MODULE VI

Linear programming problems: Formulation of the problem, solution by graphical method & simplex algorithm, degeneracy in LPP. Duality in LPP, revised simplex method.

LEARNING RESOURCES

References

- Axler, Sheldon "Linear Algebra Done Right" Springer, 2014.
- Deisenroth, Marc Peter, et al.,"Mathematics for Machine Learning", Cambridge University Press, 2020.
- Hardle, Wolfgang Karl, and Leopold Simar "Applied Multivariate StatisticalAnalysis" Springer, 2015.
- Morin, David. Probability, "Probability: For the Enthusiastic Beginner", CreateSpace Independent Publishing Platform, 2016.

Online Resources

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

Semester: 1	Course Code: CCS-CC-512	Credits: 3

ALGORITHMS- COMPLEXITY AND OPTIMIZATION

Preamble: Learn to analyze iterative and recursive algorithms for the use of resources (time memory, parallelism, bandwidth, randomness, etc.). Develop fluency with big-O notation and learn to choose and implement efficient algorithms for numeric, combinatorial, and geometric problems. Learn fundamental concepts and terminology in computability and computational complexity.

Prerequisite: Data Structures and Linear algebra.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Analyze the performance of algorithms	PO1	PSO3	U	C, P
CO2	Explain the concepts including Recurrences, Dynamic programming and Branch and bound methods	PO3	PSO6	An	C, P
CO3	Knowledge in greedy algorithms with MST	PO2	PSO3, PSO4	U, Ap	C ,P
CO4	Prioritize the knowledge of advanced search and heuristic search techniques	PO3	PSO7	U, An	P, M
CO5	Discuss about P and NP- class problems	PO2	PSO5	U	P, C
CO6	Articulate optimization procedures handled in Computer Science	PO5	PSO3	An	P
CO7	Apply the algorithm design skill in problem solving	PO2	PSO1	Ap	C, P
CO8	Describe about String Matching and algorithms related to Network Flows	PO4	PSO12	Ap, E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Concepts in algorithm analysis: Efficiency of algorithms, average and worst – case analysis, Asymptotic notation, time and space complexity. Analysis of Recursive Algorithms: Recurrence Equations, Solving Recurrence Equations – Iteration Method, Recursion Tree Method, Substitution method and Master's Theorem.

MODULE II

Greedy Strategy: Minimum Cost Spanning Tree Computation- Kruskal's Algorithms - Analysis, Single Source Shortest Path Algorithm - Dijkstra's Algorithm-analysis. Graph Search Techniques - Depth First Search, Breadth First Search, Iterative Deepening search, Best first search, Beam search, Branch and Bound search, A* algorithm.

MODULE III

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

MODULE IV

Tractable and Intractable Problems: Complexity Classes – P, NP, NP- Hard and NP-Complete Classes- NP Completeness proof of Clique Problem and Vertex Cover Problem- Approximation algorithms- Bin Packing, Graph Colouring.

MODULE V

Optimization: Classification of optimization problems, Optimization techniques – classical and advanced techniques, Optimum design concepts: Definition of Global and Local optima.

MODULE VI

Applications: Missionaries and Cannibals problem, String matching, vertex-cover problem, traveling-salesman problem, robotic motion planning, crypt arithmetic puzzles, Network flow analysis.

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", 4ed. Prentice Hall of India, New Delhi, 2020.
- Vinod Chandra S S, Anand H S, "Machine Learning: A Practitioners Approach", Prentice Hall of India, New Delhi, 2020.
- Thomas H. Corman, Charles E. Leiserson and Ronald L. Rivest, "Introduction to Algorithms", 3ed., Prentice Hall of India, New Delhi, 2009.
- Vinod Chandra S S, Anand H S, "Artificial Intelligence: Principles and Applications", 2ed., Prentice Hall of India, New Delhi, 2020

Semester: 1	Course Code: CCS-CC-513	Credits: 3

WEB TECHNOLOGY

Preamble: Web development is the work involved in developing a web site for the Internet or an intranet. Web development can range from developing a simple single static page of plain text to complex web-based internet applications, electronic businesses, and social network services. In this course, the student will learn about basic of internet, to design websites which normally describes the design process relating to the front-end design of a website including Laravel, ReactJS, NodeJS, AngularJS and to launch them on webserver space.

Prerequisite: Knowledge in HTML, CSS, JavaScript and PHP.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarize and develop applications using PHP framework and Laravel	PO1	PSO1, PSO6, PSO12	U, Ap	P, C
CO2	To Understand different components in XML	PO3	PSO12	U	C
CO3	Familiarize user interactions using JavaScript and to study the different information interchange formats like XML and JSON	PO4	PSO6, PSO12	U, Ap	P, C
CO4	Impart knowledge about ReactJS and Nodejs	PO3	PSO6, PSO12	U, Ap	P, C
CO5	Develop and implement Dynamic Web Pages using AngularJS	PO5	PSO6, PSO12	U, Ap	P, C
CO6	Develop Web applications using Django	PO4	PSO6, PSO12	U, Ap	P, C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

XML: The Syntax of XML, XML Document Structure, Namespaces, XML Schemas, Displaying Raw XML Documents, Displaying XML Documents with CSS, XSLT Style Sheets, XML Applications, Document Object Model (DOM) -Form processing.

MODULE II

JSON (Basics Only): Overview, Syntax, Datatypes, Objects, Schema, Comparison with XML. PHP - Origin and Uses General Syntactic Characteristics - Primitives, Operations, and Expressions - Control Statements, Arrays, Functions, Pattern Matching, Form Handling, Cookies, Session Tracking.

MODULE III

Web Servers: Client-Side Scripting versus Server-Side Scripting, Accessing Web Servers. Server Side Scripting with Node.js: Getting to know node, node.js changed JavaScript forever, features of node, when to use and not use node, asynchronous callbacks, Hello World in Node, package.json, modules, Built-in Modules: FS Module, HTTP Module, middleware.

MODULE IV

Laravel PHP framework: Artisan CLI- Configuring Laravel Project- HTML Template to Laravel Blade Template- Template inheritance -Master layout - Extending the master layout - Displaying variables - Blade conditional statements - Blade Loops - Executing PHP functions in blade, Creating a registration & user login form.

MODULE V

ReactJS: JSX, Rendering, Routers, Arrow functions, Redux. Angular - Advanced JavaScript, TypeScript, Angular, Webpack, Model Driven Forms, Reactive Forms, Validations, File- Upload.

MODULE VI

Django: Basics, Forms-Render HTML Forms (GET & POST), ModelForm – Create form from Models, Templates , Views, CRUD (Create, Retrieve, Update, Delete) Function Based Views, Django Models, Django ORM – Inserting, Updating & Deleting Data.

LEARNING RESOURCES

References

- Mele, Antonio, "Django 3 By Example: Build powerful and reliable Python web applications from scratch", Packt Publishing Ltd, 2020.
- Robert W Sebesta, "Programming the World Wide Web" 7 ed., Pearson Education Inc., 2014.
- Jon Duckett, "JavaScript and JQuery: Interactive Front–End Web Development", Wiley.
- Matt Stauffer," LARAVEL up and Running, A framework for building modern PHP apps"1 ed., O'REILLY.

Semester: 1	Course Code: CCS-CC-514	Credits: 3

PRINCIPLES OF COMPUTING

Preamble: Formal languages and automata theory deal with the concepts of automata, formal languages, grammar, computability and decidability. Automata Theory possesses a high degree of permanence and stability, contrasting with the ever-changing paradigms of computer systems technology, development, and management. Further, parts of the Automata theory directly affect practice, such as Automata on circuit design, compiler design, and search algorithms; Formal Languages and Grammars on compiler design; and Complexity on cryptography and optimization problems in manufacturing, business, and management. Research-oriented students will use the Automata theory studied in this course.

Prerequisite: Calculus, Data Structures and Algorithms, Set Theory.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Familiarizing students with regular language and regular expressions	PO2	PSO5, PSO6	U	C
CO2	Understand and Construct NFA, DFA, and minimal DFA	PO5	PSO5, PSO7	U, Ap	C, P
CO3	Identify Context-Free Grammar and construct equivalent push-down automata	PO1	PSO6, PSO7	An, Ap	C, P
CO4	Illustrate the working of different Turing machines	PO4	PSO5, PSO7	Ap	P
CO5	Discuss the different types of computability problems	PO2	PSO5, PSO6, PSO7	U	C
CO6	Apply and Analyse the applications of computing principles	PO3	PSO5, PSO7	Ap, An	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Alphabets, strings, languages, regular expressions, Closure Properties of Regular Languages, Proving Languages not to be regular –pumping lemma, Regular expressions.

MODULE II

Finite Automata: Deterministic Finite Automata – Non-deterministic Finite Automata – Finite Automata with Epsilon Transitions, Equivalence of NFA - DFA, DFA Minimization- Myhill- Nerode theorem.

MODULE III

Context-Free Languages: Properties of context free languages, Context free Grammars, Ambiguity, Chomsky Normal form, Pumping lemma for CFG. Push down automata, Equivalence of PDA-CFG, Deterministic push down automata.

MODULE IV

Turing Machines: Formal definition, Recursive enumerable languages and grammar, Variants of turing machines- Multi tape turing machine, Non-deterministic Turing machines, Enumerators.

MODULE V

Computability Theory: Decidability, halting Problem, Universal Turing Machine, Reducibility, The recursion theorem, posts- correspondence problem.

MODULE VI

Applications: Automata in electronic circuits, Applications of finite automata in networking, Application of regular expression in search engines, Application of context free grammar in natural language processing, A study on Turing machine and its applications.

LEARNING RESOURCES

References

- Michael Sipser, "Introduction to the Theory of Computation" 2ed., Thomson Course Technology, 2006
- Dexter C.Kozen, "Automata and computability", Springer,1997
- K. L. P. Mishra, N. Chandrasekaran, "Theory of Computer Science Automata, Languages and Computation", 3ed., PHI, 2006
- Derick Wood, "Theory of Computation", Harper and ROW Publishers, 1987

Semester: 1	Course Code: CCS-CC-515	Credits: 3

ADVANCED COMPUTER NETWORKS

Preamble: This course enables the learners to understand networking concepts, technologies and terminologies which in turn help the students to different networking protocols. It presents the concepts of wireless LAN, Software Defined Networking and also gives the glimpses of recent trends in computer networks.

Prerequisite: Computer Networks and Distributed Systems concepts.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Identify Transport layer protocols – TCP and UDP and Internet layer protocol – IP	PO1	PSO1	U, An	C, F
CO2	Differentiate interior and exterior gateway protocols- OSPF, RIP, BGP	PO4	PSO6	U, An	C, P
CO3	Describe about Wireless LAN, WiMAX and Bluetooth	PO2	PSO1	U, An	C, P
CO4	Comprehend features of SDN and its application to next generation systems	PO3	PSO9	Ap	C, P
CO5	Describe inter-process communication	PO5	PSO12	Ap, An	C, P
CO6	Understand the technologies that support distributed applications such as RPC, RMI	PO1	PSO12	Ap, An	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Basic concepts: TCP, UDP, IPV4 and IPV6 datagram format, Routing Algorithms, Routing in the Internet - Interior gateway routing protocols: OSPF, RIP and Exterior gateway Routing Protocols: BGP.

MODULE II

Wireless LAN (802.11): Architecture, Frame structure, Services- WEP (Wired Equivalent Privacy), Wi-Fi Protected Access (WPA), Broadband Wireless- WiMAX (802.16) Architecture, Frame structure, Bluetooth (802.15), 5G.

MODULE III

Software Defined Networking: Comparison between SDN and traditional networks, SDN Controller, Architecture, SDN in Data Center Networking.

MODULE IV

Distributed Systems: Introduction, Distributed system models, Message Passing-Inter process Communication, Issues in IPC by Message, Synchronization, Buffering, Multi datagram Messages, Encoding and Decoding of Message Data, Process Addressing, Failure Handling, Group Communication.

MODULE V

Distributed Objects and Remote Invocation: Communication between distributed objects-Remote procedure calls - Events and notifications. Implementing RPC Mechanism, Stub Generation, RPC Messages, Marshalling Arguments and Results, Server Management, Communication Protocols for RPCs.

MODULE VI

Applications: Next generation networks, Distributed systems in Next generation networks - Open Flow network, Common Object Request Broker Architecture (CORBA), Distributed Component Object Model (DCOM).

LEARNING RESOURCES

References

- Andrew S. Tanenbaum, David J. Wetherall, "Computer networks", 5ed.
- Kurose James F, Ross Keith W, "Computer networking: a top-down approach" 6ed., Addison-Wesley.
- Paul Goransson, Chuck Black, "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann Publications, 2014.
- Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks", O'Reilly, 2013.
- M. van Steen, A.S. Tanenbaum, "Distributed Systems", 4ed., distributed-systems.net, 2023.
- Nunes, Bruno AA, et al. "A survey of software-defined networking: Past, present, and future of programmable networks." Communications Surveys & Tutorials, IEEE 16.3 (2014): 1617-1634.
- Lantz, Bob, Brandon Heller, and Nick McKeown. "A network in a laptop: rapid prototyping for software-defined networks." Proceedings of the 9th ACM SIGCOMM Workshop on Hot Topics in Networks. ACM, 2010.
- WeijiaJia, Wanlei Zhou, "Distributed Network Systems-From Concepts to Implementations", Springer US , 2006.

Online Resources

- Software-Defined Networks: A Systems Approach, Peterson, Cascone, O'Connor, Vachuska, and Davie. https://sdn.systemsapproach.org/index.html

Semester: 1	Course Code: CCS-CC-516	Credits: 3

WEB TECHNOLOGY LABORATORY

Preamble: The main objective of this laboratory is to impart the ability to develop a web application using network technologies to create fully functional website/web application with MVC architecture.

Prerequisite: Strong foundation in any object oriented programming like java, python, HTML, XML etc. and database queries.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Implement Web Programming concepts in any suitable language	PO1	PSO1	U, An	C, P
CO2	Implement Web Programming using templates and frameworks	PO4	PSO6	U, Ap	C, P
CO3	Able to implement the major graph algorithms	PO2	PSO2	U, Ap	C, P
CO4	Identify the key characteristics of a given problem and analyse the suitability of a specific algorithm design technique for the problem	PO3	PSO1	U, Ap	C, P
CO5	Implement the algorithms for String matching and constructing minimum cost spanning trees	PO5	PSO9	Ap, An	C, P
CO6	Devise and design various greedy algorithms and graph traversal methods to analyse the difference between their complexities	PO1	PSO12	U, Ap, An	C, P
CO7	Develop solution to complex problems using appropriate method, technologies, framework, web services and content management	PO4	PSO1	Ap	C, P
CO8	Implement dynamic websites with good aesthetic sense of designing and latest applications	PO3	PSO9	Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

Students should practice any programming language and implement different algorithms

Warmup Cycle

- Implement basic programs to familiarize programming skills.

- Familiarization of XML programming exercises.

Algorithms and Complexity Cycle

- Constructing minimum cost spanning trees using Prim's and Kruskal's algorithm.
- Implement Dijkstra's algorithm for solving Single source shortest paths problem.
- Implement graph traversal methods.

Web Technology Cycle

- Design a Ticket Reservation Web Application System using Laravel.
- Design webpage that perform insert, update and delete operations.
- Develop an application with javascript program to validate the login authentication.
- Develop a web application for Automated Toll Collection using Django Framework.
- Design and Develop an online shopping cart application with Angular, React and Node js web technologies.
- Develop a web application for online voting system using HTML and Javascript.
- Develop a web application for Airline Ticket reservation system using PHP.

ASSESSMENT

Basic laboratory programs: 30 marks
The basic level gives an awareness of the course through a set of programming exercises.

Mini Project/Case Study Evaluation: 50 marks
At the advanced level, advanced programming exercises are given to understand the application level of the course.

End Semester Viva: 20 marks
The students answer questions in speech, which are commonly based on the respective course discipline. Viva questions are an important part of an academic program and often occur after a semester/year.

Laboratory Record: All Students attending the End Semester Viva should prepare a Fair record and should be produced at the time of evaluation. The record should be certified by the Faculty-in-charge of the laboratory countersigned by the Course coordinator.

Semester: 1	Course Code: CCS-SE-4B1	Credits: 2

ENTREPRENEURSHIP AND PROFESSIONAL DEVELOPMENT

Preamble: This course aims to inspire students and help them imbibe an entrepreneurial mindset. The students will learn what entrepreneurship is and how it has impacted the world and their country. They will be introduced to the critical traits of an entrepreneur and be allowed to assess their strengths and identify gaps that need to be addressed to become a successful entrepreneur.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Develop communication competence in prospective students	PO1	PSO3	Ap	C, P
CO2	Demonstrate the ability to plan, organize, and execute a project or new venture with the goal of bringing new products and service	PO4	PSO1	Ap	C, P
CO3	Possess the professional skills including learning skills and career skills	PO2	PSO1, PSO2	U, Ap	P
CO4	Provide critical thinking process within students	PO3	PSO1, PSO3	Ap	P, M
CO5	Inculcate the soft skills competence in prospective engineers	PO3	PSO2	Ap	P, C
CO6	Equip the students to face interview & Group Discussion	PO5	PSO1	Ap, An, E	P
CO7	Able to work in Group & Teams	PO1	PSO1, PSO3	Ap	C, P
CO8	Prepare the students to become an entrepreneur	PO6	PSO1	Ap, E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Entrepreneurship: Definition of Entrepreneurship, Entrepreneurship and Enterprise, Phases of Entrepreneurship Development, Role of Entrepreneurship, Characteristics of Entrepreneurship, Entrepreneurial Process: Venture Life Cycle and Product Life Cycle- Business Life Cycle.

MODULE II

Entrepreneurship skills: Types of Entrepreneurship skills: Business management skills, Teamwork and leadership skills, Problem-solving skills, Critical thinking skills, Strategic thinking and planning skills, Time management and organizational skills- Entrepreneurial Imagination and Creativity.

MODULE III

Interpersonal skills: Communication skills- Verbal and Non-verbal Communication- Brain storming- Leadership skills- Team building skills- Public Speaking – Team Work.

MODULE IV

Learning skills: Principles of study skills- Memory techniques- Pomodoro technique- Improving your memory for studying- 3 Rs of memory- Mind Mapping.

MODULE V

Life skills: SWOC Analysis- Self Awareness- Stress Management- Time management- Procrastination- Making Schedules - Interview skills –Preparation for the Interview - Planning and Goal Setting.

MODULE VI

Career skills: CV and Resume Writing, Brain Storming- Idea generation, Group Discussion, Facing Interviews - Long Term and Short-Term Goal Setting - Introduction to Latex, Writing report in latex - Portfolio Preparation.

LEARNING RESOURCES

References

- Jonsthan Hancock, Cheryl Buggy, "Memory techniques", Hodder and Stoughton 2003.
- Cecile Niewwenhuizen, "Entrepreneurial Skills", 2ed.
- J. W. Bames, "Statistical Analysis for Engineers and Scientists", Tata McGraw-Hill, New York, 1994.
- Katherine Carpenter, "Introduction to Entrepreneurship", University of Victoria, 2021.
- Michael Laverty, Global Chris Littel, "Entrepreneurship" OpenStax, 2019.

Semester: 1	Course Code: CCS-GC-4B1	Credits: 2

SOCIAL CYBER ETHICS

Preamble: Social Cyber Ethics is an interdisciplinary course that explores the ethical issues and challenges arising from the use of technology, particularly in the context of cyberspace. The course examines the ethical implications of Net Neutrality, online behaviors, and digital interactions, with a focus on developing ethical decision-making skills in the digital realm.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Assess the role of technology, media, and social platforms in information warfare.	PO3	PSO3	An	C, P
CO2	Foster critical thinking and ethical decision-making skills in the context of autonomous weapon systems in warfare.	PO2	PSO9	Ap	C, P
CO3	Explore the role of technology and social media platforms in facilitating cyberbullying	PO3	PSO3	U	F, C
CO4	Analyze the relationship between net neutrality and freedom of expression, innovation, and digital equity.	PO3	PSO6	An	C
CO5	Explore the techniques and tools used for cyber intelligence gathering.	PO4	PSO2	U	F, C
CO6	Analyze case studies and real-world scenarios to apply ethical frameworks and principles.	PO2	PSO3	An	C,P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Net Neutrality- Introduction and key principles of net neutrality- Freedom of expression, privacy, and digital rights in the context of an open internet- Understanding the digital divide and its relationship to net neutrality.

MODULE II

Information Warfare - Introduction to Information Warfare- Types and objectives of information warfare - challenges- Cyber-attacks and digital sabotage in information warfare - Role of traditional media, social media, and online platforms in information warfare.

MODULE III

Cyber Space and intelligent gathering - Key concepts and terminology in cyber intelligence- Techniques and tools for cyber threat intelligence gathering- HUMINT and TECHINT methods for collecting and analyzing technical data.

MODULE IV

Cyberbullying: Definition and characteristics of cyberbullying- cyberbullying and traditional bullying- Forms of Cyberbullying- Online harassment and verbal aggression- Cyberstalking and online threats.

MODULE V

Digital exclusion and social manipulation- Technology and social media platforms in cyberbullying- digital citizenship and responsible online behavior- Ethical responsibilities of online platforms.

MODULE VI

Impact of emerging technologies: 5G, Internet of Things (IoT), and cloud computing, on net neutrality - Artificial intelligence and machine learning in cyber intelligence - Best practices for addressing cyberbullying incidents.

LEARNING RESOURCES

References

- Quinn, M. J. Ethics for the Information Age. Pearson, 2020.
- Spinello, R. A.Cyber ethics: Morality and Law in Cyberspace. Jones & Bartlett Learning, 2019.
- Reynolds, G.Ethics in Information Technology. Cengage Learning, 2020.
- Ess, C.Understanding Cyber ethics: From Theory to Practice. Routledge, 2017.
- Kaliski, B. S. Cyberethics: Social and Moral Issues in the Computer Age. Wiley, 2018.
- Johnson, D. G., & Miller, K. W. Computers, Ethics, and Society. Oxford University Press, 2019.
- Freitas, W. J.Ethics in a Computing Culture. Cengage Learning, 2019.

Semester: 2	Course Code: CCS-CC-521	Credits: 3

SOFTWARE ENGINEERING FOR INDUSTRY

Preamble: This course aims to develop a student as a software engineer professionals ir Computer Science Industry. At the end of the course, a student can develop software througl the software development lifecycle based on industrial perspectives.

Prerequisite: Basics of Software Engineering.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Apply UML diagrams for real world problems	PO1	PSO5	U, An	F,C
CO2	Compare Object oriented programming and procedural programming	PO4	PSO10	U, An	C,P
CO3	Analyse the significance of agile models in software industry	PO2	PSO5	An, Ap	C,P
CO4	Illustrate the different stages in Extreme programming	PO3	PSO7	An, Ap	C,P
CO5	Compare Domain-specific and Service-Oriented architectures	PO5	PSO10	An, Ap	C,P
CO6	Analyse the significance of microservices in software development	PO1	PSO5	An, Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Software Engineering, Why Object Orientation, Procedural Programming and Object Oriented Programming - Object Oriented Systems development life Cycle. Object oriented Methodologies- Patterns and Frameworks. Introduction to Legacy Code - Working with Legacy Code.

MODULE II

UML diagrams: Use case diagram- Class diagram- Activity diagram- Sequence Diagram- State Chart Diagram -Design Patterns.

MODULE III

Agile: Software Development Life Cycle - Agile Modeling -Scrum- Disciplined Agile Delivery (DAD)- The Agile Process Flow - The Agile Iteration Workflow - Making the Agile Process Work- Story Board- Steps in Story Boarding.

MODULE IV

Extreme Programming (XP): XP life cycle- XP Team- XP concepts- Pair Programming- Thinking- Collaborating- Releasing- Planning- Developing- Microservice Architectures for Software Development- Characteristics of Microservices- Microservices and Services Oriented Architecture.

MODULE V

Software Architecture: Introduction - Scope of software architectures - Arriving at an architecture - Domain-specific software architectures (DSSA) - Architectural Styles - Service-Oriented Architectures.

MODULE VI

Applications: UML diagrams for designing the applications for Petrol Filling station, Railway Booking System- Library Management System- Payment Systems- Implementation of a simple microservice program.

LEARNING RESOURCES

References

- Ali Bahrami, "Object Oriented Systems Development", Tata McGraw-Hill, 1999.
- Martin Fowler, "UML Distilled", 2ed., PHI/Pearson Education, 2002.
- D.E. Perry and A.L. Wolf, "Foundations for the Study of Software Architecture", ACM SIGSOFT Software Engineering Notes, vol. 17, no. 4, pp. 40-52, October 1992.
- Roger Pressman. S., "Software Engineering: A Practitioner s Approach", 4ed., McGraw Hill, 1997.
- Stephen R. Schach, "Introduction to Object Oriented Analysis and Design", Tata McGraw-Hill, 2003.
- James Rumbaugh, Ivar Jacobson, Grady Booch, "The Unified Modeling Language Reference Manual", Addison Wesley, 1999.

Semester: 2	Course Code: CCS-CC-522	Credits: 3

DATABASE SYSTEMS FOR BIG DATA

Preamble: The course will focus on the diverse techniques, tools, and systems commonly used for performing data science on large volumes of data. It covers relational database systems, still a mainstay in data management systems, and the so-called "NoSQL" systems. The goals of the course are to provide a broad overview of data management systems, emphasise foundations and understand the strengths and limitations of the different systems.

Prerequisite: Knowledge in programming language, Practice SQL (queries and sub-queries), and have exposure to open-source environment.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Explain in detail about bigdata, its types, characteristics and bigdata databases	PO1	PSO6	U	F, C
CO2	Discuss about Hadoop technology, features, hadoop core components	PO3	PSO4	U, An	C, P
CO3	Explain in detail about Hadoop file system- HDFS and Mapreduce framework	PO5	PSO6	An, Ap	C, P
CO4	Describe about the architecture and working of YARN and HBase	PO1	PSO4	An, Ap	C, P
CO5	Discuss about the NoSQL data store, architecture and its advantages	PO4	PSO4	An, Ap	C, P
CO6	Explain the use of MongoDB and implement its basic commands- CRUD operations	PO3	PSO6	An, Ap	C, P
CO7	Apply big data technologies in various application areas including Uber and Google	PO1	PSO9	Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Evolution of bigdata, need of bigdata, classification of data - structured, semi-structured and unstructured, Bigdata - definition, characteristics of bigdata, Locality of reference, Latency, High availability, Parallel and distributed processing.

MODULE II

Big data systems: Characteristics, Reliability, Fault tolerance, Availability, Consistency, Consistency types. CAP Theorem, Bigdata life cycle – Acquisition Extraction, Loading, Transformation, Analysis and Visualizations, Mapreduce paradigm– Divide and conquer, mapreduce file formats- avro, parquet, json, text, csv.

MODULE III

Hadoop: Introduction, architecture, Mapreduce in Hadoop, Hadoop distributed storage system HDFS, YARN – cluster resource manager and scheduler, life cycle of a Hadoop applications. Hadoop Ecosystem - Database- HBase, Querying- Pig and Hive, Integration, coordination and monitoring - Sqoop, Flume, Zookeeper, Oozie.

MODULE IV

Introduction to Apache Spark: Architecture, Features, RDD- Resilience, Lineage, Motivation, Streaming on spark.

MODULE V

NoSQL data store: Schema less models, Architecture patterns, Features MongoDB – Definition, Characteristics, SQL and MongoDB, Data modelling, data types, Commands in MongoDB, CRUD operations.

MODULE VI

Applications: Significance of Cloud computing in Big data, Big data processing at Uber, Distributed Graph processing at Google, Introduction to Real-time Stream Processing.

LEARNING RESOURCES

References

- Jawad Ahmed Shamsi, Muhammad Ali Khojaye,"Big Data Systems A 360-degree Approach", Chapman & Hall,First Edition 2021.
- Tom White, "Hadoop The Definitive Guide Storage and Analysis ar Internet Scale", O Reilly, 4th Ed. 2015.
- 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.
- Jiawei Han, MichelineKamber, Jian Pei, "Data Mining: Concepts and Techniques",Morgan Kaufmann, 3rd Ed., 2012.
- Chris Eaton, Dirk deroos et al. "Understanding Big data ", McGraw Hill, 2012.
- NoSQL distilled, Martin Fowler.

On-line Resources

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

Semester: 2	Course Code: CCS-CC-523	Credits: 3

COMPILER CONSTRUCTION

Preamble: Studying compilers enables students to design and implement their own domain specific language. Compilers benefit tremendously from careful analysis of a problem, and from tools for performing that analysis. A study of compiler design gives a good feeling for how a large problem can be broken down and solved in a manner that is not ad-hoc. Through this course the students will be getting awareness about the different phases of compiler in detail. It gives a clear idea about how the different tools can be used for designing and verifying codes using compiler.

Prerequisite: Knowledge in programming languages, Principles of Computing.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand compiler phases and their design process	PO1	PSO6	U	C
CO2	Illustrate different types of languages and language processing tools	PO2	PSO1, PSO6	Ap	P
CO3	Identify how lexical tokens are handled in the compilation	PO4	PSO6	An	C, P
CO4	Analyze the importance of syntax and semantic phase in the compilation	PO3	PSO1	An	C
CO5	Demonstrate the working of different types of parsing techniques and parsers	PO2	PSO1, PSO5	Ap	P
CO6	Evaluate intermediate code and different ways to represent it	PO4	PSO5, PSO6	E	C, P
CO7	Apply code optimization techniques to improve computing performance	PO4	PSO5, PSO6	Ap	P
CO8	Design and verification of code using compiler tools	PO5	PSO1, PSO5	Cr	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Language Processors: Compiler: Analysis-Synthesis model, phases of a Compiler. Lexical Analysis: The role of Lexical Analyzer, Input Buffering - Tokens: Expressions, Recognition and representations. Syntax Analysis: The parsing process, Context-Free Grammars, Derivation trees and Parse Trees, Ambiguity.

MODULE II

Parsing: Top-Down Parsing: Recursive Descent parsing, LL Parsing- First and Follow sets. Bottom-Up Parsing: Shift Reduce parsing – Operator precedence parsing - LR parsing: Constructing SLR parsing tables. Error Handling and Recovery in Syntax Analyzer.

MODULE III

Semantic Analysis: Semantics and Semantic errors – Attribute grammars - Syntax directed Translation (SDT): S-attributed SDT, L- attributed SDT, Evaluation process, Type Checking: Specification of a simple type checker.

MODULE IV

Run-Time Environments: Source Language issues, Storage organization and allocation, Symbol Table - Intermediate Code Generation (ICG): Intermediate languages representations-Three Address Code generation - Quadruples & Triples – Graphical representations.

MODULE V

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

MODULE VI

Applications: Identification of tokens using LEX, Parse tree generation, verification and traversal using YAAC, Metacompiler design, Algorithm generation for optimizing new computer architectures.

LEARNING RESOURCES

References

- Alfred V Aho, Jeffrey Principles of compiler Design, Ullman PHI.
- Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D, Compilers Principles, Techniques, & Tools, Ullman PHI.
- 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 Design, Tata McGraw Hill Education Publishers, 2010.
- Steven S. Muchnick, Advanced Compiler Design & Implementation, Harcourt Asia PTE TD, 1997.

Semester: 2	Course Code: CCS-CC-524	Credits: 3

DATABASE LABORATORY

Preamble: The aim of this course is to understand the implementation procedures for advanced database concepts using HIVE/ SQL. Students are expected to create databases using NOSQL database and also to draw different UML diagrams.

Prerequisite: Foundation in SQL queries.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Analyze and populate the Relational Database through HIVE	PO1	PSO4	An, Ap	C, P
CO2	Demonstrate various constraints in the database through SQL Queries	PO2	PSO5	U, Ap	C, P
CO3	Implement External and Managed table	PO2	PSO4	An, Ap	C, P
CO4	Run Apache Spark using HDFS	PO4	PSO4	An, Ap	P
CO5	Implement basic Map Reduce program	PO3	PSO4	An, Ap	C, P
CO6	Create a document oriented database in Mongo DB	PO1	PSO10	An, Ap	C, P
CO7	Implement UML diagrams for different real-world scenarios	PO5	PSO10	U, Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

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

Warmup Cycle

- Execute SQL queries in HIVE.
- Create, alter and drop tables (use constraints while creating tables) and insert rows into a table and retrieve data using select command.
- Write queries to sort and aggregate the data in a table using HiveQL.

Big Data Cycle

- External table, Managed Table – basic operations – create, select and delete operations.
- Run Apache Spark using YARN and HDFS.
- Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm. Find the number of occurrence of each word appearing in the input file(s).

- Install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL Commands.
- Create a document oriented database in Mongo DB using Create, Read, Update and Delete (CRUD) operations.

UML Cycle

- Draw the UML diagrams for Online HR management system.
- Design Bank transactions using UML diagrams.
- Draw UML diagrams for University Information system.
- Create a hostel management system using UML diagrams.

ASSESSMENT

Basic laboratory programs: 30 marks
The basic level gives an awareness of the course through a set of programming exercises.

Mini Project/Case Study Evaluation: 50 marks
At the advanced level, advanced programming exercises are given to understand the application level of the course.

End Semester Viva: 20 marks
The students answer questions in speech, which are commonly based on the respective course discipline. Viva questions are an important part of an academic program and often occur after a semester/year.

Laboratory Record: All Students attending the End Semester Viva should prepare a Fair record and should be produced at the time of evaluation. The record should be certified by the Faculty-in-charge of the laboratory countersigned by the Course coordinator.

Semester: 2	Course Code: CCS-DE-525(i)	Credits: 3

BLOCK CHAIN TECHNOLOGY

Preamble: The purpose of this course is to create awareness and understanding among students on the foundation of blockchain technology. The course introduces the cryptographic principles behind blockchain and helps the students understand concepts like consensus, crypto-currency, smart contracts, use cases etc. The course enables students to develop simple decentralized applications using blockchain networks such as Ethereum.

Prerequisite: Data Structures and Operating Systems.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Discuss and describe the history, technology, and applications of Block chain	PO2	PSO1	U	C, P
CO2	Analyse the significance of crypto currencies in the digital world	PO4	PSO5	An	C, P
CO3	Identify the functional/operational aspects of crypto currency ecosystem	PO1	PSO2, PSO6	U, Ap	C ,P
CO4	Understand emerging abstract models for Block chain Technology	PO3	PSO5	U, An	P, M
CO5	Illustrate the working of Ethereum Virtual Machine	PO3	PSO5	U	P, C
CO6	Assess Block chain applications in a structured manner	PO1	PSO4	An	P
CO7	Analyse the process of creating a crypto currency	PO4	PSO5	Ap	C, P
CO8	Create an own Crypto token	PO2	PSO6	Ap, E	M, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

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 crypto currency: A short overview of Hashing, signature schemes, encryption schemes and elliptic curve cryptography.

MODULE IV

Bit coin: Wallet - Blocks - Merkley Tree - hardness of mining - transaction verifiability - anonymity - forks - double spending - mathematical analysis of properties of Bit coin.

MODULE V

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

Zero Knowledge proofs and protocols in Block chain - Succinct non interactive argument for Knowledge (SNARK) - pairing on Elliptic curves - Zcash.

MODULE VI

Trends and Topics: Block chain Use cases in Big Data- Ensuring Data Integrity, Preventing, Malicious Activities, Predictive Analysis, Real Time Data Analysis, Managing Data Sharing, Applications of Block Chain Technology with Big Data Analytics- Anti Money Laundering, Cyber Security, Supply chain monitoring, Financial AI systems, Medical Records, Block Chaining and Machine Learning- Recent Trends in Machine Learning Applications.

LEARNING RESOURCES

References

- Melanie Swan, "Block chain: Blueprint for a New Economy", O'Reilly Media, 2015.
- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. "Bit coin and crypto currency technologies: a comprehensive introduction", Princeton University Press, 2016.
- William Mougayar, "The Business Block chain: Promise, Practice, and Application of the Next Internet Technology", Wiley, 2016.
- Melanie Swa, "Block chain", O'Reilly Inc., 2015.
- Joseph Bonneau et al, SoK: Research perspectives and challenges for Bit coin and crypto currency, IEEE Symposium on security and Privacy, 2015.
- Neeraj Kumar, N.Gayathri, Md. Arafatur Rahman and B. Balamurugan-"Block chain, Big Data, and Machine Learning – Trends and Applications", CRC Press, 2020.

Online Resources

- https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html
- https://www.hyperledger.org/projects/fabric
- https://eprint.iacr.org/2016/916.pdf

Semester: 2	Course Code: CCS-DE-525(ii)	Credits: 3

INTERNET OF EVERYTHING

Preamble: This course equips the learners with fundamental of the Internet of Things (IoT) and the IoT ecosystem. It covers the architecture of IoT, communication mechanisms, protocols, hardware, software, data analytics, and the cloud platforms for IoT. This course enables the students to design smart IoT applications for real world problems.

Prerequisite: Data Communication, Computer Networks.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Realize the revolution of Internet in smart systems	PO4	PSO1, PSO2	U	C
CO2	Understand the various concepts, terminologies and architecture of Smart systems	PO2	PSO4	U	C
CO3	Familiarize the terminology, technology and its applications	PO3	PSO1	An	C
CO4	Familiarize with the concept of M2M (machine to machine) with necessary protocols	PO1	PSO9, PSO10	An	C
CO5	Understand the role of IoE in various domains of Industry	PO5	PSO8	An	P
CO6	Understand the roles of sensors, APIs to connect IoE related technologies	PO2	PSO7	U	C
CO7	Analyze the middleware for Internet of Everything and its future aspects	PO5	PSO10	An, E	P
CO8	Apply and identify the role of big data, cloud computing and data analytics in a typical computing system	PO1	PSO10, PSO11	Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: 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 and APIs.

MODULE II

Internet Communication Technologies: Networks and Communication, Processes, Data Management - IoT Related Standardization: Communication protocols, Addressing Schemes - Machine to Machine (M2M), Software define Network2M Service Layer Standardization - OGC Sensor Web for IoT, IoT levels.

MODULE III

Internet of Everything: Constituent elements of the Internet of Everything-People, Things, Data, Processes. Internet of Things vs Internet of Everything. Internet of Everything (IoE) Taxonomies. Key features of IoE-Decentralized data processing, Interconnection with other technologies, Data input / output.

MODULE IV

Cloud computing and AI for Internet of Everything: Advanced Cloud Computing Techniques, Introduction to Fog Computing, Data Analytics, Machine learning, Types of ML models, Model building process, Security basis, Smart Security Architecture, Security Requirements, Research State of Crucial Technologies.

MODULE V

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

Zero Knowledge proofs and protocols in Block chain - Succinct non interactive argument for Knowledge (SNARK) - pairing on Elliptic curves - Zcash.

MODULE VI

Applications: Mirai botnet and the algorithm, Adafruit Cloud, Smart perishable tracking with IoT and Sensors, IFTTT, connected cars. Home automation.

LEARNING RESOURCES

References

- Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram,"Internet of things", Wiley, 2020.
- Adrian McEwen, Hakim Cassimally, "Designing internet of things", Wiley, 2013.
- Anthony Townsend., "Smart cities: big data, civic hackers, and the quest for a new utopia", WW Norton and Company, 2013.
- Arshdeep Bahga, Vijay Madisetti, "Internet of things: a hands-on approach", CreateSpace Independent Publishing Platform, 2013.
- Dieter Uckelmannark Harriso Michahelles Florian, "Architecting the internet of things", Springer, 2011.
- Ovidiu Vermesan, Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers, 2013.

Semester: 2	Course Code: CCS-DE-525(iii)	Credits: 3

CYBER SECURITY AND CYBER LAW

Preamble: Objective of this course is to inculcate in students an awareness of cyber world. The student should realize the potential of technology in bringing in cyberlaws and cyber security. The course has been designed to give students an extensive overview of cyber security issues, tools and techniques critical in solving problems in cyber security domains. The course provides students with concepts of computer security, cryptography, digital money, secure protocols, detection and other security techniques. The course will help students understand essential techniques in protecting information systems, IT Infrastructure, analyzing and monitoring potential threats and attacks, devising security architecture and implementing security solutions. The students will also have a wider perspective on information security from a national security perspective from both a technology and legal perspective.

Prerequisite: Knowledge in Internet and Computer Networking.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understanding the security aspects in computing Profession and its vulnerabilities	PO1	PSO1	U	C
CO2	Understand the fundamentals of cyberspace, cyber security and threat landscape	PO3	PSO2	U	C
CO3	Analyze and evaluate the importance of personal data its privacy and security	PO4	PSO2, PSO3	An	C
CO4	Identify the role of human in security systems with an emphasis on ethics, social engineering vulnerabilities and training	PO2	PSO2	An	C
CO5	Evaluate the digital payment system security and remedial measures against digital payment frauds using modern cryptographic techniques	PO3	PSO3	E	P
CO6	Develop a deeper understanding and familiarity with various types of cyber-attacks, cybercrimes, vulnerabilities and remedies thereto	PO4	PSO3, PSO4	Ap	P
CO7	Apply different computer forensic tools to a given cybercrime scene and examine current practices to data recovery and acquisition	PO1	PSO1	U	C
CO8	Generalize the impact based on the Risk assessment, plan suitable security controls, audit and compliance in network security	PO3	PSO2	U	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Cyber Security: Types of Attacks, Unauthorized Access, Impersonation, Denial of Service, Malicious Software, Viruses, Worms, Trojan Horses. Cybercrime, classification of cybercrime, Modus Operandi of various cybercrimes and frauds – Definition of various types of cyber frauds – Modus Operandi - Fraud triangle – fraud detection techniques including data mining and statistical references – counter measures.

MODULE II

Risk Assessment Basis: Risk Analysis, Risk Evaluation, Information Security - Threats - Frauds, Thefts, Malicious Hackers, Malicious Code, Denial-of-Services Attacks, Access Control - Access Control fundamentals, User Identity and Access Management (IAM).

MODULE III

Introduction to Computer Forensics: Types of Computer Forensics techniques - Incident and incident response methodology, Forensic duplication and investigation. Preparation for IR: Creating response tool kit and IR team. Forensics Technology and Systems - Understanding Computer Investigation, Data Acquisition.

MODULE IV

Analysis and Validation: Validating Forensics Data, Data Hiding Techniques, Performing Remote Acquisition, Network Forensics, Email Investigations, Cell Phone and Mobile Devices Forensics.

MODULE V

Email security: web authentication, SSL and SET, Penalties and Offences, amendments. Mobile forensics, Mobile forensic and its challenges, Mobile phone evidence extraction process, The evidence intake phase, The identification phase, The preparation phase, The isolation phase, The processing phase, The verification phase, Salient features of the IT Act, 2000, various authorities under IT Act and their powers.

MODULE VI

Applications: The Concept of Cyberspace E-Commerce, The Contract Aspects in Cyber Law, The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law, The Criminal Aspect in Cyber Law, Global Trends in Cyber Law, Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking, The Need for an Indian Cyber Law.

LEARNING RESOURCES

References

- Sumit Belapure and Nina Godbole, "Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley India Pvt. Ltd., 2011.

- Dorothy F. Denning, "Information Warfare and Security", Addison Wesley, 1998.
- Natraj Venkataramanan and Ashwin Shriram , "Data Privacy Principles and Practice", CRC Press, 2016.
- W. KragBrothy "Information Security Governance, Guidance for Information Security Managers", Wiley Publication, 2007.
- Martin Weiss, Michael G. Solomon, "Auditing IT Infrastructures for Compliance", 2edn., Jones Bartlett Learning, 2015.
- R. C Mishra , "Cyber Crime Impact in the New Millennium", Auther Press, 2010.
- Bill Nelson, Amelia Phillips, Frank Enfinger, Christopher Steuart, "Computer Forensics and Investigations", Cengage Learning, 2016.
- William Stallings,"Network Security Essentials: Applications and Standards", John R.Vacca, Computer Forensics, 2005.
- NinaGodbole, Sunit Belapure,"Cyber Security", Wiley, 2008.
- Talat Fatima, "Cyber Law in India", Wolters Kluwer, 2017.

Semester: 2	Course Code: CCS-DE-525(iv)	Credits: 3

SOFT COMPUTING TECHNIQUES

Preamble: This course will provide students with the basic concepts of different methods and tools for processing uncertainty in intelligent systems, such as fuzzy models, neural networks, and probabilistic models, and the foundations of their use in real systems. This course covers the main concepts of the philosophy of artificial intelligence, hybrid intelligent systems, classification and architecture of hybrid intelligent systems.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understanding the concept of Neural Networks	PO1	PSO7	U, Ap	C, P
CO2	Prepare the students to apply Neural Networks to solve problems	PO5	PSO7, PSO9	Ap	C, P
CO3	Familiar the various rules and models used in NN	PO4	PSO7	U	C
CO4	Implement the perceptron for classification	PO3	PSO5, PSO7	Ap	C,P
CO5	Analyse the working of Back propagation Algorithms	PO2	PSO5	Ap, An	C,P
CO6	Equip the students to apply fuzzy techniques in research problems	PO5	PSO5	Ap, An, E	C,P
CO7	Familiar the Genetic algorithm concepts with different operations	PO2	PSO5	U, Ap	C, P
CO8	Implement and evaluate different application using soft computing techniques	PO3	PSO6	Ap, E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Structure of biological neuron, Artificial neural networks, applications of neural network, Models of ANNs; Feed forward & feedback networks, Activation functions, Neuron Models, Learning rules; Hebbian learning rule, perception learning rule, delta learning rule, Widrow-Hoff learning rule, correction learning rule, Winner –lake all learning rule.

MODULE II

Pattern Classification: Biases and thresholds, linear seperability, HEBB NET-Algorithm, Implementing logic functions, Perceptron, Architecture, Algorithm, implementing logic functions, Perceptron learning rule convergence theorem, Adaline.

MODULE III

Linear inseperability: Multilayer perceptron, Back propagation Network – Architecture, Algorithm, Learning factors, RBF Networks.

MODULE IV

Classical Sets: Operations and properties, Fuzzy sets – Operations and Properties, Crisp Relations, Fuzzy Relations, Fuzzy Equivalence Relations, Features of Membership Functions, Various forms, Fuzzification and Defuzzification, λ-cuts for Fuzzy Relations, Classical Logic, Fuzzy Logic – Approximate reasoning. Fuzzy Rule-based Systems.

MODULE V

Genetic Algorithms: Introduction, Biological background, genetic algorithm Vs. Traditional algorithms, Basic terminologies, Genetic algorithm steps, Operators in genetic algorithm- Encoding, Selection, Crossover, Mutation, Stopping criteria, Problem solving using Genetic algorithm.

MODULE VI

Neural Network Applications: Character recognition, Speech recognition, signature verification, Fuzzy based applications- microwave oven, washing machine, Genetic algorithm based applications.

LEARNING RESOURCES

References

- Fausett, Laurene V, "Fundamentals of neural networks: architectures, algorithms and applications", Pearson Education India, 2006.
- Roy, Samir, and Udit Chakraborty, "Introduction to soft computing: neuro-fuzzy and genetic algorithms", Pearson, 2013.
- Volna, Eva. "Introduction to Soft Computing Book." (2013).
- Pratihar, Dilip Kumar, "Soft computing: fundamentals and applications", Alpha Science International, Ltd, 2013.
- Rajasekaran, Sanguthevar, and GA Vijayalakshmi Pai, "Neural networks, fuzzy logic and genetic algorithm: synthesis and applications", PHI Learning Pvt. Ltd., 2003.
- Haykin, Simon, "Neural networks: a comprehensive foundation", Prentice Hall PTR, 1998.
- Liang, Ping, and N. K. Bose, "Neural network fundamentals with graphs, algorithms, and applications.", Mac Graw-Hill (1996).
- Lamba, V. K., „Neuro fuzzy systems", University Science Press, 2008.
- Goldberg, David E. "Genetic algorithms in search, optimization and machine learning. Addsion-Wesley Longman." Reading (1989).
- Sivanandam, S. N., and S. N. Deepa, "Principles of soft computing", John Wiley & Sons, 2007.

Semester: 2	Course Code: CCS-DE-525(v)	Credits: 3

CRYPTOGRAPHY AND NETWORK SECURITY

Preamble: The course aims at providing students with concept of computer security, cryptography, digital money, secure protocols, detection and other security techniques.

Prerequisite: Computer Networks, Data Communication.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Create awareness for the various cryptographic primitives and to understand the security concerns and vulnerabilities	PO1	PSO1, PSO3	U	C
CO2	Familiarize with different types of cryptosystems thereby generating the ability to analyse different types of attacks on various cryptosystems	PO4	PSO2, PSO3	An	C
CO3	To be able to secure a message over insecure channel by various means of conventional cryptographic encryption techniques	PO2	PSO3	E	P
CO4	Identify and mitigate software security vulnerabilities in existing systems and should be able to inculcate ciphers and key based principles	PO3	PSO1, PSO3	An	P
CO5	To understand various protocols for network security to protect against the threats in the networks	PO2	PSO2	U	C
CO6	Apply methods for authentication, access control, intrusion detection and prevention	PO3	PSO3	Ap	P
CO7	Understanding various protocols for network security to protect against the threats in the networks	PO1	PSO1, PSO2, PSO3	U	F
CO8	Generate and distribute a PGP key pair and use the PGP package to send an encrypted email message	PO2	PSO10	Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Security:- Security Attacks -Interruption, Interception, Modification and Fabrication, Security Services and Mechanisms A model for Internetwork security, Internet Standards and RFCs, Buffer overflow & format string vulnerabilities, TCP session hijacking, ARP attacks, route table modification, UDP hijacking, and man-in-the-middle attacks.

MODULE II

Conventional Encryption Principles: Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, key distribution Approaches of Message Authentication, Secure Hash Functions and HMAC.

MODULE III

Public-Key Cryptography: Principles of Public-Key Cryptography, RSA Algorithm, Key Management, Diffie-Hellman Key Exchange Cryptographic Hash Functions-Message Authentication, Secure Hash Algorithm (SHA-512), Authentication requirements, HMAC.

MODULE IV

Digital Signatures: Elgamal Digital Signature Scheme. Key Management and Distribution, Network security - Transport-level Security- Web security considerations, Secure Socket Layer and Transport Layer Security, HTTPS, Secure Shell (SSH).Wireless Network Security, Integrity checks.

MODULE V

Authentication Algorithms: MD5 - Secure hash algorithm (SHA), Digital Signatures - authentication protocols - Digital signature standards (DSS), Introduction to Number Theory, Fermat's and Euler's Theorems, Testing for Primality Miller-Rabin Algorithm A Deterministic Primality Algorithm Distribution of Primes.

MODULE VI

E-Mail Security: Pretty Good Privacy, Security and cryptography in everyday life, Virus and antivirus software, Honeypots, Traffic flow security, Firewalls, Electronic Money-Encryption/Decryption in e-mail, OpenPGP, SIM card Authentication.

LEARNING RESOURCES

References

- William Stallings, "Cryptography and Network security Principles and Practices", Pearson/PHI.
- Wade Trappe, Lawrence C Washington, "Introduction to Cryptography with coding theory", Pearson.
- W. Mao, "Modern Cryptography – Theory and Practice", Pearson Education.
- Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India.
- AtulKahate, "Cryptography and Network Security", 2ed. Tata McGraw Hill, 2003.
- Bernard Menezes, Network Security and Cryptography-Cengage Learning India, 2011.
- Bruce Schneier, "Applied Cryptography: Protocols, Algorthms, and Source Code in C", Second Edition, John Wiley and Sons Inc, 2001.

Semester: 2	Course Code: CCS-DE-526(i)	Credits: 3

COMPUTATIONAL BIOLOGY

Preamble: This course helps the learners to understand the fundamental concepts in Molecular Biology, Genomics, Proteomics and Modelling. This course introduces bio macromolecules such as genes and proteins, different biological databases, tools and algorithms for biological data processing, analysis and interpretation, and the elements of the systems approach to Molecular Biology. This course enables the learners to contribute towards drug discovery, computational analysis and modelling of biological processes.

Prerequisite: Basic background in Higher Secondary Biology.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Describe the basic concepts of molecular biology and biological data including DNA and RNA	PO1	PSO7	U	C, P
CO2	Analyze DNA, RNA, and protein sequences	PO2	PSO8	An	C, P
CO3	Explain the properties of DNA, RNA, and proteins, the relationships among these molecules	PO4	PSO3	U, An	C ,P
CO4	Knowledge in sequence alignment in biological sequences	PO2	PSO5	U, An	P, M
CO5	Identify primers, motif and domain of RNA sequences	PO3	PSO11	U	P, C
CO6	Describe about in algorithms computational biology including Gene Finding Approaches and Bayesian via Hidden Markov models	PO2	PSO10	An	P
CO7	Articulate the basic concepts of Genetic algorithm and its applications in Microbial informatics, Biomedical Images and Microarray	PO5	PSO8	Ap	C, P
CO8	Investigate implementation of machine learning and optimization algorithm in biological sequences	PO1	PSO12	Ap, E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

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 Baxevanis and 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.
- Diego Forero, Vinod Chandra S S, "Bioinformatics and Human Genomics Research", CRC Press, UK, 2021.

Semester: 2	Course Code: CCS-DE-526(ii)	Credits: 3

SOFTWARE AGENTS AND MULTIAGENT SYSTEMS

Preamble: This course includes the concepts, techniques and tools of intelligent agents. It enables the learners to do problem solving and planning among agents and to evaluate different agent oriented methodologies.

Prerequisite: Algorithms and Data Structures.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Explain the significance of intelligent agents in the computing world	PO1	PSO9	An	C
CO2	Describe the basic concepts, methods, techniques, and tools for the use of intelligent agents in computer-based systems	PO3	PSO5	U	F
CO3	Identify the components and functions of intelligent agents	PO4	PSO12	U	F, C
CO4	Apply the principles and methods of intelligent agents to a small-scale application problem	PO5	PSO2	A	C, P
CO5	Critically evaluate Agent Oriented methodologies	PO3	PSO5	E	C, P
CO6	Explain the problem solving and planning among agents	PO2	PSO9	An	C
CO7	Apply agent based modeling techniques for solving real life problems	PO6	PSO2	A	C, P
CO8	Illustrate Agent oriented methodologies including Gaia Methodology, MASE, OPEN process framework, Tropos with neat diagram	PO1	PSO12	A	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Intelligent agents - Abstract architectures, Concrete architecture for intelligent agents, Agent Programming languages. Multiagent Systems and Societies of Agents – Agent Communications, Agent Interaction Protocols.

MODULE II

Distributed Problem Solving and Planning: Introduction, Task Sharing Result Sharing, Distributed Planning, Distributed Plan Representations- Distributed Planning and Execution.

MODULE III

Learning in Multi-agent Systems: General Characterization, Principal categories, Differencing features. Learning and activity coordination– Reinforcement Learning, Isolated, Concurrent Reinforcement Learners, Interactive Reinforcement Learning for Coordination.

MODULE IV

Distributed Artificial Intelligence (DAI): Introduction, DAI in Industry, Industrial life-cycle, Application of agents in Product design- Planning and scheduling.

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 – JADE.

LEARNING RESOURCES

References

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

Online Resources

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

Semester: 2	Course Code: CCS-DE-526(iii)	Credits: 3

MACHINE LEARNING

Preamble: This course enables the learners to understand the fundamental concepts and algorithms in machine learning. The course covers the standard and most popular learning algorithms such as linear regression, logistic regression, support vector machines and kernels, basic clustering algorithms and basics of deep architectures. This course helps the students to provide machine learning-based solutions to real-world problems.

Prerequisite: Linear Algebra, Probability and Statistics, Python programming.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Design a machine learning system	PO1	PSO9	U	F,C
CO2	Illustrate the types of learning	PO2	PSO1	U	F,C
CO3	Analyse the performance of clustering algorithms	PO4	PSO9	U	C
CO4	Apply the different regression techniques	PO2	PSO6	U	F,C
CO5	Compare the features of machine learning and deep learning	PO3	PSO12	U	C
CO6	Implement PCA, Regression, SVM	PO2	PSO9	U	C
CO7	Explain bagging and boosting techniques	PO5	PSO2	U	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Designing a learning system- choosing the training experience-choosing the target function – choosing the representation for the target function-choosing a function approximation algorithm- Final design- Goals, Applications and challenges of Machine Learning, Types of learning methods.

MODULE II

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.

MODULE III

Regression: Relationship between attributes using Covariance and Correlation Regression: Relationship between multiple variables: Regression (Linear, Multivariate) in prediction. Linear Regression, LASSO regression, Ridge regression-Logistic Regression.

MODULE IV

Support Vector Machine- Types of SVM- Working of SVM- Support Vectors –Margin- Soft Margin SVM- Different Kernels- Advantages and Limitations of SVM.

MODULE V

Deep Learning: Convolutional Neural Network, Building blocks of CNN, Transfer Learning- Pretrained Models- ResNet50, Inception, VGG16. Residual Networks- Unsupervised Learning with Deep Network, Autoencoders.

MODULE VI

Applications: Dimensionality reduction, Implementation of SVM, Develop a custom CNN network, Perform Linear regression and Ridge regression. K-Means Clustering.

LEARNING RESOURCES

References

- Aurelien Geron "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: 2	Course Code: CCS-DE-526(iv)	Credits: 3

MOBILE COMPUTING

Preamble: The purpose of this course is to understand the concept of mobile computing paradigm, novel applications, limitations and also to impart knowledge on the typical mobile networking Infrastructure through a popular GSM protocol. It also helps the students to get exposed to Ad-Hoc Networks and gain knowledge about different mobile platforms and application development.

Prerequisite: Data Communication, Computer Networks.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Impart basic understanding of the wireless communication systems	PO1	PSO6	U	F, C
CO2	Expose students to various aspects of mobile and ad-hoc networks	PO2	PSO1	U	F, C
CO3	Learn networking concepts relevant to modern wireless systems	PO4	PSO2, PSO6	U	C
CO4	Outline the LAN technologies used in mobile communication	PO1	PSO6	U	F, C
CO5	Explain the fundamental concepts of next generation mobile networks	PO3	PSO9	U	C
CO6	Learn emerging mobile computing ideas and best practices	PO5	PSO6	U	C
CO7	Identify the technology trends for cellular wireless networks	PO3	PSO2,PSO9	U	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Wireless Transmission – Frequencies for radio transmission, Signals, Antennas, Signal Propagation, Multiplexing, Modulations, Spread spectrum. Cellular concepts- channel assignment strategy- hand off strategy interface and system capacity- improving coverage and capacity in cellular system.

MODULE II

Medium Access Control: SDMA, FDMA, TDMA, CDMA, Cellular Wireless Networks. Telecommunication systems – GSM, GPRS, DECT, TETRA, UMTS and IMT-2000. Satellite Systems- GEO, LEO, MEO.

MODULE III

Satellite Networks: Basics, Parameters and Configurations, Capacity Allocation – FAMA and DAMA. Broadcast Systems– DAB, DVB. Wireless LAN – IEEE 802.11 – IEEE 802.11a – 802.11b, HIPERLAN – Blue Tooth.

MODULE IV

Wireless LANS: Wireless LAN Standards – IEEE 802 Protocol Architecture, IEEE 802.11 System Architecture, Protocol Architecture & Services, Cellular Networks: Channel allocation, multiple access, location management, Handoffs. MAC Layer & Management, Routing - Classification of Routing Algorithms, Algorithms such as DSR, AODV, DSDV, Mobile Agents, Service Discovery.

MODULE V

Mobile Network Layer: Mobile IP, Dynamic Host Configuration Protocol, Mobile ad-hoc networks. Introduction to wireless sensor networks. Mobile Transport Layer – Traditional TCP, Classical TCP improvements. Support for mobility – File Systems, WWW, WAP, i-mode, SyncML, WAP 2.0.

MODULE VI

Security issues in mobile computing: Information Security, Components of Information Security, Next Generation Networks- LTE – Architecture & Interface – LTE radio planning and tools, 5G architecture, MIMO, Super core concept, Features and Application. LiFi.

LEARNING RESOURCES

References

- Wireless Communications and Networks - William Stallings, Pearson Education.
- Mobile Communications - Jochen Schiller, 2ed., Pearson Education.
- Asoke K. Talukder, Hasan Ahmad, Mobile Computing Technology- Application and Service Creation, 2ed., McGraw Hill Education.
- Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley Publishers, 2015.
- Theodore S. Rappaport, Wireless Communications Principles and Practice, 2ed, PHI, New Delhi, 2004.

Semester: 2	Course Code: CCS-DE-526(v)	Credits: 3

SOCIAL NETWORK ANALYSIS

Preamble: This interdisciplinary course is designed to benefit from a broad representation of students from different disciplines. The primary learning objective of this course is to enable students to put Social Network Analysis projects into action in a planned, informed and efficient manner.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Identify the basic concepts semantic web, social networks, and Ontology	PO1	PSO6	U	C
CO2	Describe the basic concepts and measures of Social Network Analysis	PO2	PSO6	U	C
CO3	Discuss the basic metrics used in Social network analysis degree distribution, clustering coefficient, clique, k-core, k-plex, and network motifs	PO4	PSO2, PSO6	U, Ap	C, P
CO4	Understand and analyze the affiliation networks, graphs and partitioning techniques	PO2	PSO6, PSO9	U, An	C, P
CO5	Apply the centralities and find the relevance of web pages using page ranking algorithms	PO3	PSO6	Ap	P
CO6	Implement an algorithm to solve social media mining and sentimental analysis	PO2	PSO2, PSO5, PSO6	Ap	P
CO7	Develop practical skills of network analysis in R programming language	PO3	PSO1, PSO6	Ap	C, P
CO8	Evaluate the working of social networks for various applications	PO1	PSO2, PSO6	E	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: 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 , transitivity, centrality measures, Cohesion- reciprocity, density, clustering, average and longest distance, 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

Network Communities: Divisive methods, Graph partitioning and cut metrics. Edge betweenness. Modularity clustering. Affiliation network and bipartite graphs.

MODULE V

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

MODULE VI

Applications: Implement Social networks with some publicly available datasets and find the different centrality measures, community detection through centrality measures, Social media mining-sentiment mining. Knowledge graph and Neo4j.

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.
- Peter J. Carrington, John Scott, Stanley Wasserman; "Models and Methods in Social Network Analysis"; Cambridge University Press
- 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.

- Steven S. Muchnick, "Advanced Compiler Design & Implementation", Harcourt Asia PTE TD, 1997.

Online Resources

- http://library.uc.edu.kh/userfiles/pdf/18.Models%20and%20Methods%20in%20Social%20Network%20Analysis.pdf

Semester: 2	Course Code: CCS-SE-4B2	Credits: 2

IT ACT AND CONSTITUTION OF INDIA

Preamble: To realize the significance of the constitution of India to students from all walks of life and help them to understand the basic concepts of the Indian constitution and the IT act. It covers the entire Information Technology Act, its amendments, and applicable rules. Apart from the statutory provisions related to cyberspace, this syllabus also emphasizes the social and intellectual property issues and legal analysis of emerging cyberspace technologies. Students can identify the importance of fundamental rights and duties, understand the functioning of Union, State and Local Governments in the Indian federal system. Students also learn the procedure and effects of emergencies, composition and activities of the election commission and amendment procedures.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Knowledge in Information Technology and its use	PO1	PSO1	U	C, P
CO2	Understand cyber space and cybercrimes	PO3	PSO2	U	C, P
CO3	Understand and explain Technology act	PO5	PSO1	U	C ,P
CO4	Understand and explain the significance of Indian Constitution as the fundamental law of the land	PO2	PSO1	U, An	P, C
CO5	Exercise his fundamental rights in proper sense at the same time identifies their responsibilities in national building	PO3	PSO3	U	P, C
CO6	Knowledge in state and central government laws and powers	PO6	PSO1	U	P
CO7	Analyze the Indian political system, the powers and functions of the Union, State and Local Governments in detail	PO4	PSO1	An	C, P
CO8	Understand Electoral Process, Emergency	PO1	PSO10	U	C, P

	provisions and Amendment procedure

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

IT: Information Technology (use of computers to store, retrieve, transmit and manipulate data); understanding cyberspace (cyberspace is a notional environment in which communication over computer network occurs; borderless environment), scope and regulation; internet, e-mail and world wide web; use– academics, e-commerce (B2B, B2C, C2C), social networking by individuals.

MODULE II

Interface of information technology and law: Current challenges– mobiles, cyber security, cloud computing and data privacy, misuse of social media.
Cyber Crimes– financial frauds (money laundering, credit card frauds, social crimes -cyber stalking, pornography, identity theft, IPR related crimes, cyber terrorism, defamation.

MODULE III

Purpose and Object of Information: Technology Act, 2000 (to facilitate e- commerce to remove major hurdles of writing and signature requirement for legal recognition, providing regulatory regime for to supervise certifying authorities and digital signature certificates, to create civil and criminal liabilities for contravention of provisions, and consequential amendments in other Acts.

MODULE IV

Introduction to Constitution: Meaning and importance of the Constitution, salient features of Indian Constitution. Preamble of the Constitution. Fundamental rights- meaning and limitations. Directive principles of state policy and Fundamental duties -their enforcement and their relevance.

MODULE V

Union Government: Union Executive- President, Vice-president, Prime Minister, Council of Ministers. Union Legislature- Parliament and Parliamentary proceedings. Union Judiciary-Supreme Court of India –composition and powers and functions.

MODULE VI

EC and powers: Election provisions, Emergency provisions, Amendment of the constitution, Election Commission of India-composition, powers and functions and electoral process. Types of emergency-grounds, procedure, duration and effects. Amendment of the constitution- meaning, procedure and limitations.

LEARNING RESOURCES

References

- Kamath Nandan, "Law Relating to Computers Internet & E-commerce – A Guide to Cyberlaws & The Information Technology Act, Rules, Regulations and Notifications along with Latest Case Laws", 2012.
- Karnika Seth, "Computers Internet and New Technology Laws", 2013.
- Durga Das Basu, "Introduction to the Constitution of India", Gurgaon; LexisNexis, (23ed). 2018.
- M.V. Pylee, "India's Constitution", New Delhi; S. Chand Pub., (16ed.) 2017.
- J.N.Pandey, "The Constitutional Law of India', Allahabad; Central Law Agency, 55ed., 2018.

Online Resources

- "Constitution of India "(Full Text), India.gov.in., National Portal of India, https://www.india.gov.in/sites/upload_files/npi/files/coi_part_full.pdf
- https://legislative.gov.in/constitution-of-india/
- https://eprocure.gov.in/cppp/rulesandprocs/kbadqkdlcswfjdelrquehwuxcfmijmuixngudufgbuubgubfugbububjxcgfvsbdihbgfGhdfgFHytyhRtMjk4NzY=
- https://www.loc.gov/resource/llscd.57026883/?st=gallery
- https://www.indiacode.nic.in/bitstream/123456789/13116/1/it_act_2000_updated.pdf

Semester: 3	Course Code: CCS-CC-531	Credits: 3

ANALYTICS AND DATA SCIENCE

Preamble: This course helps the learner to understand the basic concepts of data analytics. It covers mathematics for data analytics, predictive and descriptive analytics of data and visualization using R programming tool. It includes the essentials of statistics and how to prepare the data before processing in real time applications. The students will be able to handle imputation of missing data and detection of any outliers available in the dataset. Students will be able to explore definitions of data science in business context and it also discovers some use cases for data science which covers the usage of machine learning pipelines to fit models.

Prerequisite: Machine Learning.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Illustrate Machine Learning concepts and basics of supervised learning concepts	PO1	PSO6	U	F, C
CO2	Differentiate data science and data analytics	PO2	PSO4	U	C
CO3	Illustrate the statistical and visualization techniques in data science	PO4	PSO4, PSO6	Ap	P
CO4	Compare and contrast different supervised machine learning algorithms	PO2	PSO6	E	C
CO5	Discuss about the different machine learning algorithms for data science	PO3	PSO4	U	P
CO6	Implement different data science and analysis problems using R programming language	PO2	PSO6, PSO9	Ap, An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to Machine Learning: Types of Learning- Supervised learning, Unsupervised learning, Reinforcement learning, Association, Applications, Feature representation, Hypothesis class, Version space, Vapnik Chervonenkis (VC) Dimension, Typical errors, Learning Multiple classes, Model Selection and Generalization.

MODULE II

Data Analytics: Introduction, Types of Data Analytics- Descriptive Analytics, Diagnostic Analytics, Predictive Analytics, Prescriptive Analytics- Analytics Process Model, Analytical Model Requirements and Data Analytics Life Cycle.

Data Science: Basic concepts, definition and architecture, Visualization techniques, Data Preprocessing– Cleaning, Integration, Reduction, Transformation, Discretization.

MODULE III

Classification: Binary versus multi class classification, Linear classifiers, Naive Bayes Classification, Regression- Linear Regression, Decision Trees- Entropy, Information Gain, Tree construction, ID3, Issues in Decision Tree learning- Avoiding Over-fitting, Reduced Error Pruning, The problem of Missing Attributes, Gain Ratio, Classification by Regression (CART).

MODULE IV

Classifier Performance: Accuracy, Precision, Recall, F1 Score, Sensitivity, Specificity, ROC, AUC, Confusion matrix, Cross validation and re-sampling methods- K-fold cross validation, Boot strapping. Clustering -Similarity measures, Clustering criteria, Distance functions, Partitional clustering- K-means, Hierarchical Clustering- Agglomerative clustering, Density based clustering-DBSCAN.

MODULE V

Dimensionality Reduction: Subset selection, Feature extraction, Combining multiple learners, Ways to achieve diversity, Model combination schemes, Voting, Bagging, Booting Handwritten digits classification.

Overview of modern data analytic tools: Introduction to R - Data Import and Export, Attribute and Data Types, Data Wrangling, Data manipulation dplyr. Plotting-Visualization with ggplot2.

MODULE VI

Case Study: Spam Filtering, Stock Price Prediction , Handwritten Digit classification, Fake News Detection, Leaf disease detection and prediction, Movie Recommendation System, Anomaly Detection.

LEARNING RESOURCES

References

- Ethem Alpaydın, "Introduction to Machine Learning (Adaptive Computation and MachineLearning)", MIT Press, 2004.
- Kotu, V., Deshpande, B, "Data science: Concepts and practice", Morgan Kaufmann. 2019.
- David Dietrich, "EMC Education Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", John Wiley & Sons, 2015.
- Jaiwei Han, Micheline Kamber, "Data Mining Concepts and Techniques", Elsevier, 2006.
- Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

Semester: 3	Course Code: CCS-CC-532	Credits: 3

SMART APPLICATION DEVELOPMENT

Preamble: Application Development course deals with the processes of developing applications for mobiles, smartphones and tablets. The course covers software development, mobile application development, web app development, mobile computing, android multimedia, iOS multimedia, app safety and security, app functionality, etc.

Prerequisite: Mobile programming, Database.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Discuss the basic concepts of mobile networks, architecture and Operating system	PO1	PSO5	U	C, P
CO2	Understand mobile application platforms and its operations	PO2	PSO8	U	C, P
CO3	Explain different android app architectures and Android Studi	PO4	PSO5, PSO6	U, An	C, P
CO4	Understand ViewData and LiveData in android platform	PO2	PSO7	U, An	P, M
CO5	Describe the basics of Kotlin and familiarize basic Hello World App	PO3	PSO5	Ap	P, C
CO6	Discuss about the Android Architecture and databases	PO2	PSO10	U, An	P, M
CO7	Explain the basic concepts of cross platform development and Flutter	PO3	PSO11	An, Ap	C, P
CO8	Development of Mobile application with camera and video in IOS and Android platform	PO5	PSO12	Ap, E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Device Hardware, Peripheral and Platform Architecture: Device hardware - ARM processors. Sensors - Base sensors, Composite Sensors, Peripherals - Audio and Custom Accessories. Mobile Operating systems (no details required). Platform Architecture: iOS and Android. Development languages: Swift for iOS, Kotlin for Android.

MODULE II

Mobile Application Architecture: Introduction to Android: Mobile application architectures - MVC, MVP, MVVM. Introduction to Android Studio IDE-Project structure, User interface, Gradle build system, Project overview – Modules, Project

files, Project Structure settings. Android App Components - Activities, Services, Notifications, Broadcast Receivers, Content Providers.

MODULE III

Introduction to Kotlin: Basic elements – Basic types, Functions and Variables, Classes and Properties, Conditions and Loops. Familiarization of basic apps using Kotlin by a Hello World Project.

MODULE IV

Android Architecture Components and Database: Android Architecture Components – ViewModel - Overview, Implementation, Lifecycle, Sharing Data with fragments, Replacing Loaders with View Model, LiveData-Overview, Advantages, Work with LiveData Objects Database – SQLite-Defining a schema, Create a database, Insertion, Deletion and Updation of Data, Room- Overview, Primary components, Sample Implementation.

MODULE V

Cross Platform Development: Introduction to Flutter, Why Flutter, Other options, Native Solutions, Flutter App Architecture Layer, Reactive User Interfaces, Widgets, Rendering model.

MODULE VI

Mobile with Camera: Taking pictures. Speech API: TextToSpeech, Bluetooth: Controlling local Bluetooth device, Discovering and bonding with Bluetooth devices. Animation: Android Animation API. Android Graphics: Graphics API, 2D Graphics, Canvas, Paint class. Android Application Deployment on Android Play Store, Timeline in mobile phone development: Zero G, 1G , 2G, 3G, 4G, (4G LTE, VoLTE) and 5G, Future of Android. Spam Filtering, Stock Price Prediction , Handwritten Digit classification, Fake News Detection, Leaf disease detection and prediction, Movie Recommendation System, Anomaly Detection.

LEARNING RESOURCES

References

- Lyla B Das, Embedded Systems an Integrated Approach, Pearson, 2013.
- Varun Nagpal, Android Sensor Programming by Example -PACKT Publishing, 1stedition, 2016 .
- Dmitry Jemerov and Svetlana Isakova , "Kotlin in Action" ,Hanning, 2017.
- Bill Philips, "Android Programming: The Big Nerd Ranch Guide", 3ed., 2017.
- Josh Skeen, Kotlin Programming: The Big Nerd Ranch Guide (Big Nerd Ranch Guides) 1st Edition, 2018.
- Rap Pyne," Beginning App Development with Flutter: Create Cross-Platform MobileApps",APress, 2019.
- Ian Darwin, "Android Cookbook" 2ed., O'Reilly, 2017.
- Micheal Burton,"Android Application Development For Dummies", October 2012.
- Dawn Griffiths, David Griffiths,"Head First Kotlin", O'Reilly Media, 2019.
- Marco L. Napoli,"Beginning Flutter: "A Hands on Guide for App Development", Wiley, 2019.

Online Resources

- Android Sensors and Peripheral: https://source.android.com/devices/sensors/sensor-types
- Mobile OS list: https://www.g2.com/articles/mobile-operating-systems
- iOS Platform Architecture: https://cs4720.cs.virginia.edu/slides/CS4720-MADiOSArchitecture.pdf
- Android Platform Architecture: https://developer.android.com/guide/platform
- Swift: https://docs.swift.org/swift-book/
- Kotlin for Android: https://developer.android.com/kotlin/first
- Architectures: https://blog.mindorks.com/mvc-mvp-mvvm-architecture-in-android
- Android Studio : https://developer.android.com/studio/intro
- Android Project Overview: https://developer.android.com/studio/projects

Semester: 3	Course Code: CCS-CC-533	Credits: 3

NATURAL LANGUAGE PROCESSING

Preamble: This course enables the learners to understand the concepts of Natural Language Processing. The course covers basic pre-processing steps, language models, text classification using machine learning algorithms, information and relation extraction methods, Information Retrieval, Question Answer Systems and Machine Translation models. This course enables the students to apply techniques and methods to solve challenging real-world problems in NLP.

Prerequisite: Principles of Computing, Knowledge in Artificial Intelligence.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand comprehend the key concepts of NLP and identify the NLP challenges and issues	PO1	PSO11	U, An	C, P
CO2	Illustrate computational methods to understand language phenomena of word sense disambiguation	PO2	PSO12	U, An	C, P
CO3	Apply different Machine translation techniques for translating a source to target language(s)	PO4	PSO11	Ap, An	C, P
CO4	Develop Language Modeling for various text corpora across the different languages	PO2	PSO9	Ap, An	C, P
CO5	Design and develop applications for text or information extraction/summarization/classification	PO3	PSO11	Ap, An	C, P
CO6	Apply Machine translation in NLP	PO2	PSO9	Ap, An	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction to NLP: Components of NLP, Applications of NLP, Building an NLP Pipeline- Phases of NLP- NLP tasks in syntax, semantics, and pragmatics. Approaches to NLP-Applications- information extraction, question answering, and machine translation.

MODULE II

Language Modeling and Part of Speech Tagging: Unigram Language Model, Bigram, Trigram, N-gram, Advanced smoothing for language modeling, Empirical Comparison of Smoothing Techniques, Applications of Language Modeling, Parts of Speech Tagging, Morphology, Named Entity Recognition.

MODULE III

Words and Word Forms: Bag of words, skip-gram, Continuous Bag-Of-Words, Embedding representations for words Lexical Semantics, Word Sense Disambiguation, Knowledge Based and Supervised Word Sense Disambiguation.

MODULE IV

Text Analysis, Summarization and Extraction: Sentiment and Opinion Analysis, Text Classification, Text Summarization, Information Extraction, Named Entity Recognition, Relation Extraction, Question Answering in Multilingual Setting; NLP in Information Retrieval. Text Analysis, Summarization and Extraction: Sentiment and Opinion Analysis, Text Classification, Text Summarization, Information Extraction, Named Entity Recognition, Relation Extraction, Question Answering in Multilingual Setting; NLP in Information Retrieval.

MODULE V

Machine Translation: Need of MT, Problems of Machine Translation, MT Approaches, Direct Machine Translations, Rule-Based Machine Translation, Knowledge Based MT System, Statistical Machine Translation (SMT), Neural Machine Translation.

MODULE VI

Applications: NLP APIs, NLP Libraries - Sentimental classification using BERT- Text Classification with LSTM- Natural Language Generation- NLP with Machine learning - Speech recognition techniques and NLP.

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" 2ed.2017.
- Ruslan Mitkov, "The Oxford Handbook of Computational Linguistics", Oxford
- University Press 2003.
- Dan Jurafsky and James H. Martin, "Speech and Language Processing" 3ed., Draft chapters in progress, October 16, 2019.
- Philipp Koehn , "Statistical Machine Translation", 2016.

Semester: 3	Course Code: CCS-CC-534	Credits: 3

APPLICATION DEVELOPMENT LABORATORY

Preamble: This is a practical course on Mobile Application Development and student will learn how to program in Real-time Platform and develop applications on open source and other smart applications.

Prerequisite: Database Systems for Bigdata, Basic knowledge in programming.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand ViewData and LiveData in android platform	PO2	PSO12	U, Ap, An	C, P
CO2	Develop various Android applications related to layouts, GUI components etc	PO4	PSO6	Ap, Cr	C, P
CO3	Apply Layout Management to create adaptable User Interface	PO1	PSO12	Ap, An	C, P
CO4	Develop an application that makes use of database	PO3	PSO9	Ap, Cr	C, P
CO5	Develop user interface for mobile Application	PO5	PSO12	Ap, Cr	C, P
CO6	Create various games in Flutter	PO1	PSO9	Ap, Cr	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

Students are able to do their experiments in the following area.

Warmup Cycle

- Write an application that draws basic graphical primitives on the screen.
- Develop an application that uses GUI components, Font and Colors.
- Develop an application that uses Layout Managers and event listeners.
- Implement an application that implements Multithreading.
- Create a simple app with text view and edit text.
- Develop a native calculator application.

Android Cycle

- App to demonstrate generating sine wave with fixed and variable frequency.
- Develop an application that makes use of database.
- Develop an application that makes use of RSS Feed.
- Develop a native application that uses GPS location information.
- Implement an application that writes data to the SD card.
- Implement an application that creates an alert upon receiving a message.

- Write a mobile application that creates alarm clock.

Kotlin Cycle

- Create a game Tic- Tac-Toe using Kotlin.

Flutter Cycle

- Create a 2D snake game in flutter.
- Develop an online Shop app in flutter.
- Develop a nutritional app user interface using flutter.
- Portfolio Website using Flutter.

ASSESSMENT

Basic laboratory programs: 30 marks

The basic level gives an awareness of the course through a set of programming exercises.

Mini Project/Case Study Evaluation: 50 marks

At the advanced level, advanced programming exercises are given to understand the application level of the course.

End Semester Viva: 20 marks

The students answer questions in speech, which are commonly based on the respective course discipline. Viva questions are an important part of an academic program and often occur after a semester/year.

Laboratory Record: All Students attending the End Semester Viva should prepare a Fair record and should be produced at the time of evaluation. The record should be certified by the Faculty-in-charge of the laboratory countersigned by the Course coordinator.

Semester: 3	Course Code: CCS-CC-535	Credits: 2

CASE STUDY

Preamble: The objective of doing Case Study allows students with real expertise and understanding, how and why an innovation has worked in a specific case.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Identify a research problem which is significant in the area of computer science	PO1	PSO1	U	F
CO2	Analyze the literature survey in the selected topic as an individual	PO2	PSO2, PSO12	An	C,F
CO3	Design the experiment with proper hypothesis	PO4	PSO9	Ap	C,F
CO4	Evaluate and interpret the experimental results	PO5	PSO6, PSO12	An	F
CO5	Analyze effectiveness of the method implemented	PO3	PSO1	Ap	C
CO6	Suggest modifications and improvement of the system	PO4	PSO2	Ap	M,C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

A case study is a detailed investigation done by a student on a specific topic in the courses studied till Semester III. It is a milestone and precursor to the final presentation of the Project. The students must implement a published article from the Research and Development area. The presentation will be oral. A faculty member is assigned by the Department council for each student to select the case. The case study report should contain the case's background, analysis, alternatives, recommendations, and implementation plan. Students can use 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, and defending the questions.

ASSESSMENT

Continuous interaction and Discussion with guide: 20 marks
Continuous interaction and work progress will lead to a valuable contribution to the final project work.

Case study Report: 30 marks
A technical report on studies and experiments will improve your technical writing skill.

Presentation and Viva: 50 marks

The presentation skills of the students are evaluated systematically.

Semester: 3	Course Code: CCS-DE-536(i)	Credits: 3

HUMAN COMPUTER INTERACTION

Preamble: This course enables students to acquire skills to properly understand and design the relationship between the "humans", on one side and the "computers"(websites, apps, services, etc.), on other side. It deals with the design, execution and assessment of computer systems and related phenomenon that are for human use. It concerned with designing interactions between human activities and the computational systems that support them, and with constructing interface to afford those interactions.

Prerequisite: Computer Graphics, Software Engineering.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Identify the concepts of Human Computer Interaction	PO1	PSO2	U	C, P
CO2	Distinguish between Human I/O and Computer devices, memory and reasoning	PO4	PSO9	An	C, P
CO3	Illustrate interaction models, interface design and cognitive aspects	PO2	PSO12	U, Ap	C, P
CO4	Discuss various evaluation techniques of HCI patterns	PO5	PSO6	An, Ap	P, C
CO5	Demonstrate the lifecycle of HCI software process	PO1	PSO2	An, Ap	P, C
CO6	Explain cognitive models and architectures	PO3	PSO12	An, Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: History of HCI, Foundations of HCI - The Human: I/O channels – Memory – Reasoning and problem solving; The Computer: Devices– Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.

MODULE II

Interactive Design: process – scenarios – navigation– screen design – Iteration and prototyping. Understanding and Conceptualizing Interaction: Conceptual Models – Interface Metaphors – Interaction Types– Paradigms and Frameworks. Cognitive Aspects: Cognition – Cognitive Framework. Social Interaction – Emotional Interaction, Design rules: principles, standards, guidelines, rules, Evaluation Techniques – Universal Design.

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

HCI in the software process: software life cycle, Usability engineering Iterative design and prototyping Design: Prototyping in practice Design rationale Design rules Principles to support usability Standards Golden rules and heuristics.

MODULE V

HCI patterns: Evaluation techniques, Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method. Universal design, Universal design principles- Multi-modal interaction.

MODULE VI

Applications: Cognitive models goal and task hierarchies design focus, challenge of display-based systems, physical and device models, Cognitive architectures, Research design focus. Shared experience design focus, Information and data visualization design focus. Ubiquitous computing and augmented realities-applications.

LEARNING RESOURCES

References

- Dix, J. Finlay, G. D. Abowd and R. Beale, "Human Computer Interaction", 3ed, Pearson Education, 2005.
- Sharp, H., Rogers, Y., and Preece, J, "Interaction Design: Beyond Human – Computer Interaction", 3ed., John Wiley & Sons, Inc., 2011.
- Wilbert O. Galitz, "The Essential Guide to User Interface Design: An Introduction to Gui Design Principles and Techniques", 3ed., John Wiley Sons, 2002.

Semester: 3	Course Code: CCS-DE-536(ii)	Credits: 3

HIGH PERFORMANCE COMPUTING

Preamble: The aim of this course is to study the fundamental techniques for developing HPC applications, commonly used HPC platforms, and the methods for measuring, assessing and analyzing the performance of HPC applications, and the role of administration, workload and resource management in HPC management software. This course enables students for developing, analyzing, and implementing parallel and locality-efficient algorithms.

Prerequisite: Computer Networks, Distributed systems.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Illustrate the architecture of cluster computing	PO3	PSO1	U, An	C, P
CO2	Identify the concepts of distributed memory and shared memory	PO1	PSO6	U	C, P
CO3	Demonstrate the working of high-end computer systems	PO4	PSO5	U, Ap	C, P
CO4	Discuss the nature and working of grid computing	PO2	PSO6	U, Ap	C, P
CO5	Explain Task Computing and Task-based Application Models	PO5	PSO9	An, Ap	C, P
CO6	Discuss about Market-based management of clouds	PO1	PSO12	An	C, P
CO7	Illustrate the use SPMD Programming	PO3	PSO1	U, An	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Cluster Computing: Introduction to Cluster Computing, Scalable Parallel Computer Architectures, Cluster Computer and its Architecture, Classifications, Components for Clusters, Cluster Middleware and Single System Image, Resource Management and Scheduling, Programming Environments and Tools, Applications, Representative Cluster Systems, Heterogeneous Clusters, Security, Resource Sharing, Locality, Dependability, Cluster Architectures, Detecting and Masking Faults, Recovering from Faults, Condor, Evolution of Meta computing.

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

Grid Computing: Introduction to Grid Computing, Virtual Organizations, Architecture, Applications, Computational, Data, Desktop and Enterprise Grids, Data-intensive Applications, High-Performance Commodity Computing, High-Performance Schedulers, Grid Computing Security, Introduction to GridSim.

MODULE IV

Cloud Computing: Introduction to Cloud Computing, Types: Deployment and Service Models, Characteristics, Applications, Service-Level Agreement, Virtualization, High-Throughput Computing: Task Computing and Task-based Application Models, Market-Based Management of Clouds, Energy-Efficient and Green Cloud Computing Architecture, Resource Allocation, Leases, Task Scheduling.

MODULE V

Single Program Multiple Data (SPMD) Programming (threads, OpenMP, MPI): I/O and File Systems, Partitioning Global Address Space (PGAS) languages (UPC, Titanium, Global Arrays).

MODULE VI

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

LEARNING RESOURCES

References

- Georg Hager a Gerhard Wellei,." Introduction to High Performance Computing for Scientists and Engineers", 1ed. CRC Press, Chapman Hall/CRC Computational Science, India, 2010.
- Vipin Kumar, Ananth Grama, Anshul Gupta, George Karypis, "Introduction to Parallel Computing", 2ed. Pearson India. 2003.
- Hurwitz, Bllor, Kaufman, Halper, "Cloud Computing for Dummies", Wiley India.
- Anthony Velte, Toby Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGrawHill.

Semester: 3	Course Code: CCS-DE-536(iii)	Credits: 3

OPTIMIZATION TECHNIQUES

Preamble: The course provides the students with knowledge of optimization techniques and approaches. After completing the course, students can formulate a real-world problem as a mathematical model and find solutions.

Prerequisite: Foundation in algebra.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Identify the concepts of optimization techniques and its types	PO1	PSO3	U	C, P
CO2	Discuss different optimum design concepts and methods	PO3	PSO8	An	C, P
CO3	Solve the Linear Programming models using graphical and simplex methods	PO4	PSO3, PSO4	U, Ap	C, P
CO4	Concept of optimality and its applications	PO2	PSO6	U, An	P, M
CO5	Explain the need of optimization of engineering systems	PO3	PSO5, PSO7	U	P, C
CO6	Evaluate different algorithmic methods for solving constrained and unconstrained optimization problems	PO2	PSO3, PSO8	An	P
CO7	Illustrate how dynamic programming used to solve multi stage decision problems	PO3	PSO8, PSO10	Ap	C, P
CO8	Introducing multisite dynamic problems	PO4	PSO12	Ap, E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

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

- Kalyanmoy Deb, "Optimization for Engineering Design, Algorithms and Examples" - Prentice Hall of India, New Delhi, 2012.
- Mokhtar S. Bazaraa, John J. Jarvis, Hanif D. Sherali, "Linear Programming and Network Flows", Wiley, 2010.
- Singiresu S. Rao, "Engineering Optimization: Theory and Practice", 5ed., New Age International Publishers, 2013.

Semester: 3	Course Code: CCS-DE-536(iv)	Credits: 3

NATURE INSPIRED COMPUTING

Preamble: This course provides an overview of popular nature-inspired computing methods. Methods that are inspired by both biological and non-biological systems are considered. These methods have been applied to solve problems in various areas of computing, such as optimization, machine learning, and robotics. Examples of nature-inspired computing methods studied include cellular automata, neural networks, evolutionary computing, swarm intelligence, artificial life, and complex networks. Contributions made in nature-inspired computing that have led to advances in the natural sciences are also discussed.

Prerequisite: Algorithms-complexity and Optimization.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Describe about bio inspired computing fundamentals	PO3	PSO3	U	C, P
CO2	Explain about optimization problems and its types	PO4	PSO8	U, An	C, P
CO3	Familiar with Genetic algorithm and its applications	PO1	PSO3	U	C ,P
CO4	Compare different Ant Colony Optimization algorithmic models	PO2	PSO6	U, An	P, M
CO5	Compare different Artificial Bee Colony Optimization algorithmic model	PO1	PSO5	An	P, C
CO6	Illustrate Particle swam optimization algorithm with an example	PO2	PSO3	AP	P
CO7	Compare different natural inspired computing algorithms	PO3	PSO1	An	C, P
CO8	Real world problem with nature inspired optimization	PO2	PSO12	Ap, E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

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 optimization, 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.

Semester: 3	Course Code: CCS-DE-536(v)	Credits: 3

SOFTWARE TESTING

Preamble: Aim of the course is to study the creation of test cases for white-box, black-box, and grey-box approaches. This course describes the various techniques for test case design used to test software artifacts, including requirements, design, and code. The course includes different techniques for test case design based on graphs, programming language syntaxes and inputs. The course also covers symbolic execution using PEX tool.

Prerequisite: Software Engineering for Industry.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods	PO3	PSO8	U	F, C
CO2	Discuss various software testing issues and the test methods like unit test; integration, regression, and system testing	PO2	PSO8	Ap	C
CO3	Understand the different types of testing and essential characteristics of tool used for test automation	PO3	PSO6, PSO8	U	C
CO4	Understand the functional and system testing methods	PO1	PSO8	U	F, C
CO5	Understand important concepts of complexity metrics	PO3	PSO8	E	F, C
CO6	Understand the process of applying tests to software and the methods for defining test cases	PO4	PSO12	An	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Software Testing Principles: The Tester's Role in a Software Development Organization – Origins of Defects – Cost of defects – Defect Classes. Testing Process - Level 0 thinking, Level 1 thinking, Level 2 thinking, Level 3 thinking, Level 4 thinking. Software Testing Terminologies - Verification, Validation and Testing, Faults, Error and Bug, Test cases, Coverage Criteria.

MODULE II

Structured approach to Testing: Developing Testing methodologies – Levels of Testing – Acceptance Testing – Special Tests – Testing Tools. Test planning - Test strategy – Test plan templates (System testing) – Guidelines for developing test plan. Building Test data and Test cases.

MODULE III

Test case Design Strategies: Black Box testing, White Box testing, Grey Box testing- Using Black Box Approach to Test Case Design – Boundary Value Analysis, Equivalence Class Partitioning, Cause-effect. Using White Box Approach to Test design –static testing vs. structural testing, code functional testing, Control Flow Graphs, Path coverage testing. Gray Box Methodology- Techniques of Grey Box Testing.

MODULE IV

Mutation testing: Mutation and Mutants, Mutation operators, Mutation score. Test metrics and Test reports – categories of the product/project test metrics, defect density – defect leakage ratio test case efficiency, guidelines for writing and using test report, benchmarking. Testing OO systems.

MODULE V

*Software test automation: S*kills needed for automation – scope of automation – design and architecture for automation – requirements for a test tool – challenges in automation – Test metrics and measurements – project, progress and productivity metrics.

MODULE VI

Applications: JUnit, Mutation testing using Junit and Muclipse, Graph Based testing using JUnit Framework, Black Box testing approaches using JUnit, Parameterized Unit Testing (PEX), Load testing, GUI testing, Website testing.

LEARNING RESOURCES

References

- Srinivasan Desikan and Gopalaswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education, 2006.
- Ron Patton, "Software Testing", 2ed., Sams Publishing, Pearson Education, 2007.
- Paul Ammann and JeffOffutt, "Introduction to Software Testing".
- Kshirasagar Naik and Priyadarshi Tripathy, Software Testing And Quality Assurance: Theory And Practice.
- King, James C, "Symbolic Execution and Program Testing", Association for Computing Machinery, July 1976.
- "Software Testing, Principles , Techniques and Tools" - M G Limaye, TMHB.

On-line Resources

- https://www.csc.ncsu.edu/academics/undergrad/honors/thesis/muclipsebinder.pdf - Muclipse tutorial.

Semester: 3	Course Code: CCS-DE-537(i)	Credits: 3

IMAGE PROCESSING

Preamble: This course is to provide the basic concepts and methodologies for Digital Image Processing, spatial and frequency domain concepts for enhancement, Convolution, correlation techniques and Otsu thresholding.

Prerequisite: Linear Algebra, Computer Graphics and Discrete Mathematics.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Perform Smoothening and Sharpening in Spatial and frequency domain	PO1	PSO10	Ap	C,P
CO2	Illustrate the skillset to solve real life problems using image processing	PO4	PSO9	An, E	C, P
CO3	Implement basic image enhancement and restoration algorithms	PO3	PSO10	Ap, An, E	C, P
CO4	Compare Convolution and Correlation techniques	PO1	PSO2	U, Ap	C, P
CO5	Apply different segmentation and noise removal in an image	PO5	PSO9	Ap	P
CO6	Apply Otsu thresholding in an image	PO2	PSO10	Ap	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Digital Image Fundamentals: Steps in Image Processing Systems, Color Models – RGB, HSI, YCbCr models, Image Sampling, Quantization, Interpolation techniques.

MODULE II

Spatial Domain: Gray level transformations – Histogram Equalization– Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering. Convolution and Correlation.

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– Inverse Filtering – Wiener filtering. Image Segmentation-Edge detection– Thresholding - Region based segmentation – Region growing – Region splitting and merging – Watershed segmentation algorithm.

MODULE VI

Applications: Image Enhancement using CLAHE- Image Denoising – Otsu Thresholding- CLAHE- Shape Extraction – Color model conversions - RGB to HSI, YCbCr – Apply Restoration filters.

LEARNING RESOURCES

References

- A.K. Jain, "Fundamentals of Digital Image Processing Fundamentals of Digital Image Processing: United States Edition", 2005.
- ∉ A. Rosenfeld and A.C. Kak, "Digital Picture Processing".
- ∉ Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 3ed., PHI, 2007.
- ∉ William K. Pratt, "Digital Image Processing: PIKS Scientific Inside", Wiley Interscience, 4ed., 2007.
- ∉ S.Jayaraman, S. Esaki Rajan, T.Veera Kumar, "Digital Image Processing", Tata McGraw Hill Pvt. Ltd., 2010.

Semester: 3	Course Code: CCS-DE-537(ii)	Credits: 3

APPLIED MACHINE LEARNING

Preamble: Students will learn how to correctly apply, interpret results. Iteratively refine and tune supervised and unsupervised machine learning models to solve diverse problems on real-world datasets. Application is emphasized over theoretical content. The main aim of the course is to provide skills to apply machine learning algorithms to real applications.

Prerequisite: Machine Learning, Soft Computing, Statistical Learning Techniques and Programming in Python language.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand PCA and its use	PO1	PSO5	U	C, P
CO2	Understand about fuzzy systems and networks	PO2	PSO8	U	C, P
CO3	Use fuzzy set theory for solving problems	PO4	PSO5, PSO6	U, An	C, P
CO4	Understand concept of ensembles and interconnected models	PO1	PSO7	U	P, M
CO5	Ensemble and adaBoost classifiers for Machine learning	PO5	PSO5	U, Ap	P, C
CO6	Compare different unsupervised ANN and their learning models	PO2	PSO10	An	P,M
CO7	Familiar with advanced ANN frameworks of SOM, ART, PNN	PO1	PSO11	U	C, P
CO8	Familiarization of real-world problems in Machine learning	PO5	PSO12	Ap, E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Dimensionality reduction and Visualization: Dimensionality reduction basics, Row vector, and Column vector, how to represent a dataset? How to represent a dataset as a Matrix, Data preprocessing: Feature Normalization, Mean of a data matrix, Data preprocessing: Column Standardization, Co-variance of a Data Matrix. Principal Component Analysis: Why learn it? Geometric intuition, Mathematical objective function, Alternative formulation of PCA: distance minimization, Eigenvalues and eigenvectors, PCA for dimensionality reduction and visualization, Limitations of PCA, PCA for dimensionality reduction.

MODULE II

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.

MODULE III

Ensemble classifier: Types of ensembles, Simple ensemble models, Advanced ensemble models, AdaBoost, Bayes Optimal classifier, Bayesian model averaging, Gradient boosting. Applying boosting models, XGBoost, Stacking ensembles, Ensemble models in dynamic applications.

MODULE IV

Pattern Association: Hebb rule, Outer products rule, Auto associative memory, hetro associative memory, Bidirectional associative memory, Hopfield networks Self-Organising Maps: Architecture of SOM, Learning Process of SOM, SOM Algorithm, SOM Example, Implications of SOM. Applications of SOM.

MODULE V

Adaptive Resonance Theory: Architecture and Operation, Implementation of ARTMAP Network, ART Example, Implications of ARTMAP Network. Recurrent Neural Network, Hopfield Networks, Boltzmann Machines, Training Boltzmann Machine, Restricted Boltzmann Machine, Probabilistic Neural Network: PNN Architecture, PNN Algorithms, Implications of PNN. Comparison of Neural Network Structures.

MODULE VI

Real world problems: Quora Question pair similarity problem, Microsoft Malware Detection, AD-Click Prediction, Human Activity Recognition, Self-Driving Car, Music Generation using Deep Learning, Survey Blog, Movie Recommendation System, Fashion Discovery Engine.

LEARNING RESOURCES

References

- M. Gopal, "Applied Machine Learning", McGraw-Hill Education, 2019.
- David Forsyth, "Applied Machine Learning", Springer International Publishing, 2019.
- Vinod Chandra S S, Anand H S, "Machine Learning: A Practitioners Approach", Prentice Hall of India, New Delhi, 2020.
- Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2020.

Semester: 3	Course Code: CCS-DE-537(iii)	Credits: 3

BRAIN COMPUTER INTERFACE

Preamble: Brain-computer interfaces (BCIs) allow their users to communicate or control external devices using brain signals rather than the brain's normal output pathways of peripheral nerves and muscles. BCI review the BCI-relevant signals from the human brain, and describe the functional components of BCIs. This course emphasis is on electroencephalogram (EEG) signals, which is the most common source for brain-computer interfaces and the kind of signals. It also covers the design principles of complex brain-controlled devices beyond recording brain signals, enhancing their signal-to-noise ratio, and decoding subjects' intents and cognitive states.

Prerequisite: Data structures, Pattern Recognition, Machine Learning, Signal Processing, Python Programming (or any other equivalent Programming Language).

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Understand the overview of a Brain-Computer Interface, related hardware and brain sensing devices (EEG, fMRI, etc.)	PO1	PSO7	U	C, P
CO2	Analyze and understand different brain activation patterns and potentials	PO1	PSO9	U, An, Ap	C, P
CO3	Use of different data processing methods and techniques for effective Brain-computer interfaces	PO2	PSO2, PSO5	An, Ap	C, P
CO4	Acquiring skill set in implementing Machine Learning and Artificial intelligence algorithms for Brain-computer interfaces	PO3	PSO2, PSO5	U, Ap	C, P
CO5	Understanding of Cognitive Neuroscience for implementing better Brain-computer interfaces	PO3	PSO7	U, Ev	C, P
CO6	Conduct case studies and analyze the results	PO3	PSO4	An, Ev	C, M
CO7	Research on open areas of Brain-Computer Interfaces	PO1	PSO7	U	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Brain structure and function, Brain Computer Interface Types – Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI – Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, EcoG, MEG, fMRI.

MODULE II

Brain activation patterns: Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

MODULE III

Data Processing: Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization and coherence.

MODULE IV

Classification techniques: Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis - Introduction to deep learning-. Convolutional Neural Network, building blocks of CNN, Transfer Learning, Hyper parameter tuning, batch normalization, pre-trained models, Recurrent Neural Networks (RNN), Long Short Term Memory (LSTM), Gated Recurrent Unit (GRU), Encoder Decoder architectures, Auto encoders.

MODULE V

Cognitive Neuroscience: Peripheral and central nervous system, brain structure, motor pathways, Cognitive functions of the brain, brain computer interface types, Electrophysiology, Neuropsychology and Neuro imaging methods in cognitive neuroscience. Cognitive Neuroscience of Attention :Cognitive functions of the brain, Attention and perception; Attention and neglect, Frontal lobe functions, the multifaceted human attention system and its relationship with sensory and other cognitive systems, Behavioral outcomes of dysfunctions of attention, Research methodology used in measuring attention.

MODULE VI

Case Study: Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection, Ethics of Brain Computer Interfacing.

LEARNING RESOURCES

References

- Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, 1ed., 2013.
- Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, 1ed., January 2012.
- Guger C, Allison BZ, Gunduz, "A. Brain-computer interface research: a state-of-the-art summary", Springer International Publishing, 2021.

Semester: 3	Course Code: CCS-DE-537(iv)	Credits: 3

AUGMENTED REALITY IN METAVERSE

Preamble: The course focuses on the concepts of augmented reality, extended reality and virtual reality. Students will learn architecture of metaverse, metaverse in artificial intelligence and education.

Prerequisite: Artificial Intelligence, Programming skills.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Visualise the world of immersive technologies including virtual and augmented reality	PO1	PSO6	U, An, Ap	C,P
CO2	Illustrate the architecture of Metaverse	PO2	PSO12	U, An	C,P
CO3	Create a Metaverse Application in Spark AR	PO4	PSO12	Ap, An	C,P
CO4	Applications of Metaverse in Education	PO1	PSO9	Ap, An	C,P
CO5	Hands on Expertise with Spark AR software	PO4	PSO6	Ap, An	C,P
CO6	Apply Metaverse technologies in AI	PO3	PSO12	Ap, An	C,P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Introduction: Origin of the Metaverse- Definition and Features of metaverse- Convergence of the virtual and real world- Augmented Reality – Extended Reality – Virtual Reality, Digital identity, Immersive and multisensory experience - Three layer architecture of metaverse Shaping of metaverse– Discovery- Conceptualization- Story Telling Case studies.

MODULE II

Metaverse in Artificial Intelligence: Automatic digital twin – Computer Agent- Autonomy of Avtar- Visual localization and Mapping- Human Pose and Eye Tracking- Holistic Scene Understanding- Semantic Segmentation and Object Detection - Image Enhancement and restoration.

MODULE III

Framework of the Metaverse in education: Computing and analytical technologies, Modeling and rendering technologies- Interaction Technologies- Smart Wearable

Device- Avtar - Learning Scene- Learning analysis-learning activity- Features of metaverse in education- Metaverse and Blended Learning- Virtual Experimental learning.

MODULE IV

Extended reality: Building a Meaningful Learning Experience with XR- Immersion – Interactivity – Invisibility- Increasing Interest and Motivation to Learn- Visualization- Personalization- Active learning – Game based learning- Immersive Story telling.

MODULE V

Introduction to Spark AR software: Face Effects –Green Umbrella Angel Case Study, Adding Assets to a Face Effect Project , Adding Face Mesh, Materials and Textures , Attaching 2D Objects onto a Face, Attaching 3D Objects onto a Face - Testing AR Effects.

MODULE VI

Layers in Spark AR: Background Segmentation-Introduction to Image Sequences - Animation Using Image Sequences -Adding Foreground Stickers- Adding Sounds into your Face Effects- Introduction to Target Tracking -AR Flower Collection Case Study -AR Map Case Study - Initiating the Target Tracker

LEARNING RESOURCES

References

- Zhang, X., Chen, Y., Hu, L., & Wang, Y. (2022), „The metaverse in education: Definition, framework, features, potential applications, challenges, and future research topics", Frontiers in Psychology, 13.
- Lee, L. H., Braud, T., Zhou, P., Wang, L., Xu, D., Lin, Z., ... & Hui, P. (2021), "All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda", arXiv preprint arXiv:2110.05352.
- Kiong, Liew Voon, "Metaverse Made Easy: A Beginner's Guide to the Metaverse: Everything you need to know about Metaverse", NFT and GameFi, 2022.

Semester: 3	Course Code: CCS-DE-537(v)	Credits: 3

CLOUD COMPUTING

Preamble: This course focuses on basic concepts, types and applications of cloud computing Students will learn different deployment models and services offered by cloud and the security issues in cloud.

Prerequisite: Computer Architecture, Computer Networks, Distributed Systems.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Discuss about Cloud Computing, its types and applications	PO1	PSO1	U	C
CO2	Illustrate the application of Cloud Computing on technology, infrastructure, and globalize workspace	PO2	PSO9	Ap	C, P
CO3	Discuss the issues and challenges related to cloud computing	PO4	PSO1	U	C
CO4	Analyse the security and authentication management in cloud	PO1	PSO6	An	C, P
CO5	Design a private cloud and integration of different types of cloud	PO5	PSO1	An	C, P
CO6	Summarize the steps of developing AWS instances, volumes and understanding AWS services	PO3	PSO6	E	C, P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

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 Application: Cloud SOA, Basics of developing a private cloud, Moving applications to the cloud, Integration of clouds.

MODULE VI

Cloud computing applications: Amazon web services, managing and creating Amazon EC2 instances and EBS volumes, Simple Storage Service (S3).

LEARNING RESOURCES

References

- Barrie Sosinsky ,"Cloud Computing Bible", 2011, Wiley-India.
- Nick Antonopoulos, Lee Gillam, "Cloud Computing: Principles, Systems and Applications" 2012, Springer.
- Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", 2011, Wiley.

Semester: 3	Course Code: CCS-SE-4B3	Credits: 2

PUBLICATION ETHICS AND RESEARCH PRACTICES

Preamble: This course focuses on the basics of the philosophy of science and ethics, research integrity, and publication ethics. Sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open-access publications, research metrics (citations, h-index, impact factor, etc.) and plagiarism tools are introduced in this course.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Develop research skills in a student	PO2	PSO8	Ap, An	C
CO2	Provide expertise in writing a research article	PO1	PSO12	Ap	C, P
CO3	Able to compare Copyright, Trademark and Patent	PO3	PSO6	An	C
CO4	Assess the quality of scientific publications	PO4	PSO8	An	C
CO5	Identify whether a journal is indexed in WoS and Scopus	PO5	PSO3	U, An	C, P
CO6	Understand the best practices followed for performing research	PO4	PSO4	U, Ap	C
CO7	Analyse the publication ethics practiced in research	PO2	PSO8	An	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

MODULE I

Research Skills: Introduction, Research Process, how to read a research paper? Steps to perform Literature Review- Structure of Research Report, Layout of Research paper, Mechanism of writing a research Thesis, IMRAD format.

MODULE II

Article level Metrics: H-index- i10- index- g index- Altmetrics - Google Scholar- Journal Level Metrics- Impact factor- SCImago Journal ranking, Scientometrics -Citations- ORCID ID, Journal Citation Report, SNIP, SJR, Cite Score.

MODULE III

Indexing Databases: Citation databases- Web of Science, Scopus. Intellectual Property Rights- Copyrights, Trademarks and Patents, IPR Laws. Creative commons licenses. Digital Object Identifier (DOI), Journal - ISSN. Referencing styles- IEEE, Vancover, APA style

MODULE IV

Publication Ethics: Committee on Publication Ethics (COPE)- Predatory publishers and journals. Scientific Conduct: Intellectual honesty and research integrity - Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP)- Redundant publications: duplicate and overlapping publications.

MODULE V

Best Practice in Scholarly Publishing: Directory of Open Access Journals (DOAJ), the Open Access Scholarly Publishing Association (OASPA), Publication: Steps for publication- Paper Publication Process- Peer Review Process- Open Access publications.

MODULE VI

Applications: Prepare References using reference management software including Mendeley, Zotero. Plagiarism Checking software including Turnitin, Urkund. Publication: Steps for publication- Paper Publication Process– Prepare documents with creative common licences. Identify whether a journal is indexed in WoS and Scopus.

LEARNING RESOURCES

References

- Kara, Helen. "Research ethics in the real world". Bristol: Policy Press, 2018.
- Sismondo, Sergio, and Mathieu Doucet. "Publication ethics and the ghost management of medical publication." Bioethics, 2010.
- Paneerselvam. R, "Research Methodology", 2ed., PHI, 2014.
- Vinod Chandra S S, Anand H S, "Research Methodology", Pearson Education, 2017.
- Santhosh Kumar Yadav, Research and Publication Ethics, Ane Books 2020
- Beisiegel, Ulrike. "Research integrity and publication ethics." Atherosclerosis, 2010.

Semester: 3	Course Code: CCS-SE-4B4	Credits: 2

MASSIVE ONLINE OPEN COURSE (MOOC)

Preamble: MOOCs enable access to quality education for as many students as possible and contribute to the continuous education of various social groups. MOOCs can be addressed to the unemployed, helping them develop skills needed for employability.

Prerequisite: Nil.

COURSE CONTENT

Massive Open Online Courses (MOOCs) are free online courses for anyone to enroll. MOOCs provide an affordable and flexible way to learn new skills, advance your career and deliver quality educational experiences at scale. Millions of people worldwide use MOOCs to learn for various reasons, including career development, changing careers, college preparations, supplemental learning, lifelong learning, corporate eLearning and training, and more. For instance, SWAYAM provides an integrated platform for online courses, using information and communication technology (ICT) and covering courses for post-graduate subjects, including skill sector courses, to ensure that every student benefits from learning material through ICT.

The Department Council will announce the sources of MOOC at the time of the semester beginning. Students can choose their course from MOOC as per their choice and inform the course coordinator before they join. Each student must submit a report on what MOOC has completed during their M Sc programme to complete their Semester III.

LEARNING RESOURCES

Online Resources

- https://www.ugc.gov.in/pdfnews/8449573_Intruction-Manual.pdf

Semester: 4	Course Code: CCS-CC-541	Credits: 18

DISSERTATION AND VIVA VOCE

The case study and dissertation are sequentially ordered, where the studies conducted in the initial course can be exploited further in the later. The course aims to equip the students to understand high standard research publications and construct research questions that can be empirically addressed during the study. In addition, the students should understand the purposes, assumptions, and logic inherent in research methodologies. The experimentally evaluated studies should be documented systematically in the form of a dissertation, and it will help the students to prepare their own research publications in later stages. The objectives are:

1. To analyse the practical knowledge for solving a research-oriented problem.
2. To enable the students to experience the method of solving real-life problems under the guidance of a supervisor.
3. To prepare the students for the demand of national/international organizations.
4. To train the students in scientific approaches in solution formulation and result analysis.
5. Develop technical document writing and presentation skills.
6. Inculcate the spirit of collaborative work and time management.

Prerequisite: CCS-CC-535-Case study, Strong foundation of Computational techniques.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Investigate the related and recent works in the area of dissertation	PO2	PSO9	U, An	C
CO2	Apply critical thinking and design new strategies for the work	PO1	PSO2	Ap	C, P
CO3	Implement and analyse the performance of the new method	PO3	PSO5	An	C
CO4	Propose a new algorithm or design in the area of study	PO4	PSO5	An, Ap	C
CO5	Prepare a dissertation on the work done in the prescribed format	PO5	PSO9	U, An, Ap	C, P
CO6	Presentation on the entire work done as part of the course	PO4	PSO1	U, Ap	C

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create,
KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

This programme will equip the student with a skillset on Computational techniques. The courses up to the last semesters will give a comprehensive perspective of the theories and concepts of computational methods. The case study and dissertation are sequentially pipelined to conduct continuous studies through experiments in a particular area of

research. An enthusiastic student can critically evaluate methods and design experiments to evaluate them further for possible contributions. The supervisor will assist the student throughout the course to properly study the problem, design and evaluate the experiments. The finding of the studies should be documented in the form of a dissertation with all the components of a typical research document focusing on the literature reviews, understanding concepts, defining research problems and methods, collecting and analysing data, experimental evaluation and communicating the findings. Students are expected to

- Perform an in-depth study of the topic assigned in light of the detailed study in Semester III.
- Prepare the problem statement with proper objectives with the help of the supervisor.
- Prepare a detailed action plan for conducting the investigation, process flow and design.
- Perform detailed analysis/ modelling/ simulation/ design/ problem solving/ experiment as needed.
- Evaluate and fine-tune the model with proper enhancements and modifications.
- Analyse the outcome of the experiments and studies, and validate with the objectives targeted.
- Prepare the list of achievements and challenges of the studies.
- Plan for a research publication by exploiting the findings of the experiments.
- Prepare a dissertation of the work in the standard format for being evaluated by the External Assessment.
- Present the work precisely and concisely in front of the panel at the evaluation.

The assessment of the course will be carried out in two phases - continuous assessment and end-semester examination. Apart from the continuous monitoring by the respective supervisor, the continuous assessment will consist of two presentations in front of the panel of teachers. The first internal presentation will be carried out in the midst of the semester, which will evaluate the progress and feasibility of the proposal. The second internal presentation will be conducted before preparing for the final presentation. Students have to incorporate the recommendations of the panel while preparing the final dissertation and presentation. A panel chaired by the Head of the Department will conduct the end-semester examination. In addition to the external expert, the supervisor will be a mandatory panel member. The marks will be awarded in the continuous evaluation and end-semester examination in a 40:60 ratio. The assessment will be on the basis of Content (40), Methodology (30), Presentation (20), and Viva (10); where the figure in bracket represents the maximum percentage of grades that can be awarded in each category. In the internal evaluation, the criteria content will be awarded by the respective supervisor based on the continuous monitoring of the work and dissertation, and others by the panel of teachers.

Semester: 4	Course Code: CCS-SE-4B5	Credits: 2

INDUSTRY INTERNSHIP

Preamble: The Internship course provides students with the opportunity to intern in the professional setting of a company, and help develop their abilities as a professional.

Prerequisite: Nil.

COURSE OUTCOMES & TAGGING

Course Outcomes		PO	PSO	CL	KC
CO1	Apply classroom and laboratory concepts and principles in an industry work environment	PO2	PSO12	U, Ap	C,P
CO2	Establish goals by working with supervision to define work objectives for the internship experience	PO1	PSO1	An, Ap	C, P
CO3	Demonstrate time and project management skills by completing the work objectives within the specified time limits	PO3	PSO6	An	P
CO4	Demonstrate the ability to work as a team member to successfully complete the assigned work objectives in an assigned company work group.	PO4	PSO12	An, Ap	P
CO5	Demonstrate the ability to effectively present ideas and solutions in the context of written, oral, and electronic media.	PO5	PSO6	U, An, Ap	C, P
CO6	Demonstrate and promote a proper work ethic	PO4	PSO3	U, Ap	P

(CL- Cognitive Level: R-remember, U-understand, Ap- Apply, An-Analyse, E- Evaluate, Cr- Create, KC - Knowledge Category: F-Factual, C- Conceptual, P-Procedural, M- Metacognitive)

COURSE CONTENT

Internships are educational and career development opportunities, providing practical experience in a field or discipline. They are structured, short-term, supervised placements focused on particular tasks or projects with defined timescales. An internship may be compensated, non-compensated, or sometimes may be paid. The internship has to be meaningful and mutually beneficial to the intern and the organization. The internship program's objectives and activities must be clearly defined and understood. The following are the intended objectives of internship training:

- Will expose students to the industrial environment, which cannot be simulated in the classroom, creating competent professionals for the industry.
- Provide possible opportunities to learn, understand and sharpen the real-time technical/managerial skills required on the job.
- Exposure to the current technological developments relevant to the subject area of training.

- Experience gained from the 'Industrial Internship' in the classroom will be used in classroom discussions.
- Create conditions conducive to the quest for knowledge and its applicability on the job.

LEARNING RESOURCES

Online Resources

- https://www.ugc.gov.in/pdfnews/8449573_Intruction-Manual.pdf