Mahatma Education Society's

Pillai College of Engineering

(Autonomous)

Affiliated to University of Mumbai

Dr. K. M. Vasudevan Pillai's Campus , Sector 16, New Panvel – 410 206.

PCE

PILLAI COLLEGE OF ENGINEERING

AUTONOMOUS

Department of Computer Engineering

Syllabus

of

M. Tech. in Computer Engineering

for

The Admission Batch of AY 2024-25

First Year - Effective from Academic Year **2024-25**

Second Year - Effective from Academic Year **2025-26**

as per

Choice Based Credit and Grading System

Mahatma Education Society's

Pillai College of Engineering

Vision

Pillai College of Engineering (PCE) will admit, educate and train a diverse population of students who are academically prepared to benefit from the Institute's infrastructure and faculty experience, to become responsible professionals or entrepreneurs in a technical arena. It will further attract, develop and retain, dedicated, excellent teachers, scholars and professionals from diverse backgrounds whose work gives them knowledge beyond the classroom and who are committed to making a significant difference in the lives of their students and the community.

Mission

To develop professional engineers with respect for the environment and make them responsible citizens in technological development both from an Indian and global perspective. This objective is fulfilled through quality education, practical training and interaction with industries and social organizations.

Dr. K. M. Vasudevan Pillai's Campus , Sector - 16, New Panvel – 410 206

Department of Computer Engineering

Vision

To evolve as a centre of academic excellence and to adapt itself to the rapid advancements in the Computer Engineering field.

Mission

To produce highly qualified, well rounded and motivated graduates who can meet new technical challenges, contribute effectively as team members and be innovators in computer hardware, software, design and application. To pursue creative research and new technologies in computer engineering and across disciplines in order to serve the needs of industry, government, society and the scientific community. To inculcate strong ethical values and responsibility towards society.

Program Educational Objectives (PEOs):

I. Our graduates will have knowledge, skills and attitude that will allow them to contribute significantly to the research and the discovery of new knowledge and methods in computing and enable them to communicate effectively and work in a team.

II. Our graduates will function ethically and responsibly, and will remain informed and involved as full participants in our profession and our society. Our graduates will successfully function in multi-disciplinary teams.

III. Our graduates will apply the basic principles and practices of engineering in the computing domain to the benefit of society and to pursue lifelong learning and professional developments.

IV. Our graduates will use theoretical and technical computer science knowledge to specify requirements, develop a design, and implement and verify a solution for computing systems of different levels of complexity.

Program Outcomes:

Engineering Graduates will be able to:

1. Engineering knowledge:
   Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis:
   Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions:
   Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems:
   Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage:
   Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society:
   Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability:
   Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics:
   Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work:
   Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication:
    Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance:
    Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning:
    Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

1. To analyze, design and develop computer programs using appropriate hardware, software and mathematical models in the areas related to algorithms, system software, multimedia, mobile and web technology, data storage and computing, and networking for efficient and secure systems.
2. To use professional engineering practices, logic and strategies for creating innovative career paths to be an entrepreneur, and an urge to pursue higher studies.
3. To Formulate and solve real life engineering problems for the public health and safety with social and environmental awareness along with ethical responsibility.

The Autonomous status of the institute has given an opportunity to design and frame the curriculum in such a way that it incorporates all the needs and requirements of recent developments in all fields within the scope of the technical education. This curriculum will help postgraduates to attain excellence in their respective field. The curriculum has a blend of basic and advanced courses along with provision of imparting practical knowledge to students through minor and major projects. The syllabus has been approved and passed by the Board of Studies.

Outcome based education is implemented in the academics and every necessary step is undertaken to attain the requirements. Every course has its objectives and outcomes defined in the syllabus which are met through continuous assessment and end semester examinations. Evaluation is done on the basis of Choice Based Credit and Grading System (CBCGS). Optional courses are offered at department level.

Every learner/student will be assessed for each course through (i) an Internal/Continuous assessment during the semester in the form of either Practical Performance, Presentation, Demonstration or written examination and (ii) End Semester Examination (ESE), in the form of either theory or viva voce or practical, as prescribed by the respective Board Studies and mentioned in the assessment scheme of the course content/syllabus. This system involves the Continuous Evaluation of students' progress Semester wise. The number of credits assigned with a course is based on the number of contact hours of instruction per week for the course. The credit allocation is available in the syllabus scheme of each semester.

The performance of a learner in a semester is indicated by a number called Semester Grade Performance Index (SGPI). The SGPI is the weighted average of the grade points obtained in all the courses by the learner during the semester. For example, if a learner passes five courses (Theory/labs./Projects/ Seminar etc.) in a semester with credits C1, C2, C3, C4 and C5 and learners grade points in these courses are G1, G2, G3, G4 and G5 respectively, then learners SGPI is equal to:

$$SGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4G_4 + C_5G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

The learner's up to date assessment of the overall performance from the time s/he entered for the programme is obtained by calculating a number called the Cumulative Grade Performance Index (CGPI), in a manner similar to the calculation of SGPI. The CGPI therefore considers all the courses mentioned in the scheme of instructions and examinations, towards the minimum requirement of the degree learners have enrolled for. The CGPI at the end of this semester is calculated as,

$$CGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + \ldots + C_i * G_i + \ldots + C_nG_n}{C_1 + C_2 + C_3 + \cdots + C_i + \ldots + C_n}$$

The Department of Computer Engineering offers a M. Tech. programme in Computer Engineering. This is a four semester course. The complete course is a **80 credit** course which comprises core courses and department level elective courses. There are 3 department level optional course choices for semester I and II separately. The students have to select one course from each DLOC course list.

Preface by Board of Studies in Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present the **M.Tech Computer Engineering** syllabus effective from the Academic Year 2022-23 . We are sure you will find this syllabus interesting, challenging, and fulfill certain needs and expectations.

Computer Engineering is one of the most sought-after courses amongst engineering students. The syllabus needs revision in terms of preparing the student for the professional scenario relevant and suitable to cater the needs of industry in the present-day context. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully become acquainted with the demands of the industry worldwide. They obtain skills and experience in up-to-date knowledge to analysis design, implementation, validation, and documentation of computer software and systems.

This syllabus is finalized through a brainstorming session attended by Heads of Department and senior faculty members of Department of Computer Engineering. The syllabus falls in line with the vision and mission of the Computer Engineering Department and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

We would like to place on record our gratitude to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

1. Dr. Sharvari S. Govilkar	Coordinator (Chairman)
2. Dr. Prashant P Nitnaware	Member
3. Prof. Varunakshi Bhojane	Member
4. Prof. Payel Thakur	Member
5. Dr. Neeta Deshpande	Member
6. Dr.Jyoti Malhotra	Member
7. Dr.Kavita Sonawane	Member
8. Prof.Pranita Mahajan	Member
9. Mr. Samir Mahindre	Member
10. Prof. Deepti Lawand	Member

Program Structure for
Master of Technology in Computer Engineering
Semester I

W.e.f. A.Y 2024-25

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
CE500	Computer Programming Paradigms	03	--	03	--	03
COMM501	Business Communication and Intellectual Property Rights	03	--	03	--	03
CE51x	Department Level Optional Course-I	03	--	03	--	03
CE52x	Department Level Optional Course-II	03	--	03	--	03
CE53x	Department Level Optional Course-III	03	--	03	--	03
CE501	DLOC Lab-I	--	02	--	01	01
CE502	Dissertation-I	--	02	--	01	01
TOTAL		**15**	**04**	**15**	**02**	**17**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)	Term Work	Oral /Practs	Total
		Test 1	Test 2	Avg					
CE500	Computer programming Paradigms	40	40	40	60	2	-	-	100
COMM501	Business Communication and Intellectual Property Rights	40	40	40	60	2	-	-	100
CE51x	Department Level Optional Course-I	40	40	40	60	2	-	-	100
CE52x	Department Level Optional Course-II	40	40	40	60	2	-	-	100
CE53x	Department Level Optional Course-III	40	40	40	60	2	-	-	100
CE501	DLOC Lab-I	--	--	--	--	--	25	25	50
CE502	Dissertation-I	--	--	--	--	--	25	25	50
TOTAL		**200**	**200**	**200**	**300**	**15**	**50**	**50**	**600**

Department Level Optional Courses :

Every student is required to take 3 Department Elective Courses for Semester I. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

Sr No	Department Level Optional Course-I	Department Level Optional Course-II	Department Level Optional Course-III
1	CE511 Big Data Analytics	CE521 Natural Language Processing	CE531 **User experience Design**
2	CE512 **Ethical Hacking and Digital Forensics**	CE522 Internet of Everything	CE532 High performance Computing
3	CE513 Computer Vision	**CE523 Deep Learning**	CE533 Reinforcement Learning

Program Structure for

Master of Technology in Computer Engineering
Semester II

W.e.f. A.Y 2024-25

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
CE503	Algorithm and Complexity	03	--	03	--	03
CE504	Generative and Explainable AI	03	--	03	--	03
CE54x	Department Level Optional Course-IV	03	--	03	--	03
CE55x	Department Level Optional Course-V	03	--	03	--	03
CE56x	Department Level Optional Course-VI	03	--	03	--	03
CE505	DLOC Lab-II	--	02	--	01	01
CE506	Dissertation-II	--	02	--	01	01
TOTAL		**15**	**04**	**15**	**02**	**17**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)	Term Work	Pract/ Oral	Total
		Test1	Test 2	Avg					
CE503	Algorithm and Complexity -	40	40	40	60	2	--	--	100
CE504	Generative and Explainable AI	40	40	40	60	2	--	--	100
CE54x	Department Level Optional Course-IV	40	40	40	60	2	--	--	100
CE55x	Department Level Optional Course-V	40	40	40	60	2	--	--	100
CE56x	Department Level Optional Course-VI	40	40	40	60	2	--	--	100
CE505	DLOC Lab-II	--	--	--	--	--	25	25	50
CE506	Dissertation-II	--	--	--	--	--	25	25	50
TOTAL		**200**	**200**	**200**	**300**	**15**	**50**	**50**	**600**

Department Level Optional Course :

Every student is required to take 3 Department Elective Courses for Semester II. Different sets of courses will run in both the semesters. Students can take these courses from the list of department electives, which are closely allied to their disciplines.

Sr. No	Department Level Optional Course-IV	Department Level Optional Course-V	Department Level Optional Course-VI
1	**CE541 Data Science**	**CE551 Social Media Analytics**	CE561 Social Computing and Collaboration:
2	CE542 Blockchain Technology	CE552 Network and Cloud Security	CE562 Penetration testing and Vulnerability Assessment
3	CE543 Quantum Intelligence	CE553 Augmented Reality and Virtual Reality	**CE563 AI in Healthcare**

Program Structure for
Master of Technology in Computer Engineering

Semester III

W.e.f. A.Y 2025-26

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
CE600	Internship / Relevant Certification	-	16	-	08	08
CE601	Dissertation-III	-	30	-	15	15
TOTAL		-	46	-	23	**23**

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)	Term Work	Pract/Oral	Total
		Test1	Test 2	Avg					
CE600	Internship / Relevant Certification	-	-	-	-	-	50	50	100
CE601	Dissertation-III	-	-	-	-	-	100	100	200
TOTAL		-	-	-	-	-	150	150	300

Program Structure for

Master of Technology in Computer Engineering
Semester IV

W.e.f. A.Y 2025-26

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
CE602	Dissertation-IV	-	46	-	23	23
		-	46	-	23	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
CE602	Dissertation-IV	-	-	-	-	-	100	100	200
TOTAL		-	-	-	-	-	100	100	200

Semester I

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE500	Computer programming Paradigms	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE500	Computer Programming Paradigms	40	40	40	60	-	-	-	100

1. Course Objectives:

1. To Introduce students to functional, logic and concurrent programming paradigms.
2. To Enable students to formulate newer abstractions in the above paradigms.
3. To Familiarize students with writing functional and Object oriented programs.
4. To Prepare students to solve real-world problems using appropriate programming paradigms.

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Understand and apply the concepts that form the basis of functional, logic and object oriented programming paradigms.
2. Formulate abstractions with procedures and data in different programming paradigms.
3. Write programs in different programming paradigms especially functional, logic and object oriented paradigms.
4. Formulate, implement and solve a given problem scenario using appropriate programming paradigm

3. Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction**	**Overview of different programming paradigms** – Imperative,logical, functional and object-oriented Programming.	**2**

2	**Java Programming**	**Introduction:** Principles of OOP, Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism, Message passing Features of Java Language , Data Types, Operators. **Control Statements:** If-Statement, If-else, Nested-if, Switch Statement, break, continue. **Iteration Statements:** for-loop, while-loop, and do-while-loop.	**8**
3	**Python Programming**	**Introduction:** Features, Identifiers, Keywords, Indention, Variables and Comments, Basic data types: Numeric, Boolean, Compound. **Operators:** Arithmetic, comparison, relational, assignment, logical, bitwise, membership, identity operators, operator precedence. **Control flow statements:** Conditional statements (if, if…else, nested if. Looping in Python: while-loop, for-loop, nested-loops, Loop manipulation using continue, pass, break. **Functions:** Introduction to Functions, Decorators, Iterators and Generators.	**8**
4	**R Programming**	**Introduction:** Basic functionalities of R , data types and operations: numbers, characters and composites, Numeric variables, strings and factors,R packages. **Data structures:** vectors, matrices, lists and data frames.Grouping, loops and conditional execution, Functions. **Exploratory data analysis:** Range, summary, mean, variance, median, standard deviation, histogram, box plot, scatterplot,Graphics and tables , Visualizations and interpretation of results.	**8**
5	**Matlab programming**	**Introduction:** Features, Interface, File Types, Array, Matrix Operation. Arithmetic Operator Logical, Relational. **Branch and Loop:** If-statement, If-else statement, Else-if statement Pause, Break, Continue, Switch-case, try-catch, Return Statement, For Loop,While Loop. Types of Function, Return Types. **Interface and Graphics:** Plotting, Multiple Plot, 2-D Plot, Introduction to Graphical User Interface, GUI Function, Property, GUI Component Design.	**8**
6	**Metaverse Technology**	History, Features, Metaverse value chain, Technologies Involved in the Metaverse. Blockchain Adoption in Metaverse, AR, VR, MR in Metaverse, NFT (non-fungible token) for Metaverse. Financial and Economics of Metaverse, Benefits of Metaverse, Use-cases.	**5**

4. Theory Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks.

End Semester Examination: 60 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum

5. Books and References:

A. Books:

1. Scott M L, Programming Language Pragmatics, 4th Edn., Morgan Kaufmann Publishers, 2015
2. E. Balaguruswamy, “Programming with Java A primer”, Fifth edition, Tata McGraw Hill Publication
3. Dr. R. Nageswara Rao, ”Core Python Programming” , Dreamtech Press, Wiley Publication
4. Metaverse: Introduction to The Virtual Reality, Augmented Reality,ISBN-13 : 978-1806030484
5. Beginning R: The Statistical Programming Language by Dr. Mark Gardener, Wiley Publications
6. Peter I. Kattan, MATLAB for Beginners: A Gentle Approach, 2008. ISBN: 9781438203096

B. References:

1. Programming Languages: Concepts and Constructs; 2nd Edition, Ravi Sethi, Pearson Education Asia, 1996.
2. Herbert Schildt, “Java-The Complete Reference”, Tenth Edition, Oracle Press, Tata McGraw Hill Education.
3. Navigating the Metaverse by Cathy Hackl, Dirk Lueth, Tommaso Di Bartolo, John Arkontaky, Yat Siu Released May 2022 Publisher(s): Wiley ISBN: 9781119898993
4. Hands-On Programming with R by Grolemund, O Reilly Publications
5. Stormy Attaway, "MATLAB: A Practical Introduction to Programming and Problem Solving," 2018, Butterworth-Heinemann, ISBN: 978-0128154793

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
COMM501	Business Communication and Intellectual Property Rights	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
COMM501	Business Communication and Intellectual Property Rights	40	40	40	60	-	-	-	100

Course Objectives:

1. To provide an outline to effective organisational communication.
2. To enable learners to formulate professional documents in a structured manner that meets the corporate requirements.
3. To foster a comprehensive understanding of marketing strategies for establishing the brand of the business using digital technologies and aim at better customer experience
4. To develop creative and impactful presentation skills
5. To acquaint learners with the procedure of obtaining Patents, Copyrights, Trademarks and Industrial designs
6. To inculcate the ethical code of conduct and corporate etiquettes.

Course Outcomes:

1. Apply business communication strategies and principles to prepare effective communication for developing and presenting business messages.
2. Acquire the writing skills necessary for professional documents to meet the corporate requirement.
3. Understand existing and emerging social media tools to execute a comprehensive communication plan.
4. Able to illustrate effective presentation, research, organisational and creative skills necessary for lifelong learning.
5. Recognize the crucial role of IP in organisations of different industrial sectors for the purposes of product and technology development.
6. Able to determine the importance of ethics and etiquettes in social and professional situations

Prerequisite: Basic language skills

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	BUSINESS COMMUNICATION	1.1 Role of communication in business organisation 1.2 Relevance of communication 1.3 Types- Verbal Non-verbal 1.4 Channels- Vertical, Horizontal and Lateral	2	CO1
II	BUSINESS WRITING	2.1 Business Proposals (SWOT analysis) 2.2 Grant / Research Proposals 2.3 1.2 Memos 2.4 1.3 Press Releases 2.5 1.4 Business Plans	8	CO2
III	DIGITAL SOCIAL MEDIA	3.1 Communicating via Social Media 3.2 Social Media and Public Relations, Social Media strategy and Planning 3.3. Content Strategy. Web Content, Organisation and Distribution 3.4 Social Networking Sites (LinkedIn, Twitter), Photo sharing Sites (Instagram, Snapchat, Pinterest 3.5 News Writing and Community Management 3.6. Facebook and business 3.7. YouTube and Live Streaming	6	CO3
IV	SPEAKING SKILLS	4.1 Speaking on Panels, Moderating Panels, Speaking as keynote or Individual Talk 4.2 Introducing speakers, Summarising speeches and Meeting conference content 4.3 Presentation Skills- Visually present relationship between two or more data sets Data Presentation Methods- Line graph, Column chart, Vertical bar, scatter plot Presentation style- Audience analysis, Care and concern for the audience, effective use of transitions and animations, slide design and content.	7	CO4
V	INTELLECTUAL PROPERTY FOR BUSINESS	5.1. Meaning, Relevance, Business Impact, Protection of Intellectual Property 5.2. Types of Intellectual Property **Copyrights** – Introduction, Nature of copyright, Indian copyright law, copyright works, Author and ownership of copyright, Licensing of copyrights,	8	CO5

		Infringement of copyrights, Remedies and actions, Copyright for digital media, Software/ Internet **Patents-** Concept of patent, Product/Process Patents, Patent Law, Patentable subject matter, Patentability criteria, Duration of patent, Procedure for filing Patent Application, Types of Applications, Procedure of Opposition, Revocation of Patents, Ownership and Maintenance of Patents, Compulsory licensing, Qualification and registration Procedure **Trademarks-** Introduction, Rationale of protection of trademark as (a) an aspect of commercial and (b) of consumer rights, Kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks), Indian Trademarks Law, Procedure for Registration of Trademarks, Non Registrable Trademarks, Infringement of Trademarks and Right of Goodwill, Offences and Penalties **Trade secrets** **Designs-** Need for Protection of Industrial designs, Procedure and Infringement **Geographical Indications –** Concept, Procedure of Registration, duration of protection, Infringement, Penalties and Remedies		
VI	ETHICS AND ETHICAL CODE OF CONDUCT	6.1 Writing Resume and statement of purpose 6.2 Business and corporate activities(special emphasis on business meetings, emails, blogs and web pages) 6.3 Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions.	4	CO6

Text Books and References:

1.Raman Meenakshi & Singh Prakash, *Business Communication Second edition,* Oxford University Press, Paperback, 2012.
2. Jeremy Harris Lipschultz, *Social Media Communication: Concepts, Practices, Data, Law and Ethics Third edition,* Paperback, 2020

3. V. K. Ahuja, *Intellectual Property Rights In India,* Hardcover, 2015

Sr. No.	Details of Assignments	Details of Activities	Hours	CO Mapping
I	Written assignment on summarising a research proposal 4 page grant proposal (to be included as part of term work)	Example of summarising techniques to be demonstrated.	4	CO1, CO2
II	Written assignment on blog posts, web content	NA	4	CO1, CO3, CO4
III	Presentation skills	Mock Presentation	6	CO1, CO4
IV	Written Assignment on Resume writing/Statement of Purpose.	NA	2	CO2, CO6
V	Written Assignment on Intellectual Property	NA	4	CO5

Term work will consist of-

1. Assignments-10 marks
2. Grant Proposal- 10 marks
3. Attendance -5 marks
4. Presentation- 15 marks

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE511	Big Data Analytics	Contact Hours	3	2	-	5
		Credits	3	1	-	4

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE511	Big Data Analytics	40	40	40	60	-	-	-	100

1. Course Objectives:

The course is aimed to:

1. To provide an overview of an exciting growing field of big data analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql Map-Reduce.
3. To introduce programming skills to build simple solutions using big data technologies such as NoSql, Map-Reduce and write the parallel algorithm for multi process execution.
4. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
5. To enable students to have skills that will help them to solve complex real-world problems in decision support.

2. Course Outcomes:

On successful completion of course learner/student will be able to:

1. Understand the key issues in big data management and its associated applications in intelligent business and scientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map Reduce and NO SQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

3. Detailed Theory Syllabus:

Module No	Module	Detailed Content	Hrs.
1	Overview Of big data analytics	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	3
2	Data analytics using MapReduce/ Hadoop	Introduction to Big Data Frameworks: Hadoop, Core Hadoop Components; Hadoop Ecosystem-Overview, Hadoop Limitations. MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce	10
3	No SQL	Introduction to NoSQL, NoSQL Business Drivers, NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study, NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems.	6
4	Mining Data Streams	The Stream Data Model: A Data- Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data in a Stream : Sampling Techniques. Filtering Streams: The Bloom Filter Counting Distinct Elements in a Stream : The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm.	12
5	Finding Similar Items and Clustering	Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance. CURE Algorithm, Stream-Computing , A Stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries.	10
6	Real-Time Big Data Models	PageRank Overview, Efficient computation of PageRank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. Introduction to Recommendation System: content based Recommendation System, collaborative Recommendation System, hybrid Recommendation System. Issues and challenges Recommendation System Big Data Case Studies – How big companies use Big Data : Walmart, Netflix, eBay etc…. Demonstration of Graph Database : NEO4J Example: Social Network Circle ,	4

4. Suggested Experiments:

Software Requirements if any: Windows / Linux Desktop OS / Kali Linux, Hadoop, R studio, Mongodb

1. HDFS Basics, Hadoop Ecosystem Tools Overview.
Installing Hadoop.
2. Copying File to Hadoop.
3. Copy from Hadoop File system and delete file.
4. Moving and displaying files in HDFS.
5. Programming exercises on Hadoop.
6. To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands.
7. Experiment on Hadoop Map-Reduce / PySpark:
8. Write a program to implement a word count program using MapReduce.
9. Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc.
10. Implementing DGIM algorithm using any Programming Language/ Implement Bloom Filter using any programming language
11. Implementing any one Clustering algorithm (K-Means/CURE) using Map-Reduce
12. Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web)

5. Theory Assessment:

A. **Internal Assessment (IA):** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

6. Term Work Assessment: The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. **Term Work:** Term Work shall consist of practical's based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. **Term Work Marks:** 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance).

7. Books and References:

A. **Books:**

1. CreAnand Rajaraman and Jeff Ullman Mining of Massive Datasets, Cambridge University Press,
2. Alex Holmes Hadoop in Practice, Manning Press, Dreamtech Press.
3Dan Mcary and Ann Kelly Making Sense of NoSQL – A guide for managers and the rest of us Manning Press

B. **References:**

1. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press
2. Alex Holmes "Hadoop in Practice", Manning Press, DreamTech Press. [3] Dan McCreary and Ann Kelly "Making Sense of NoSQL" – A guide for managers and the rest of us, Manning Press.

3. Bill Franks , “Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics”, Wiley
4. Chuck Lam, “Hadoop in Action”, Dreamtech Press
5. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, “Big Data for Dummies”,
6. MongoDB: The Definitive Guide Paperback, Kristina Chodorow (Author), Michael Dirolf, O'Reilly Publication

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE512	Ethical Hacking and Digital Forensics	Contact Hours	3	2	-	5
		Credits	3	1	-	4

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE512	Ethical Hacking and Digital Forensics	40	40	40	60	-	-	-	100

1. Course Objectives:

The course is aimed to:

1. To understand underlying principles of Ethical hacking and digital forensic practices.
2. To learn gathering information from various cyber spaces.
3. Perform security scan to test the applications and systems for vulnerability.
4. Understand and deal with the hacking environment and strategies for covering attack tracks.
5. To learn the importance of incident response and evidence handling in digital forensics
6. To apply digital forensic knowledge to use various digital forensic tools for live data collection

2. Course Outcomes:

On successful completion of course learner/student will be able to:

1. Describe principles of Ethical hacking and digital forensic
2. Gather the information required for Digital forensics and Ethical hacking from various cyber spaces
3. Evaluate testing plan for applications and systems for vulnerability
4. Understand hacking environments and learn hacker hiding techniques
5. Explain the methodology of incident response and various security issues
6. Install and Examine various Digital forensics tools for data collection.

3. Detailed Theory Syllabus:

Prerequisite: Cryptography and Security, Computer Networks, Basics of various operating systems.

Module No	Module	Detailed Contents of Module	Hrs.
1	Introduction to Ethical Hacking and	Introduction to Ethical hacking: definition, difference between hacking and ethical hacking. Vulnerability, Attack Vector. Five stages of hacking:	4

	Digital Forensics	Reconnaissance, Probing, Actual attack, maintaining presence, Covering attack tracks, Digital Forensic, Rules for Digital Forensic, The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics, Digital Evidences: Types and characteristics and challenges for Evidence Handling.	
2	Information Gathering	**Information gathering:** from social media accounts, extraction of photographs, exit data, phone number, vehicle registration number, dumpster dumping, google street view and google history. Social Engineering techniques, Google Dork query, Browser extension to collect information. Principles of Ethical hacking (Legality & Ethics) Introduction to OWAPS, types of OWAPS	6
3	Enumeration and System Hacking	**Scanning & Enumeration**: Port Scanning, Network Scanning, Vulnerability Scanning, NMAP Scanning tool, OS Fingerprinting, Enumeration. **System Hacking**: Password cracking techniques, Keyloggers, Escalating privileges, URL Hiding Files, Sniffers & SQL Injection: Active and passive sniffing, ARP Poisoning, Session Hijacking, DNS Spoofing, Conduct SQL Injection attack, Countermeasures. Study of open-source scanning tools.	7
4	Hacking Environment by Hiding hacker details	Installation and configuration of DVWA environment. Virtual box installation, Installation of Kali Linux within virtual box. Kali Linux penetration testing and ethical hacking tools. What is TOR? How can you use it to protect your anonymity online? Proxy chain for using proxy servers, hiding your IP and obtaining access. What is VPN and how you can stay anonymous with VPN. Mac-changer, use of mac-changer to change your MAC address. Incident Response and Forensic Analysis.	8
5	Incident Response Methodology	Incident Goals of Incident response, Incident Response Methodology, Formulating Response Strategy, IR Process – Initial Response, Investigation, Remediation, Tracking of Significant, Investigative Information, Reporting Pre-Incident Preparation, Incident Detection	6
6	Digital Forensic Tools	Live Data Collection: Live Data Collection on Microsoft Windows Systems: Live Data Collection on Unix-Based Systems Forensic Duplication Forensic Image Formats, Traditional Duplication, Live System Duplication, Forensic Duplication tools Disk and File System Analysis: Media Analysis Concepts, File System Abstraction Model The Sleuth Kit : Installing the Sleuth Kit , Sleuth Kit Tools Partitioning and Disk Layouts : Partition Identification and Recovery, Redundant Array of Inexpensive Disks Special Containers : Virtual Machine Disk Images, Forensic Containers Hashing, Carving : Foremost , Forensic Imaging : Deleted Data , File Slack , dd , dcfldd , dc3dd Data Analysis Analysis Methodology Investigating Windows systems , Investigating UNIX systems , Investigating Applications, Web Browsers, Email, Malware Handling: Static and Dynamic Analysis, Writing a Report, sample for writing a forensic report	8

4. Suggested Experiments:

1. Using Social Engineering/Media to gather personal information about the target person.
2. Using NMAP commands and exploring the features.
3. Configure DVWA web application to simulate and practice OWASP.
4. Study kali linux penetration testing tools.
5. Using Metasploit to extract data from Mobile.
6. Live capture of volatile data from windows and Linux systems.
7. Creation of forensic duplication using forensics tools.
8. Analysis of forensic image and report generation using Autopsy/AccessData FTK.

5. Theory Assessment:

A. **Internal Assessment:** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and half hour.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

6. Practical Assessment: An Practical / Oral exam will be held based on the above syllabus. The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. **Term Work:** Term Work shall consist of practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. **Term Work Marks:** 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

7. Books and References:

A. Books:

1. Mark Rhodes-Ousley, “Information Security: The Complete Reference”, Second Edition, McGraw-Hill, 2013
2. DafyddStutarf, Marcus Pinto, “Web Application Hackre’s Handbook”, Wiley
3. Skoudis E. Perlman R. “Counter hack: A step by step Guide to Computer Attacks and effective Defense”, Prentice Hall Professional technical Reference, 2001.
4. Jason Luttgens, Matthew Pepe, Kevin Mandia, “Incident Response and computer forensics”,3rd Edition Tata McGraw Hill, 2014.
5. Nilakshi Jain, Dhananjay Kalbande,”Digital Forensic: The fascinating world of Digital Evidences” Wiley India Pvt Ltd 2017.
6. Cory Altheide, Harlan Carvey”Digital forensics with open-source tools “Syngress Publishing, Inc. 2011.

B. References:

1. The Internet of Things (MIT Press) by Samuel Greengard.
2. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).
3. RFID and the Internet of Things, by Herve chabanne, Wiley

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE513	Computer Vision	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE513	Computer Vision	40	40	40	60	-	-	-	100

1. Prerequisite: Basic coordinate geometry, matrix algebra, linear algebra

2. Course Objectives: The course aims to:

1. To introduce fundamentals of computer vision and its relationship with Artificial Intelligence.
2. To learn the process of image formation, transformation and geometric primitives using a digital camera.
3. To learn various algorithms in computer vision.
4. To study various algorithms for Image Descriptors and Features.
5. To explore pattern recognition and classification techniques using ANN and CNN.
6. To know computer vision applications such as motion estimation, segmentation and object recognition.

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. To describe fundamentals of Computer Vision and distinguish between Image Processing and Computer Vision and also explain its relationship with other domains like AI,ML etc.
2. To describe the process of image formation and storage using digital devices.
3. To remember and apply image pre-processing techniques required for computer vision.
4. To extract color, texture and shape features from images to describe and perform analysis.
5. To implement classification techniques to identify and recognize objects.
6. To identify and apply computer vision techniques in real life situations.

3. Detailed Theory Syllabus:

Module No	Module	Detailed Contents of Module	Hrs.
I	Introduction	What is Computer Vision (CV), Challenge of CV, Tasks in CV, Difference between Image Processing and CV, Relationship of Artificial Intelligence and CV.	3
II	Image Formation	**Transformations:** Camera, Sampling and aliasing, Geometric primitives. 2D and 3D transformation, 3D rotations, 3D to 2D projections, Lens distortions. **Photometric image formation:** Lighting, Reflectance and shading, Optics.	6
III	Image Preprocessing	**Image Enhancement:** Point Processing, Mask Processing, Spatial and Frequency Domain Filtering. **Image Transforms:** Haar, Curvelet, Ridgelet, Shearlet, Contourlet Transform **Image Morphology**: Binary Morphological operations, Dilation, Erosion, Opening and Closing. Grayscale Morphological operations.	8
IV	Image Feature Representation	**Image Features:** Color, Texture, Shape. Histogram of Oriented Gradients, Scale Invariant Feature Transform. **Image Representation and Description**: Chain Code, Shape Number, Fourier Descriptors, Image Moments. **Texture Descriptors:** Texture representation methods,Gabor filter, MPEG-7 homogeneous texture descriptor **Edge Detection:** Gradient-based methods, Laplacian of Gaussian operator, Difference of Gaussian Operator, Canny Edge Detector, Hough Transform.	8
V	Pattern Recognition and Classification	**Introduction to Pattern Recognition:** Linear Regression, Decision Functions, Statistical Decision Theory, Gaussian Classifier, Parameter Estimation, Dimension Reduction, Template Matching. **Image Classification:** Artificial Neural Network (ANN), Convolutional Neural Networks (CNNs), Autoencoder.	8
VI	Applications of Computer Vision	Motion Estimation and Object Tracking, Gesture Recognition, Face and Facial Expression Recognition, Image Fusion, Medical Image Segmentation.	4

5. Suggested Experiments:

Software Requirements if any: Python.

1. Install OpenCV for Python on Windows & Manipulate with the images Images.
2. Image Processing:
    a. Image Processing:OpenCV Resize Image ,OpenCV Image Rotation
    b. OpenCV Drawing Functions,Eroding an Image,Blurring an Image,Create Border around Images, Grayscaling of Images,Scaling, Rotating, Erosion and Dilation of images

c. Convert an image from one color space to another ,Filter Color with OpenCV Denoising of colored images,Visualizing image in different color spaces

3.Feature Detection:

a. OpenCV Blob Detection,Canny Edge Detection
b. OpenCV Image Smoothing
c. Shifting and Edge Detection
d. Line detection using Hough Line method
e. Circle Detection
f. Detect corner of an image

4.Histogram:

a. Analyze an image using Histogram,Histograms Equalization, Simple Thresholding Adaptive Thresholding
b. OpenCV Image Threshold OpenCV Contours,OpenCV Mouse Event

5.Pattern Recognition and Classification

a. OpenCV Video Capture
b. Face Detection with OpenCV
c. Car detection with OpenCV

6. Theory Assessment:

A. Internal Assessment (IA): Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one hour.

B. End Semester Theory Examination: In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

7. Practical Assessment under DLOC Lab: An Practical / Oral exam will be held based on the above syllabus. The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. **Term Work:** Term Work shall consist of practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. **Term Work Marks:** 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

8. Books and References:

A. Text Books:

1. Bhuyan, Manas Kamal. Computer vision and image processing: Fundamentals and applications. CRC Press, 2019.
2. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.
3. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010

B. References:

1. Milan Sonka,Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" Thomson Learning
2. E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012
3. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012
4. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE521	Natural Language Processing	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE521	Natural Language Processing	40	40	40	60	-	-	-	100

1. Course Objectives: The course is aimed to:

1. To understand natural language processing and to learn how to apply basic algorithms in this field.
2. To understand the basic text processing techniques and significance of morphology.
3. To get acquainted with the basic concepts and algorithmic description of the main language levels: syntax, semantics.
4. To understand language models generation and applications.
5. To recognize the significance of pragmatics and discourse for natural language understanding.
6. To design and implement applications based on natural language processing

2. Course Outcomes: On successful completion of course learner student:

1. Have a broad understanding of the field of natural language processing.
2. Be able to apply text processing techniques and analysis of morphology of text
3. Be able to model linguistic phenomena with formal grammars and design semantic structure
4. Be able to create language model and apply it for NLP applications
5. Understand the mathematical and linguistic foundations underlying approaches to analyse pragmatic and resolve coreference
6. Be able to apply NLP techniques to design real world NLP applications such as machine translation, text categorization, text summarization, information extraction...etc.

3. Detailed Theory Syllabus:

Prerequisite: Data structure & Algorithms, Theory of computer science, Probability Theory.

Module No	Module	Detailed Contents of Module	Hrs.
1	Introduction	Introduction to Natural Language Processing, History of NLP, Natural Language Generation, Natural Language Understanding, Generic NLP system, Ambiguity in Natural language, Stages in NLP, Challenges of NLP	3
2	Morphology analysis and Language modeling	Text Processing Challenges, Pre-processing of text (tokenization, text filtration, script validation, stop words), Survey of English and Indian Language Morphology, Inflectional morphology & Derivational morphology, Stemming (Porter stemmer), Lemmatization, Regular expression, Morphological parsing with FST, The role of language models, Simple N-gram models, N-gram for spelling correction.	8
3	Syntax analysis	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank), Rule based POS tagging, Stochastic POS tagging, Introduction to CFG, Parsing with CFG,Sequence labelling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).	8
4	Semantic Analysis	Lexical Semantics, Attachment for fragment of English-sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses (Homonymy, Polysemy, Synonymy, Hyponymy) WordNet, Vector Space Models of Semantics, Word Sense Disambiguation (WSD), Semantic Role Labelling, Semantic Parsing	6
5	Discourse Context and World Knowledge	Pragmatic analysis and understanding, Discourse: reference resolution, Reference Phenomena, Preferences in Pronoun Interpretation and resolution, Syntactic and Semantic Constraints on Coreference, Coreference Resolution: Coreference, Distinctions in Coreference, Coreference vs. Anaphora, Application,Challenges of Coreference Resolution	6
6	Applications of NLP	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition,Plagiarism Detection	8

4. Theory Assessment:

A. **Internal Assessment (IA):**
Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.Duration of each test shall be one and half hour.
B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.
1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5. Books and References:

A. Books:

1. Sharvari Govilkar, Sagar Kulkarni, Dhiraj Amin ― Natural Language Processing, 2018, StartEDU solutions.
2. Daniel Jurafsky, James H. Martin ―Speech and Language Processing‖ Second Edition, Prentice Hall, 2008.
3. Christopher D.Manning and Hinrich Schutze, ― Foundations of Statistical Natural Language Processing ―, MIT Press, 1999.

B. References:

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and ImedZitouni ― Multilingual natural language processing applications Pearson, 2013.
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) ― The Handbook of Computational Linguistics and Natural Language Processing
4. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
5. Brian Neil Levine, An Introduction to R Programming
6. Niel J le Roux, Sugnet Lubbe, A step by step tutorial: An introduction into R application and programming.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE522	Internet of Everything	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE522	Internet of Everything	40	40	40	60	-	-	-	100

1. Course Objectives:

The course is aimed to:

1. To learn the concepts of IOT.
2. To identify the different technologies.
3. To learn different applications in IOT.
4. To learn different protocols used in IOT.
5. To learn the concepts of smart city development in IOT.
6. To learn how to analyze the data in IOT.

2. Course Outcomes:

On successful completion of course learner/student will be able to:

1. Apply the concepts of IOT.
2. Identify the different technologies.
3. Apply IOT to different applications.
4. Analysis and evaluate protocols used in IOT.
5. Design and develop smart cities in IOT.
6. Analysis and evaluate the data received through sensors in IOT.

3. Detailed Theory Syllabus:

Module No	Module	Detailed Content	Hrs.
1	Introduction	Definition of Internet of Everything (IoE), Pillars of IoE, Relationship between M2M, IoT and IoE, Objects and Identifier.	3
2	RFID Technology	Introduction, Principle, Components and Architecture of RFID, RFID middleware, Issues in RFID, IPv6 Addressing Schemes and Electronic Product Code, RFID Applications and case studies, Hardware issues.	8

3	RFID Protocols	Types of Protocols : Pure, Slotted, Frame slotted ALOHA, Tree protocols, Tree splitting algorithms, Binary search algorithms, Bitwise arbitration protocols, Main query tree protocols. Basic Differences between protocols.	8
4	Communication Protocols and Localization	Introduction to Wireless Sensor Network, Protocols: MQTT, CoAP, REST Transferring data, Basic Difference between Protocols, Security IoT Protocols and Technology: CoAP and DTLS, Localization, mobility management	8
5	Industrial Internet of Things	Introduction ,Industry 4.0 , Industrial Internet of Things (IIoT) , IIoT Architecture , Basic Technologies Applications and Challenges	8
6	Data Analytics for IoE	Big Data Analytics, Cloud and Fog Computing in the Internet of Things: IoT System Requirements, Cloud Computing in IoT ,Advantages of Using the Cloud for IoT, Examples of Cloud - Based IoT	4

4. Suggested Experiments:

Software Requirements if any: Arduino IDE, Tinkercad, Proteus

1. Create a Problem statement based on Survey, identify the Hardware and software requirement for their mini project problem statement.
2. Study of IoT architecture with respect to your mini project.
3. Identify and design the required hardware and sensors for your circuit board configuration.
4. Use suitable software and an emulator for coding the input devices and sensors.
5. Interface hardware with Web to publish or remotely access the data on the Internet.
6. Analyze the readings obtained in the project and identify its future scope
7. Documentation (PPT + Report) of mini-project and technical paper writing.

5. Theory Assessment:

A. **Internal Assessment (IA):**

Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

6. Term Work Assessment: The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. **Term Work:** Term Work shall consist of practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. **Term Work Marks:** 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

7. Books and References:

A. **Books:**

1. Hassan, Q. F, "Internet of things A to Z: technologies and applications",Wiley; IEEE Press, 2018
2. Internet of Things connecting objects to the web, by Hakima Chaouchi, Wiley.
3. Internet of Things (A Hands-on-Approach) by Arshdeep Bhaga and Vijay Madisetti.
4. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015
5. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3642-19156-5 e-ISBN 978-3-642-19157-2, Springer.

B. **References:**

1. The Internet of Things (MIT Press) by Samuel Greengard.
2. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications).
3. RFID and the Internet of Things, by Herve chabanne, Wiley
4. Cuno Pfister, Getting Started with the Internet of Things, O'Reilly Media, 2011, ISBN: 978-1-4493-9357-1
5. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess River Publishers, 2013, ISBN: 978-87-92982-96-4 (E-Book), ISBN: 978-87-92982-73-5 (Print)
6. "The Internet of Things Connecting Objects to the Web" Hakima Chaouchi, ISBN: 978-184821-140-7, Willy Publications
7. Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers", Manoel Carlos Ramon Apress, 2014.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE523	Deep Learning	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE523	Deep Learning	40	40	40	60	-	-	-	100

1. Course Objectives:

The course is aimed to:

1. To present the mathematical, statistical and computational challenges of building neural networks
2. To apply Deep Learning models to real world problems in an efficient and optimized way.
3. To understand Convolution Neural Networks for solving various computer vision problems.
4. To understand Recurrent Neural Networks basic concepts.
5. To apply RNN for solving various sequence modelling problems.
6. To learn to apply pre-trained models for solving various deep learning problems.

2. Course Outcomes:

On successful completion of course learner/student will be able to:

1. Understand basics of neural networks
2. Improve Neural Network using various hyperparameter tuning.
3. Design Convolutional Neural Network for various applications
4. Apply Recurrent Neural Network to real life problems
5. Understand and use sequence models
6. Understand transfer learning models

3. Detailed Theory Syllabus:

Prerequisite: Machine Learning, Applied Mathematics

Module No	Module	Detailed Contents of Module	Hrs.
1	Introduction to Deep Learning and Neural Networks basics	What is a neural network? Supervised Learning with Neural Networks, Binary Classification and Logistic Regression, Gradient Descent, Shallow neural networks, Deep Neural Networks	4
2	Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization	Practical Aspects of Deep Learning- Bias / Variance, Regularization, Normalizing inputs, Weight Initialization for Deep Networks, Optimization algorithms- Mini-batch gradient descent, Gradient descent with momentum, RMSprop, Adam optimization algorithm, Hyperparameter tuning- Using an appropriate scale to pick hyperparameters, Normalizing activations in a network, Fitting Batch Norm into a neural network, SoftMax Regression, Batch Normalization and Programming Frameworks	8
3	Convolutional Neural Networks	Edge Detection, Padding, Strided Convolutions, One Layer of a Convolutional Network, Pooling Layers Deep convolutional models- ResNets, Networks in Networks and 1x1 Convolutions, Inception Network, Object Detection-Object Localization, Landmark Detection, Object Detection, Convolutional Implementation of Sliding Windows, Bounding Box Predictions, Intersection Over Union, Non-max Suppression, Anchor Boxes	8
4	Recurrent Neural Networks	Recurrent Neural Network Model, Backpropagation through time, Different types of RNNs, Language model and sequence, generation, Vanishing gradients with RNNs, Gated Recurrent Unit (GRU), Long Short-Term Memory (LSTM), Bidirectional RNN, Deep RNNs	8
5	Sequence models & Attention mechanism	Basic Models, Picking the most likely sentence, Beam Search, Refinements to Beam Search, Error analysis in beam search, Attention Model, Speech recognition, Trigger Word Detection	5
6	Transfer Learning	What is transfer learning? What is a Pre-trained Model? use of pre-trained models, Customize a pretrained model: Feature Extraction, Fine-Tuning, Transfer Learning Implementation using VGG16 Model/ MobileNetV2/YOLO/GloVe/ ResNet50	4

4. Theory Assessment:

A. **Internal Assessment (IA):** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5. Books and References:

A. Books:

1. Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal, Springer
2. A Guide to Convolutional Neural Networks for Computer Vision, Salman Khan, Hossein Rahmani, Syed Afaq Ali Shah, Mohammed Bennamoun, Morgan & Claypool Publishers
3. Recurrent Neural Networks: Design and Applications, Larry Medsker, CRC-Press
4. Natural Language Processing in Action: Understanding, analyzing, and generating text with Python, Hobson Lane, Cole Howard, Hannes Hapke, Manning Publications
5. Transfer Learning, Qiang Yang, Yu Zhang, Wenyuan Dai, SinnoJialin Pan, Cambridge University Press

B. References:

1. Grokking Deep Reinforcement Learning by Miguel Morales, Manning Publications,2020
2. Deep Learning by Josh Patterson, Adam Gibson Released August 2017, O'Reilly Media, Inc.
3. Deep Learning with Python by François Chollet, Manning Publications,2017
4. Practical Deep Learning for Cloud, Mobile and Edge: Real-World AI and Computer Vision Projects Using Python, Keras and TensorFlow by Koul, A. and Ganju, S. and Kasam, M.,O'Reilly Media, Inc.,2019

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE531	User Experience Design	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE531	User Experience Design	40	40	40	60	-	-	--	100

1. Course Objectives:

The course is aimed to:

1. To study and understand importance of user experience design principles
2. To understand elements of user experience design
3. To encourage students to participate in designing futuristic applications
4. To understand data visualization interaction design.
5. To understand prototype design.
6. To understand usability testing.

2. Course Outcomes:

On successful completion of course learner/student will be able to:

1. To Apply principles of user experience
2. To apply emerging and established technologies to enhance User Experience design
3. To create an interface for international standards with ethics.
4. To design prototypes.
5. To apply usability tests.
6. To evaluate user experience

3. Detailed Theory Syllabus:

Prerequisite: Web Technologies, Software Engineering, Human Computer Interaction

Module No	Module	Detailed Contents of Module	Hrs.
1	Introduction	Introduction to interface design, Understanding and conceptualizing Interface, Understanding User's conceptual cognition.	4
2	Elements of UX Design	Core Elements of User Experience, Working of UX elements	4
3	The UX Design Process – Understanding Users	Defining the UX, Design Process and Methodology, Understanding user requirements and goals, Understanding the Business Requirements/Goals, User research, mental models, wireframes, prototyping, usability testing.	8
4	The UX Design Process- The Structure: Information Architecture and	Visual Design Principles, Information Design and Data Visualization Interaction Design, Information Architecture, Wire framing & Storyboarding, UI Elements and Widgets, Screen Design and Layouts	8

	Interaction Design		
5	UX Design Process: Prototype and Test	Testing your Design, Usability Testing, Types of Usability Testing, Usability Testing Process, Preparing and planning for the Usability Tests, Prototype your Design to Test, Introduction of prototyping tools, conducting Usability Test, communicating Usability Test Results	8
6	UX Design Process: Case study and application Design Activity	Select any problem statement Apply UX design steps and concepts to provide low fidelity and high fidelity design , Prototype.	4

4. Theory Assessment:

A. Internal Assessment (IA): Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and half hour.

B. End Semester Theory Examination: In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5**. Books and References:**

A. Books:

1. Interaction Design, Beyond Human Computer Interaction, Rogers, Sharp, Preece Wiley India Pvt Ltd.
2. The essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin.
3. Designing The user Interface by Shneiderman, Plaisant,Cohen,Jacobs Pearson.

B. References:

1. The Elements of User Experience by Jesse James Garrett.
2. Don’t make me think, by Steve Krug.
3. Observing the User Experience: A Practitioner's Guide to User Research by Mike Kuniavsky.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE532	High Performance Computing	Contact Hours	3	-	-	3
		Credits	-	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE532	High Performance Computing	40	40	40	60	-	--	-	100

1. Course Objectives:
The course is aimed to:

1. To learn fundamental concepts of parallel processing.
2. To learn utilization of high performance computing resources using programming frameworks.
3. To learn usage of modern processor technology as a high performance computing platform.
4. To learn and appreciate core design issues in parallel computing.
5. To study application of high performance computing to practical problems.
6. To understand factors limiting performance of high performance computing systems.

2. Course Outcomes:
On successful completion of course learner/student will be able to:

1. Memorize and Understand classes of parallel computer architectures.
2. Understand standardized, multi-platform communication methods for parallel programming.
3. Understand usage of graphical processing unit hardware as a high performance computing unit.
4. Analyze fundamental issues in parallel computing.
5. Understand parallel computing implementation for a computationally intensive problem.
6. Understand practical limitations of technology for high performance computing.

3. Detailed Theory Syllabus:

Module No	Module	Detailed Contents of Module	Hrs.
1	Parallel Processing Concepts	Levels of parallelism (instruction, transaction, task, thread, memory, function), Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation etc), Architectures: N-wide superscalar architectures, multi-core, multi-threaded	6
2	Parallel Programming with MPI, OpenMP	Processor Architecture, Interconnect, Communication, Memory Organization, and Programming, building blocks of MPI, Overlapping communication and computation, collective communication operations, OpenMP Threading Building blocks; An Overview of Memory Allocators, Parallel programming model, combining MPI and OpenMP, Shared memory programing	12

3	Parallel Programming using GPU	Models in high performance computing architectures: (Examples: Nvidia Tesla GPU), Memory hierarchy and transaction specific memory design, Thread Organization, An Overview of CUDA, Programming with CUDA	8
4	Fundamental Design Issues in Parallel Computing	Synchronization, Scheduling, Job Allocation, Job Partitioning, Dependency Analysis, Mapping Parallel Algorithms to Parallel Architectures, Performance Analysis of Parallel Algorithms	8
5	Fundamental Limitations Facing Parallel Computing	Bandwidth Limitations, Latency Limitations, Latency Hiding/Tolerating Techniques and their limitations	3
6	Application of HPC	CASE study in HPC	2

4. Suggested Experiments:

1. Study and Write case study on your College network.
2. Write a program for matrix multiplication using MPI.
3. Write a program for matrix addition using OpenMP.
4. Write a program for matrix addition using CUDA.
5. Write a program for parallel quicksort algorithms.
6. Write a program to Send messages to parallel computers connected through the network and find latency.
7. Write a case study on application of HPC.

5. Theory Assessment:

A. Internal Assessment (IA): Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. End Semester Theory Examination: In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

6. Practical Assessment: An Practical / Oral exam will be held based on the above syllabus. The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. Term Work: Term Work shall consist of practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

7. Books and References:

A. Books:

1. "Advanced Computer Architecture: Parallelism, Scalability, Programmability", by Kai Hwang, McGraw Hill 1993

2. “Parallel Programming in C with MPI and OpenMP”, Michael J. Quinn, McGraw-Hill International Editions, Computer Science Series, 2008.
3. “CUDA by Example – An Introduction to General Purpose GPU Programming”,Edward Kandrot and Jason Sanders, Addison-Wesley Professional ©, 2010.
4. NVIDIA TESLA V100 GPU ARCHITECTURE
5. “Introduction to Parallel Computing”,AnanthGrama, Anshul Gupta, George Karypis, Vipin Kumar , Pearson Education, Second Edition, 2007.
6. Petascale Computing: Algorithms and Applications, David A. Bader (Ed.), Chapman & Hall/CRC Computational Science Series, © 2007.

B. References:

1. “Case for Energy Proportional Computing”, L. Barraso and Holzl, IEEE Computer Dec 2007.
2. “High Performance Computing: Paradigm and Infrastucture”, Lawrence Yang, Minyi Guo, Wiley, 2006

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE533	Reinforcement Learning	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE533	Reinforcement Learning	40	40	40	60	-	-	-	150

1. Course Objectives: The course is aimed:

1. To understand the fundamental concepts of Reinforcement Learning (RL).
2. To apply Dynamic Programming and Value-Based Methods to solve RL problems.
3. To understand the concept of policy-based reinforcement learning.
4. To apply deep reinforcement learning techniques for decision making.
5. To understand the exploration-exploitation trade-off in RL.
6. To explore advanced topics in RL with a focus on practical implementation.

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Identify the components of a Reinforcement Learning system.
2. Apply Dynamic Programming to Reinforcement Learning and implement Value-Based Reinforcement Learning algorithms.
3. Design and implement various policy-based reinforcement learning algorithms.
4. Design and implement various Deep Reinforcement Learning techniques.
5. Design and implement various algorithms for managing exploration-exploitation trade-off.
6. Apply the advanced topics to real-world problems or scenarios.

3. Detailed Theory Syllabus:

Prerequisite: Applied Mathematics, Probability and Statistics, Programming Skills, Machine Learning Basics

Module No	Module	Detailed Contents of Module	Hrs.
1	**Introduction to Reinforcement Learning**	Overview of Reinforcement Learning (RL) and its applications, Suitability of RL; Components of Reinforcement Learning: Agent, Environment, Observations, Actions, Example-The Bandit Walk Environment; Basic concepts: Markov decision processes (MDPs), Value functions, Policies, Action-value functions; Introduction to RL algorithms: Q-learning, SARSA	**7**
2	**Dynamic Programming and Value-Based Methods**	Dynamic programming and its application to RL; Value Based Reinforcement Learning, Deep reinforcement learning agents with sequential feedback, evaluative feedback, sampled feedback, Function Approximation for Reinforcement Learning; Value-based methods: Value iteration, Policy iteration, Deep Q-Networks (DQN); Implementing value-based methods using Python: Value iteration using Bellman equation, Policy iteration using policy evaluation and improvement Implementing DQN using Keras.	**8**
3	**Policy Based Reinforcement Learning**	Policy Gradient and Actor-Critic Methods: REINFORCE Algorithm and Stochastic Policy Search, Vanilla Policy Gradient(VPG), Asynchronous Advantage Actor-Critic (A3C), Generalized Advantage Estimation (GAE), Advantage Actor-Critic(A2C), proximal policy optimization (PPO)	**7**
4	**Deep Reinforcement Learning**	Introduction to deep reinforcement learning, Deep Q-Networks (DQN), Double Q-Networks (DQN), Dueling Networks; Deep Deterministic Policy Gradient (DDPG), Twin-Delayed DDPG (TD3), Soft Actor-Critic (SAC)	**5**
5	**Exploration-Exploitation Trade-off and Multi-Agent Systems**	Overview of Exploration-exploitation trade-off; Bandit Problems, Optimal Stopping Theory, Epsilon-greedy strategy, Upper confidence bound (UCB) algorithm; Multi-agent systems: Independent learners, Cooperative learners; Types of Multi-Agent Reinforcement Learning; Agent Architectures, Agent Communication and Interactions, Cooperation and Coalition Formation	**7**

6	**Advanced Models in RL**	Overview of Advanced Modles in RL: Decentralized RL, Partially observable MDPs (POMDPs) and POMDPs with noisy observations, Transfer learning in RL, RL for Robotics and Control Systems, RL for game playing agents, Hierarchical Reinforcement Learning.	**5**

4. Theory Assessment:

A. **Internal Assessment:** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5. Books and References:

A. Textbooks:

1. Richard S. Sutton and Andrew G. Barto, "Reinforcement learning: An introduction", Second Edition, MIT Press, 2019
2. Wiering, Marco, and Martijn Van Otterlo. "Reinforcement learning." Adaptation, learning, and optimization 12 (2012): 3.
3. Russell, Stuart J., and Peter Norvig. "Artificial intelligence: a modern approach."Pearson Education Limited, 2016.
4. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. "Deep learning." MIT press, 2016.

B. References:

1. Richard S. Sutton and Andrew G. Barto, Reinforcement learning: An Introduction, Second Edition, MIT Press, 2019.
2. Marco Wiering, Martijn van Otterlo(Ed),Reinforcement Learning, State-of-the-Art, Adaptation, Learning, and Optimization book series, ALO, volume 12, Springer, 2012.
3. Keng, Wah Loon, Graesser, Laura, Foundations of Deep Reinforcement Learning: Theory and Practice in Python, Addison Wesley Data & Analytics Series, 2020.
4. 4. Francois Chollet, Deep Learning with Python, Manning Publications, 2018.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE501	DLOC Lab-I	Contact Hours	-	2	-	2
		Credits	-	1	-	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE501	DLOC Lab-I	-	-	-	-	25	--	25	50

Detailed Contents :

1. Minimum 4 Laboratory Practical's to be conducted for each of the DLOC subjects as suggested in the subject syllabus.

Modality and Assessment:

1. Each Laboratory assignment will be done by each individual student. The Faculty teaching each DLOC subject will be required to propose and evaluate the respective Laboratory assignments. These will be essentially hands-on practical and not theory / research review types of assignments.

2. End Semester Examination: An oral examination is to be conducted by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE502	Dissertation -I	Contact Hours	-	2	-	2
		Credits	-	1	-	1

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE502	Dissertation -I	-	-	-	-	25	-	25	50

Guidelines for Dissertation-I

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with the Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt to solve the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization
- Clarity of objective and scope
- Quality of Written and Oral Presentation

Dissertation I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Semester II

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE503	Algorithm and Complexity	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE503	Algorithm and Complexity	40	40	40	60	-	-	-	100

Course Objectives:

1. To analyze the algorithms using space and time complexity.
2. To teach problem formulation and problem solving skills.
3. To acquire knowledge of various applied algorithms.
4. To understand selected topics in algorithms that have found applications in areas such as geometric modelling, graphics, robotics, vision, computer animation, etc.
5. To demonstrate the algorithms and optimize them
6. To apply the algorithms on real life problem

Course Outcomes: At the end of the course student should be

1. Able to analyze the complexity of algorithms
2. Able to compare the algorithms
3. Able to select correct algorithms for applications in areas such as geometric modelling, graphics, robotics, vision, computer animation
4. Able to apply the algorithms and design techniques to solve problems.
5. Able to Optimize the algorithms
6. Able to deploy the algorithms

Prerequisite: Data structure, Analysis of Algorithms, Set Theory

Sr.No.	Module	Detailed Content	Hours	CO Mapping
1	Foundations	Algorithms, Analysing algorithms, Growth of Functions-Asymptotic notation, Mathematical Background for algorithm analysis, Recurrences, The substitution method, The recursion-tree method, The master method, Randomized algorithms	**4**	**CO1, CO2**
2	Advanced Design and Analysis Techniques	Dynamic Programming-Elements of dynamic programming, Matrix-chain multiplication Greedy Algorithms-Elements of the greedy strategy, Huffman codes Amortized Analysis-Aggregate analysis, The accounting method, The potential method, Dynamic tables	**6**	**CO1, CO2**
3	Graph Algorithms	Single-Source Shortest Paths-The Bellman-Ford algorithm, Dijkstra's algorithm, Difference constraints and shortest paths All-Pairs Shortest Paths-The Floyd-Warshall algorithm Maximum Flow-Flow networks, The Ford-Fulkerson method, Maximum bipartite matching	**8**	**CO3, CO4, CO5**
4	Computational Geometry	Line-segment properties, Determining whether any pair of segments intersects, Finding the convex hull, Finding the closest pair of points	**8**	**CO3, CO4, CO5**
5	NPC and Approximation Algorithms	NP-Completeness: NP-completeness and reducibility, NP-completeness proofs, NP-complete problems, Approximation algorithms: The vertex-cover problem, The traveling-salesman problem, The set-covering problem, The subset-sum problem	**10**	**CO3, CO4, CO5**
6	Applied Algorithms	Number-Theoretic : Number Theoretic notion, Greatest common divisor, The Chinese remainder theorem, RSA String Matching Algorithms: The Rabin-Karp algorithm, The Knuth-Morris-Pratt algorithm, Longest common subsequence Facebook Graph Search algorithm Probabilistic Algorithm: Game Theoretic Techniques Randomized Algorithms: Monte Corlo and Las Vegas algorithms	**12**	**CO3, CO4, CO5**

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms", PHI, India Second Edition
2. Horowitz, Sahani and Rajsekaran, Fundamentals of Computer Algorithms", Galgotia
3. Rajeev Motwani, PrabhakarRaghavan, " Randomized Algorithm", Cambridge University Press

Reference Books:

1. Aho, Hopcroft, Ullman: The Design and analysis of algorithms", Pearson Education
2. Vijay V. Vajirani, "Approximation Algorithms",Springer.
3. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI
4. SanjoyDasgupta, Christos Papadimitriou, UmeshVazirani, "Algorithms", Tata McGraw- Hill Edition

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE504	Generative and Explainable AI	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE504	Generative and Explainable AI	40	40	40	60	-	-	-	150

1. Course Objectives: The course is aimed:

1. To understand the fundamental concepts and mathematical foundations of generative models, including probability theory, generative processes, and basic architectures such as GANs, VAEs, and Autoencoders.
2. To design and train Generative Adversarial Networks (GANs) to generate realistic images and data, and understand their applications in image generation, data augmentation, and anomaly detection.
3. To implement and apply Variational Autoencoders (VAEs) for dimensionality reduction, feature learning, and density estimation using mathematical concepts such as evidence lower bound and reparameterization trick.
4. To develop XAI skills, including feature attribution, saliency maps, and attention mechanisms, to improve model interpretability.
5. To implement and evaluate explainable generative models such as LIME, TreeExplainer, and SHAP, and apply visualization techniques like t-SNE, PCA, and UMAP to understand the behavior of generative models in applications such as medical imaging and recommender systems.
6. To explore advanced topics in generative models like flow-based models, normalizing flows, and diffusion models, as well as advanced explainability techniques for innovative computer engineering solutions.

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Demonstrate an understanding of the fundamental concepts of generative models, including generative processes, probability theory, and mathematical foundations.
2. Design and implement Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs) for various applications in computer engineering, including image and audio synthesis, data augmentation, and dimensionality reduction.
3. Analyze and evaluate the performance of generative models, including GANs and VAEs, using metrics such as precision, recall, F1-score, and mean squared error.
4. Apply Explainable AI (XAI) techniques to improve model interpretability and decision-making

systems in computer engineering applications.

5. Critically evaluate the strengths and limitations of various generative models, including GANs and VAEs, in different applications.
6. Identify research directions and future trends in generative and explainable AI, including advanced topics such as flow-based models, normalizing flows, diffusion models, causality detection, model-based explanations, and multi-modal fusion.

3. Detailed Theory Syllabus:

Prerequisite: Applied Mathematics, Machine Learning Fundamentals, Probability and Statistics, Programming Skills.

Module No	Module	Detailed Contents of Module	Hrs.
1	**Introduction to Generative Models**	Overview of generative models, Basic concepts: generative processes, probability theory, and mathematical foundations, Role of Generative models in computer engineering.	**4**
2	**Generative Adversarial Networks (GANs)**	History and motivation for GANs, Adversarial Training: Adversarial networks, generator and discriminator, Loss functions: binary cross-entropy, KL-divergence, Optimization algorithms: gradient descent, Adam; GAN Architectures: Convolutional GANs (CGANs), Conditional GANs (CGANs), Variational Autoencoder-GAN (VAE-GAN), StyleGAN; Realistic Image generation, Data augmentation, Adversarial attacks on GANs, Anomaly detection, Challenges and limitations of GANs.	**8**
3	**Variational Autoencoders (VAEs) and Variational Inference**	Overview of VAEs and variational inference, Mathematical foundations: evidence lower bound, and reparameterization trick; Role of VAEs in dimensionality reduction, feature learning, and density estimation.	**5**
4	**Explainable AI Fundamentals**	Introduction to Explainable AI (XAI); Evolution of XAI, Need for Explainability: Trust and transparency in AI, Legal and regulatory requirements, User acceptance and adoption; Explainability vs Interpretability; Types of Interpretability, Interpretability techniques: feature attribution, saliency maps, attention mechanisms; model interpretability and decision-making systems using XAI.	**8**

5	**Explainable Generative Models**	Types of explainable generative models: neural networks, Bayesian networks, Explainable generative models: LIME, TreeExplainer, SHAP, Visualization techniques for generative models: t-SNE, PCA, UMAP; Evaluation of Explainability: Quantitative Metrics, Qualitative Methods; Case Study: applying explainability techniques to various domains (e.g. medical imaging, recommender systems).	**8**
6	**Advanced Models in Generative and Explainable AI**	Advanced topics in generative models: flow-based models, normalizing flows, diffusion models, Advanced topics in explainable AI: causality detection, model-based explanations, multi-modal fusion. Research directions and future trends in generative and explainable AI.	**6**

4. Theory Assessment:

A. **Internal Assessment:** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5. Books and References:

A. Textbooks:

1. "Generative Models" by David M. Blei, Publisher: Cambridge University Press, Edition: 2020.
2. "Generative Adversarial Networks" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Publisher: MIT Press Edition: 1st Edition (2016).
3. "Explainable AI: Interpreting, Explaining and Visualizing Deep Learning" by Christoph Molnar. Publisher: Lulu Press, Edition: 2019
4. "Interpretable Machine Learning" by Christoph Molnar

B. References:

1. "Generative Adversarial Text to Image Synthesis" by T. Han et al. (2017)
2. "What You Don't Know About Deep Learning" by Jason Eisner (2017)
3. "Interpretability Beyond Feature Attribution" by Marco Tulio Ribeiro et al. (2018)
4. "Generative Adversarial Networks" by Ishaan Gulrajani, et al. (2017), Publisher: Cambridge University Press Edition: 1st edition.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE541	Data Science	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE541	Data Science	40	40	40	60	-	-	-	100

1. Course Objectives:The course is aimed to:

1. To understand the foundations of the Data Science process, methods and techniques.
2. To understand management of data and make predictions over the data.
3. To understand the principles of text analytics.
4. To understand why visualization is an important part of data analysis.
5. To understand the ethical responsibilities of data scientists and organizations.
6. To work on various applications of data science.

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Learn the fundamentals of data science to enable, reproduce and scalable data from a variety of sources.
2. Generate and process dataset and develop models for prediction
3. Analyze text for common theme and trends
4. Design visualizations and narrate stores based on data
5. Develop data science project ethically
6. Analyze importance and impact of data science in varied applications

3. Detailed Theory Syllabus:

Prerequisite: BDA, ML, DBMS, Python, NLP

Module No	Module	Detailed Contents of Module	Hrs.
1	Introduction to data science	Definition, working, defining goal, benefits and uses of Data Science, Data science vs BI, The data science process, Role of a Data Scientist.	5
2	Data management and Predictive modeling	Data management - Understanding how to create the data set, Data collection methods, Data preparation - importance of data 'cleaning', validity and quality. Data analysis - how format and volume of data limits methods of analysis available Predictive Modeling - Probability and Statistics Basics, Common machine learning models, Feature engineering, Model selection, Performance metrics and hyperparameter optimization, Model Deployment	8
3	Text Analytics	Introduction to text Analytics, Need of Text Analytics, Understanding Text, Cleaning Text Data Sets, Text Classification, Text Clustering, Text mining techniques	5
4	Data visualization and communication	Identifying audience requirements, Data scientist as 'storyteller', Building a narrative, Explaining the technical - how to communicate the role played by ML and/or AI techniques resulting in an informed audience, Introduction to Data Visualization, Visualization Tools(Area Plots, Histograms ,Bar Charts, Pie Charts, Box Plots, Scatter Plots, Waffle Charts, Word Clouds), Visualizing Geospatial Data, visualizing time series data, Importance of data visualization Dashboards	8
5	Ethics of data science	Responsibilities of actuaries around data science and AI, Data Science Ethics, Doing good data science, Owners of the data, Valuing different aspects of privacy, Getting informed consent, The Five Cs, Developing ethical and professional safeguards	5
6	Applications	Healthcare, Banking, Finance, Sports, Advertisement, Transport, Tourism	5

4. Theory Assessment:

A. **Internal Assessment (IA):** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and half hour.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5. Books and References:

1. Davy Cielen, Meysman, Mohamed Ali, “Introducing Data Science”, Dreamtech Press
2. Kevin P. Murphy, “Machine Learning a Probabilistic Perspective”, The MIT Press
3. Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O’ Reilly, 1st edition, 2018
4. Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data, Wiley
5. Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
6. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
7. EMC Education Services,”Data Science and Big Data Analytics”,Wiley

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE542	BlockChain Technology	Contact Hours	3	2	-	5
		Credits	3	1	-	4

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE542	BlockChain Technology	40	40	40	60	25	-	-	125

1. Course Objectives: The course is aimed to:

1. Understand how blockchain systems work
2. Understand the use of cryptography required for blockchain
3. Integrate ideas from blockchain technology into their own projects.
4. Understandthe concept of public blockchain
5. Understandthe concept of private blockchain
6. Design, build, and deploy smart contracts and distributed applications using cryptocurrency

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Explain blockchain concepts.
2. Apply cryptographic hash required for blockchain.
3. Apply the concepts of smart contracts for an application.
4. Design a public blockchain using Ethereum.
5. Design a private blockchain using Hyperledger.
6. Design a blockchain application

3. Detailed Theory Syllabus:

Module No	Module	Detailed Content	Hrs.
1	Introduction to Blockchain Technology	What is a blockchain, Origin of blockchain (cryptographically secure hash functions), Foundation of blockchain: Merkle trees, Components of blockchain, Block in blockchain, Types: Public, Private, and Consortium, Consensus Protocol, Limitations and Challenges of blockchain	5

2	Cryptocurrency	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem, Bitcoin blockchain: Consensus in Bitcoin, Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proof-of-Elapsed Time (PoET), Life of a miner, Mining difficulty, Mining pool and its methods	6
3	Programming for Blockchain	Introduction to Smart Contracts,Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts Introduction to Programming: Solidity Programming –Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling Case Study –Voting Contract App, Preparing for smart contract development	6
4	Public Blockchain	Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum Types of test-networks used in Ethereum, Transferring Ethers using Metamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain. Exploring etherscan.io and ether block structure.	7
5	Private Blockchain	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain -PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & Other Technologies Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes, Transaction Flow, Working of Hyperledger Fabric, Creating Hyperledger Network, Case Study of Supply Chain Management using Hyperledger	8
6	Blockchain in Action: Use Cases	Use case in Financial Services, Insurance, Government, Supply Chain Management, Healthcare, Healthcare payments pre-authorization, The Internet of Things (IoT), Agriculture	6

4. Suggested Experiments:

Software Requirements if any: Python, Java Scripts, Geth

1. Implementation of any symmetric and asymmetric cryptosystem.
2. Simple blockchain implementation in any suitable programming language
3. Block chain implementation with database
4. Smart contract with token/coin.
5. Smart Contract to solve/optimize a problem using Ethereum
6. Use Geth to Implement Private Ethereum BlockChain
7. Create a DApp, with Ethereum
8. Create wallet in Metamask and connect it to Ganache Test Network
9. Create a Case study of BlockChain being used in the real world.

5. Theory Assessment:

A. **Internal Assessment (IA):** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

6. Term Work Assessment: The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. **Term Work:** Term Work shall consist of practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. **Term Work Marks:** 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

7. Books and References:

A. **Books:**

1. Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and Meena Karthikeyen, Universities Press.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum,and more, 3rd Edition, Packt Publishing

B. **References:**

1. Blockchain Basics A Non-Technical Introduction In 25 Steps
2. Introduction to Blockchain Technology Author: Tiana Laurence
3. Mastering Ethereum, Andreas M. Antonopoulos, O'relly
4. Blockchain for Beginners, Yathish R and Tejaswini N, SPD
5. Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress.
6. Blockchain with Hyperledger Fabric,Luc Desrosiers, Nitin Gaur, SalmanA. Baset, Venkatraman Ramakrishna, Packt Publishing
7. https://solidity.readthedocs.io/en/v0.6.2/

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE543	Quantum Intelligence	Contact Hours	3	2	-	5
		Credits	3	1	-	4

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE543	Quantum Intelligence	40	40	40	60	25	-	-	125

1. Course Objectives: The course is aimed to:

1. Equip students with foundational knowledge of quantum mechanics and quantum computing.
2. Provide an in-depth understanding of the concepts, architectures, and algorithms for quantum neural networks.
3. Examine advanced topics such as quantum convolutional and recurrent neural networks.
4. Analyze the role of quantum computing in enhancing generative AI models.
5. Illustrate the practical applications of quantum intelligence in fields such as healthcare, finance, material science, and artificial creativity.
6. Investigate future trends in quantum intelligence, including scalability, ethical considerations, and long-term impacts on artificial general intelligence.

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Understand and Differentiate Quantum Computing Concepts.
2 Design and Implement Quantum Neural Networks.
3 Utilize advanced quantum neural network architectures, for solving complex sequence modeling and data processing problems.
4 Apply quantum computing to enhance generative models.
5 Apply Quantum AI to Real-World Problems.
6 Critically analyze emerging trends, ethical concerns, and scalability issues in quantum AI.

3. Detailed Theory Syllabus:

Module No	Module	Detailed Content	Hrs.
1	Introduction to Quantum Computing	**Basics of Quantum Mechanics:** Qubits and Quantum States, Superposition and Entanglement, Quantum Gates and Circuits **Quantum Computing Fundamentals:** Differences Between Classical and Quantum Computing, Quantum Algorithms: Shor's and Grover's Algorithm **Quantum Hardware:** Quantum Annealers vs. Gate-Based Quantum Computers, Overview of Major Platforms (IBM Quantum, Google Sycamore, D-Wave) **Role in Artificial Intelligence:** Potential Impact on AI/ML Models	6
2	Foundations of Quantum Neural Networks	**Overview of Neural Networks:** Traditional Neural Networks Recap, Limitations of Classical Neural Networks **Quantum Neural Network Concepts:** Quantum Perceptrons, Quantum Circuit Encoding for Neural Networks **Design and Optimization of QNNs:** Hybrid Models: Classical-Quantum Approaches, Variational Quantum Circuits for QNN **Quantum Learning Algorithms:** Quantum Backpropagation, Quantum State Preparation and Measurement	7
3	Quantum Convolutional Architectures for Neural Networks (QCANNs)	**Quantum Convolutional Neural Networks (QCNNs):** Building Blocks and Architecture, Training QCNNs **Quantum Recurrent Neural Networks (QRNNs):** Concepts and Practical Implications, Applications in Sequence Modeling **Quantum Noise and Error Mitigation:** Addressing Decoherence in QNNs, Noise-Tolerant Models **Comparative Performance Studies:** Classical vs. Quantum Neural Networks	7
4	Quantum Generative AI	**Quantum Generative Adversarial Networks (QGANs):** Structure and Quantum Enhancements, Training Quantum Discriminators **Quantum-enhanced Transformers:** Quantum Circuit Encoding in Transformer Models, Applications in NLP **Challenges in Quantum Generative Models:** Scalability Issues, Optimization Techniques	6

5	Applications of Quantum Generative AI	**Healthcare:** Drug Discovery and Genomics, Precision Medicine **Finance:** Quantum Portfolio Optimization, Risk Analysis and Fraud Detection **Material Science and Optimization:** Simulating Molecular Structures, Quantum-enhanced Logistics **Artificial Creativity:** Music, Art, and Content Generation with QGANs	7
6	Emerging Trends and Future Directions	**Scalability and Quantum Supremacy:** Beyond NISQ (Noisy Intermediate-Scale Quantum) Devices, Quantum Cloud Platforms **Ethical Considerations:** Security and Privacy Concerns in Quantum AI, Responsible Use of Quantum Intelligence **Future Applications:** Quantum Internet, Long-term Impacts on Artificial General Intelligence	6

4. Suggested Experiments:

1. Simulating Quantum Circuits on IBM Quantum Experience.
2. Building and Testing Simple QNN Models.
3. Case study on Applications.

5. Theory Assessment:

A. **Internal Assessment (IA):** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

6. Term Work Assessment: The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. **Term Work:** Term Work shall consist of practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. **Term Work Marks:** 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

7. Books and References:

A. **Books:**

1. Nielsen, M.A., & Chuang, I.L. Quantum Computation and Quantum Information
2. Schuld, M., Sinayskiy, I., & Petruccione, F. The Quest for a Quantum Neural Network
3. Schuld, M., & Petruccione, F. Supervised Learning with Quantum Computers
4. Benedetti, M., Lloyd, E., & Sack, S. Quantum Generative Models
5. Perdomo-Ortiz, A. et al. Quantum Applications in Diverse Industries
6. Chuang, M.A. Trends in Quantum Computing and AI

B. **References:**

1. Berthiaume, A. Introduction to Quantum Computing
2. Biamonte, J. et al. Quantum Machine Learning: An Overview
3. Havlíček, V. et al. Quantum Neural Networks: Architectures and Implementations
4. Montanaro, A. Quantum Algorithms: Insights for AI
5. Whitfield, J.D., & Aspuru-Guzik, A. Computational Chemistry via Quantum Methods
6. Preskill, J. Quantum Computing in the NISQ Era and Beyond

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE551	Social Media Analytics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE551	Social Media Analytics	40	40	40	60	-	--	-	100

1. Course Objectives: The course is aimed to:

1. Understand the concept of social media analytics and understand its significance
2. Understand social network analytics essentials and visualization tools for navigating diverse social media network
3. Develop expertise in analyzing social media text, actions, and hyperlinks
4. Recognize the significance of social media location and search engine analytics
5. Understand advanced strategies for social media engagement, brand reputation management, and risk mitigation
6. Examine social media campaigns through analytics while navigating privacy, ethics, and legal consideration

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Demonstrate an understanding of the concept of social media analytics and recognize its significance in contemporary digital environments.
2. Acquire proficiency in essential social network analytics principles and visualization tools to effectively navigate diverse social media networks.
3. Develop expertise in analyzing social media text, actions, and hyperlinks to extract valuable insights.
4. Recognize the importance of social media location and search engine analytics and apply them to optimize digital strategies.
5. Apply advanced strategies to enhance social media engagement, manage brand reputation effectively, and mitigate risks.
6. Apply analytics techniques to evaluate and optimize social media campaigns, while adhering to privacy, ethics, and legal considerations

3. Detailed Theory Syllabus:

Prerequisite: Graph Theory, Data Mining, Python/R programming

Module No	Module	Detailed Contents of Module	Hrs.
1	Social Media Analytics: An Overview	Core Characteristics of Social Media, Types of Social Media, Social media landscape, Need for Social Media Analytics (SMA), SMA in organizations. Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics,	6

		Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, The Limitations of Social Media Analytics, Social Media Analytics Tools.	
2	Social Network Structure, Measures & Visualization	Basics of Social Network Structure - Nodes, Edges & Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength & Trust Network Visualization - Graph Layout, Visualizing Network features, Scale Issues. Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools	8
3	Social Media Text, Action & Hyperlink Analytics	Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text Analysis Tools. Social Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools. Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools.	6
4	Social Media Location & Search Engine Analytics	Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools. Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools.	6
5	Social Information Filtering & Social Media Brand Reputation Management	Social Information Filtering - Social Sharing and filtering , Automated Recommendation systems, Traditional Vs social Recommendation Systems. Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks. Brand Reputation Management - Strategies for monitoring and managing online brand reputation, crisis management, and responding to customer feedback.	6
6	Social Media Campaign Analytics & Privacy, Ethical and Legal Considerations	Social Media Campaign Analytics - Evaluating the effectiveness of social media marketing campaigns, tracking conversions, and optimizing campaign performance. Addressing privacy concerns, data protection, ethical implications in social media analytics and legal considerations.	6

4. Suggested Experiments:

1. Social Media Data Collection, Preprocessing, and Storage for Business Insights on Platforms like Twitter, Facebook, and LinkedIn
2. Perform Exploratory Data Analysis, Visualization, and Social Network Analysis to Identify Key Social Media Influencers for Business Growth
3. Perform Content-Based Analysis, Sentiment Analysis, and Trend Identification from Social Media Data for Business Strategy and Customer Insight

4. Develop a Real-Time Dashboard, Conduct Competitor Social Media Analysis, and Optimize Strategy for Business Promotion

5. Theory Assessment:

A. Internal Assessment (IA): Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. End Semester Theory Examination: In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

6. Practical Assessment: An Practical / Oral exam will be held based on the above syllabus. The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. Term Work: Term Work shall consist of practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

7. Books and References:

A. Books:

1.Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, Gohar F. Khan,(ISBN-10: 1507823207).

2.Analyzing the Social Web 1st Edition by Jennifer Golbeck

3.Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly

4Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

B. References:

1.Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, Avinash Kohirkar, IBM Press

2.Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team

3.Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulus (2019), Wiley, ISBN 978-1-118-82485-6

4.Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition by Siddhartha Chatterjee , Michal Krystyanczuk

5.Learning Social Media Analytics with R,by Raghav Bali, Dipanjan Sarkar, Tushar Sharma.

6. Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013

7. Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013.

7. Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE552	Network and Cloud Security	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA2	Average					
CE552	Network and Cloud Security	40	40	40	60	-	--	-	100

1. **Course Objectives:**
   1. To implement robust security measures for the routing process, ensuring the integrity, confidentiality, and availability of network communications.
   2. To identify, analyze, and mitigate Layer 2 attacks in network environments.
   3. Understand the principles and practices of VLAN security to effectively design, implement, and manage secure virtual local area networks.
   4. Understand VPN security protocols to ensure secure remote access and data protection in network communications.
   5. understanding of firewall policies and prevention techniques to effectively secure network infrastructures against unauthorized access and cyber threats.
   6. To explore cloud privacy and Security.

2. **Course Outcomes:** At the end of the course learner will able to

   1. Students will be able to implement and evaluate security measures to protect the routing process against vulnerabilities and attacks
   2. Students will be able to identify, analyze, and implement effective mitigation strategies against Layer 2 attacks in network environments..
   3. Demonstrate the ability to understand, configure, and implement VLAN security measures to protect network integrity and data confidentiality.
   4. Students will be able to effectively implement, and manage VPN security protocols to ensure secure remote access and data protection in various network environments.
   5. Equip learners with the knowledge and skills to effectively understand, configure, and manage firewalls for optimal network security and prevention of unauthorized access.
   6. To be able to apply the knowledge of security for cloud data storage and secure server client configuration.

3. **Prerequisite:** Cryptography and System Security,computer networks

4. **Detailed Theory Syllabus**

Module No.	Module Name	Detailed Contents	Hrs
1	**Securing the Routing Protocols**	Network topologies- CAN, WAN, Data Center,SOHO,Virtual, Network Security Zones-demilitarized zone, Intranet and Extranet,VLAN Securing the Routing Process - Security on Cisco routers-	06

		Configuring SSH Access, Configuring Privilege Levels in IOS, Configuring IOS Role-Based, IOS Resilient Configuration **Securing routing protocols-** OSPF Routing Update authentication,EIGRP Routing Update Authentication	
2	**Securing the Data link layer Protocols**	Layer 2 Attacks- STP attacks,ARP spoofing,MAC spoofing, CAM table overflows,CDP/LLDP reconnaissance,VLAN hopping,DHCP spoofing Configuring DHCP Snooping,Dynamic ARP Inspection,Port Security,STP Security Features,Disabling DTP	06
3	**VLAN Security**	VLAN Security-Native VLANs,PVLANs,PVLAN Edge,PVLAN Proxy Attack,ACLs on Switches-Port ACLs-VLAN ACLs Secure management-AUX Port,VTY Ports,Console Port,Securing Network Management-SSH,HTTPS,ACLs,SNMPv3 AAA concepts,802.1x Components-RADIUS and TACACS+ Technologies-Local AAA Authentication and Accounting-SSH Using AAA-Authentication and Authorization Using ACS and ISE-Integration of Active Directory with AAA	08
4	**VPN Security**	VPNs,IPsec,Protocols,Internet Key Exchange,Internet Security Association Key Management Protocol,ESP,IPsec with IPV6,Configuring VPNs,Remote access VPN,Site-to-site VPN	05
5	**Firewall Configuration**	Understanding Firewalls,-Packet Filtering-Proxy Firewalls-Application Firewall-Stateful vs. Stateless Firewalls-Configuring NAT and Zone-Based Firewalls-Implementing NAT on ASA,Configuring Zone-Based Firewalls-Configuring the Firewall on an ASA Intrusion Prevention-IPS Terminology-Evasion Techniques-Understanding Modes of Deployment-Positioning of the IPS within the Network-Understanding False Positives, False Negatives, True Positives, and True Negatives	08
6	**Email and Cloud Security**	Spam filtering, anti-malware filtering, DLP, blacklisting, email encryption Local and cloud-based web proxies-Blacklisting, URL filtering, malware scanning, URL categorization, web application filtering, TLS/SSL decryption Cloud Identity and Access Management, Cloud Security as a Service, SAML, OAuth	06

5. Suggested Experiments:

1.Reconnaissance Attacks
2 Configure multiple privilege levels
3.Configure Cisco IOS role-based CLI access
4.Implement routing update authentication on OSPF
5.Implementing EIGRP Routing Update Authentication
6.Implement DHCP snooping
7.Implement Dynamic ARP Inspection
8.Implement port security
9.Native VLANs ,PVLAN,Port ACLs

10.Configuring and verifying secure access through SNMP v3 using an ACL
11.Local AAA Authentication and Accounting
12.SSH Using AAA
13.Configuring Remote Access VPNs
14.Configuring Site-to-Site VPNs
15.Implementing NAT on ASA 9.x
16.Implementing Firewall with DHCP
17.Implementing AAA and SSH
18.Implementing Firewall with inspection policies
19.Implementing security level specification
20.Implementing oauth

6. Theory Assessment:

A. **Internal Assessment (IA):** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and half hour.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

7. Term Work Assessment: The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. **Term Work:** Term Work shall consist of practical's based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. **Term Work Marks:** 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning
4. Network Security Bible, Eric Cole, Second Edition, Wile**y**

Reference Books:

1. Computer Security, Dieter Gollman, Third Edition, Wiley
2. CCNA security guide,Troy McMillan,CYbex Wiley brand.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE553	Augmented Reality and Virtual Reality	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course	Course Name	Examination Scheme

Code		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE553	Augmented Reality and Virtual Reality	40	40	40	60	-	-	-	150

1. Course Objectives: The course is aimed:

1. To understand the fundamental concepts of Augmented Reality (AR) and Virtual Reality (VR).
2. To comprehend the principles of Computer Graphics.
3. To learn about the principles of Virtual Reality.
4. To learn about the principles of Augmented Reality.
5. To explore the concept of Mixed Reality.
6. To apply advanced computer vision and rendering techniques to AR/VR applications.

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Understand the fundamental concepts of Augmented Reality (AR) and Virtual Reality (VR), including their history, evolution, and applications in various fields.
2. Apply computer graphics concepts, including 3D modeling, texturing, and rendering, to create visual content for AR and VR applications.
3. Design and develop VR experiences using VR hardware and software, understanding key concepts such as rendering techniques, interaction methods, and visual computation.
4. Develop an understanding of AR fundamentals, including camera calibration, object recognition, tracking, and rendering techniques, as well as visualization methods for augmented reality applications.
5. Explore the concept of Mixed Reality and its applications, including input and output methods, computer vision, and simultaneous localization and mapping (SLAM) techniques.
6. Apply advanced computer vision and rendering techniques to create complex AR/VR experiences.

3. Detailed Theory Syllabus:

Prerequisite: Applied Mathematics, Computer Graphics and 3D Modeling, Data Structures and Algorithms, Programming Skills

Module No	Module	Detailed Contents of Module	Hrs.
1	**Introduction to Augmented Reality (AR) and Virtual Reality (VR)**	Overview of AR and VR technologies, History and evolution of AR and VR, Understanding the differences between AR and VR, Applications of AR and VR in various fields, Basic concepts of 3D modeling, texturing, and rendering.	**3**

2	**Fundamentals of Computer Graphics**	3D graphics pipeline (Rendering, Transformation, Lighting), Geometric transformations (rotation, scaling, translation), Affine transformations (homogeneous coordinates), 3D modeling techniques (polygon mesh, NURBS, subdivision surface), Texturing and shading techniques (diffuse, specular, ambient Occlusion)	**5**
3	**Virtual Reality Fundamentals**	Introduction to VR hardware and software, Types of VR (PC-based, console-based, standalone), Content Creation and Development in VR, VR terminology: resolution, field of view, view frustum, frame rate, latency, clipping planes, and tracking systems, VR rendering techniques (perspective projection, orthographic projection), Interaction techniques in VR (gaze-based, motion-based), Visual Computation in Virtual Reality: Animating the Virtual Environment, Physical Simulation	**8**
4	**Augmented Reality Fundamentals**	Introduction to AR hardware and software, Types of AR (marker-based, markerless, SLAM-based), Principles of AR, Camera calibration and tracking, Object recognition and tracking, Augmented reality rendering techniques, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems	**8**
5	**Beyond AR - Mixed Reality**	Introduction to mixed reality, Applications of mixed reality, Input and Output in Mixed reality, Computer Vision and Mixed Reality, simultaneous localization and mapping (SLAM), variants of SLAM- dense tracking and mapping (DTAM), parallel tracking and mapping (PTAM) and semi-direct monocular visual odometry (SVO).	**8**
6	**Advanced Techniques in AR/VR**	Advanced computer vision techniques for AR/VR (deep learning-based object recognition, SLAM), Advanced rendering techniques for AR/VR (ray tracing, global illumination), Haptic feedback in AR/VR, Advanced interaction techniques in AR/VR (hand tracking, gesture recognition)	**7**

4. Theory Assessment:

A. **Internal Assessment:** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is

completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5. Books and References:

A. Textbooks:

1. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
2. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press,2003/2006.
3. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
4. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
5. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
6. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
7. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
8. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2nd Edition, 2006.

B. References:

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
2. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE561	Social Computing and Collaboration	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course	Course Name	Examination Scheme

Code		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE561	Social Computing and Collaboration	40	40	40	60	-	-	-	150

1. Course Objectives: The course is aimed:

1. To understand the fundamental concepts of Social Computing and Collaboration.
2. To analyze social networks, identify key metrics and apply graph theory concepts to real-world problems.
3. To learn human-computer interaction principles and design techniques for social computing systems.
4. To understand the principles of collaborative systems and platforms.
5. To extract insights from large datasets and develop applications by applying big data analytics.
6. To explore advanced topics in social computing and collaboration.

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Identify the key characteristics of social computing and explain their relevance in various contexts.
2. Apply social network analysis (SNA) to understand and analyze the structure and behavior of online social networks and their impact on individual and group behavior.
3. Design human-centered social computing systems to support effective collaboration and communication.
4. Analyze the role of collaborative systems and platforms and design scalable, performant, and secure collaborative solutions.
5. Apply big data analytics techniques to extract insights from large social computing datasets to inform decision-making in various domains.
6. Evaluate the potential applications of emerging technologies such as blockchain, artificial intelligence/machine learning, virtual/augmented reality in social computing and collaboration.

3. Detailed Theory Syllabus:

Prerequisite: Programming Skills, **Computer Networks**, **Data Structures and Algorithms**

Module No	Module	Detailed Contents of Module	Hrs.
1	**Introduction to Social Computing and Collaboration**	Overview of Social Computing and Collaboration: History and evolution, challenges; Socio-Technical Gap, Key characteristics of social computing, Key concepts: Social Networks, Online Communities, Collaboration, and Collective Intelligence, Types of Social Computing: Social Media, Virtual Worlds, and Online Games	**5**

2	**Social Network Analysis**	Introduction to social network analysis (SNA) concepts: nodes, edges, centrality measures (degree, closeness, betweenness), community detection; SNA metrics: degree centrality, closeness centrality, betweenness centrality, density, clustering coefficient; Graph theory: graph models, graph algorithms (BFS, DFS, shortest path), graph visualizations, Real-world applications: social network analysis in marketing, epidemiology, and biology	**7**
3	**Human-Computer Interaction in Social Computing**	Introduction to Human-Computer Interaction (HCI), Design principles for Social Computing systems: user-centered design, human factors engineering, usability, accessibility; HCI techniques in social computing: user studies, participatory design, usability testing; Human factors in Social Computing: social influence, social learning, and social cognition	**7**
4	**Collaborative Systems and Platforms**	Overview of collaborative systems: groupware, workflow management systems, collaborative editing systems, distributed systems, Computer-Supported Cooperative Work (CSCW); Collaborative platforms: Google Docs, GitHub, Slack; Collaborative tools: chatbots, video conferencing, instant messaging; Design considerations for collaborative systems: scalability, performance, security	**7**
5	**Big Data Analytics for Social Computing**	Introduction to big data concepts: volume, velocity, variety, veracity, Data Preprocessing, Data Cleaning, Data mining, data warehousing, data visualization, Techniques for analyzing Social Computing data: text mining, sentiment analysis, topic modeling, Applications of Big Data Analytics in Social Computing: recommender systems, social network analysis	**7**
6	**Advanced Models in Social Computing and Collaboration**	Blockchain-Based Collaboration Platforms and Decentralized Collaboration Systems, Artificial Intelligence (AI) and Machine Learning (ML) applications in Social Computing, Human-computer interaction in Virtual Reality (VR) and Augmented Reality (AR), Emerging trends and future directions in Social Computing and Collaboration	**6**

4. Theory Assessment:

A. **Internal Assessment:** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5. Books and References:

A. Textbooks:

1. Social Computing: Principles, Networks and Applications by Melva Sawyer, States Academic Press, (2022)
2. Social Computing and Social Media Technologies, by Y. Li and J. Liu (Edition: 1st, Year: 2017)
3. Collaborative Information Systems: Conceptual and Application Design, by D. W. Embley (Edition: 1st, Year: 2010)
4. Social Computing: Concepts, Methodologies, Tools, and Applications, by Subhasish Dasgupta, Mehdi Khosrow-Pour, Steve Clarke, Murray E. Jennex, and Annie Becker (2009)
5. "Collaborative Computing: Networking, Applications and Worksharing" by Lawrence W. Dowdy, CRC Press, Edition: 2nd (2019).

B. References:

1. "Handbook of Research on Social Computing and Knowledge Management" edited by M.A. Grasso, P.A. Laplace, and J.M. Kleinberg, 2011.
2. "Collaborative Social Computing: Social Media, Communities and Collaboration" edited by T.A. Tenenbaum, published in 2013.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE562	Penetration Testing and Vulnerability Assessment	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme

		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE562	Penetration Testing and Vulnerability Assessment	40	40	40	60	-	-	-	100

1. Course Objectives:

1. To learn the tools that can be used to perform information gathering
2. To identify various attacks in various domains of cyber space.
3. To detect vulnerabilities by port scanning.
4. To learn how Metasploit and Meterpreter are used to automate the attacks and penetration testing techniques.
5. To learn the web application attacks starting from information gathering to exploitation phases
6. To learn about exploits in Wireless environment

2. Course Outcomes:

1. To understand the basic principles for Information Gathering and Detecting Vulnerabilities in the system.
2. To detect vulnerabilities by scanning ports.
3. Ability to determine the security threats and vulnerabilities in computer networks using penetration testing techniques
4. Deploy and test exploits over targeting operating systems and services
5. Identify flaws and vulnerabilities in applications, websites, networks, systems, protocols, and configurations using both manual techniques and assistive tools
6. Know the various attacks caused due to the network and communication system in an application.

1. Detailed Syllabus:

Prerequisite: Web application Security, Information Security, Cryptography and network security

SN	Module	Detailed Content	Hrs	COs
1	Introduction to Hacking	**Introduction**: Terminologies, Categories and Types. Writing Reports, Risk assessment. **Reconnaissance**: Active and Passive. HTTrack Google directives, Harvester. **DNS Reconnaissance:** Whois, NSLookups, Dig.	2	CO1

		Searching for Email Addresses, Social engineering.		
2	Information Gathering Techniques	**Types**: Active, Passive, Social Engineering. **DNS Reconnaissance**: whois, Nslookup, Host, Zone Transfers, Dig. **Google directive**: site, intitle, inurl, cache, filetype. **Port Scanning Types:** TCP and UDP scan, OS fingerprinting detection using Nmap.	6	CO2
3	Vulnerabilities assessment and Attacks	**Nessus:** Nessus Policies, Scanning with Nessus**,**Web Application Scanning **Attacks:** Password Attacks, Password Management, Online Password Attacks, Offline Password Attacks. **Social Engineering:** Spear-Phishing Attack Vectors - Web attack, Mass email attack,Mass Mailer Attack	6	CO3
4	Exploitation	**Metasploit:** Metasploit framework, metasploit-Console, Payloads, Meterpreter. -Privilege Escalation,Introduction to armitage.	4	CO4
5	Web Application Testing	SQL Injection, XPath Injection, Local File Inclusion, Remote File Inclusion, Command Execution, Cross-Site Scripting,Cross-Site Request Forgery, Web Application Scanning with w3af.	7	CO5
6	Wireless Attacks	**Wireless Security:** SSID, WEP, MAC filtering, IPsec, Wardriving. **Software Tools:** Cracking wireless networks, Detecting wireless attack.	6	CO6

4. Suggested Experiments:

1. Setup Kali Linux in a Virtual machine and setup with DNS info and collection of local network.
2. Scan the network for target OS machines in the local network and virtual network.
3. Experiments to identify the open ports and firewall rules setup.
4. Use password guessing tools to guess a password. Use password strengthening tools to strengthen the password. Try guessing the password and tabulate the enhanced difficulty due to length of password and addition of special characters
5. Extract password hashes from operating systems. Use a password extraction tool, using word list, single crack or external mode to recover the password. Increase the complexity of the password and determine the point at which the cracking tool fails
6. Experiments on SQL injections.
7. Analysis of WEP flaws.
8. Experiments on Wireless DoS Attacks.
9. Buffer Overflow Prevention and prevention against Cross Site Scripting Attacks.
10. Experiments on Metasploit Framework.
11. Cross Site Scripting and Cross Site Request Forgery.
12. File upload vulnerability on Social engineering.

5. Theory Assessment:

A. **Internal Assessment (IA):** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one hour.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

6. Practical Assessment: An Practical / Oral exam will be held based on the above syllabus. The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. **Term Work:** Term Work shall consist of practicals based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.

B. **Term Work Marks:** 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance)

7. Books and References:

A. Books:

1. Georgia Weidman, ”Penetration Testing: A Hands On Introduction to Hacking”, No Startch Press, First Edition 2014. ISBN-13: 978-1593275648 ISBN-10: 1593275641.
2. Rafay Baloch, ”Ethical Hacking and Penetration Testing Guide”,CRC Press, 2015,ISBN :78-1-4822-3161-8.
3. Dr. Patrick Engebretson, The Basics of Hacking and Penetration Testing Ethical Hacking and Penetration Testing made easy , Syngress publications, Elsevier,2013. ISBN :978-0-12-411644-3.

B. **References:**

1. Andrew Whitaker and Daniel P. Newman, Penetration Testing and Network Defence The practical guide to simulating, detecting and responding to network attacks, CiscoPress, 2010. ISBN: 1-58705-208-3
2. B.Singh, H.Joseph and Abhishek Singh,”Vulnerability Analysis and Defense for theInternet, Springer, 2008 Edition. ISBN-10: 0387743898 ISBN-13: 978-0387743899.
3. Sabih, Zaid, “Learn Ethical Hacking from Scratch: Your stepping stone to penetration testing”, 2018 Packt Publishing Ltd, United Kingdom.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE563	AI in Healthcare	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme

		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE563	AI in Healthcare	40	40	40	60	-	-	-	100

1. Course Objectives: The course is aimed:

1. To understand the basics of AI in healthcare and identify the challenges and opportunities it presents.
2. To learn data preprocessing and visualization techniques to prepare healthcare data for analysis.
3. To analyze medical images using AI to improve diagnostic accuracy and patient outcomes.
4. To apply AI-powered predictive analytics to identify patterns and make predictions in healthcare data, using clustering, classification, regression, and other techniques.
5. To develop predictive models for disease risk assessment using AI algorithms and machine learning techniques to support personalized treatment planning.
6. To explore the ethical and regulatory considerations of deploying AI in healthcare, including data privacy, bias, fairness, and compliance with regulatory frameworks such as FDA guidelines and EU's GDPR.

2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Apply fundamental concepts of AI in healthcare, including medical imaging, data analytics, and machine learning to develop innovative solutions for healthcare applications.
2. Design and implement data preprocessing, visualization, and statistical modeling techniques using AI and ML algorithms to analyze healthcare data.
3. Analyze and classify medical images using AI techniques such as image classification, segmentation, and registration to support diagnostic decisions.
4. Develop predictive models using AI algorithms to identify high-risk patients and predict disease outcomes, and design decision support systems for healthcare professionals.
5. Apply AI and ML techniques to personalized medicine and treatment planning, including pharmacogenomics, precision medicine, and treatment recommendation systems.
6. Evaluate the ethical considerations and regulatory frameworks surrounding AI in healthcare, and develop responsible AI solutions that ensure data privacy, fairness, and effectiveness in healthcare applications.

3. Detailed Theory Syllabus:

Prerequisite: Applied Mathematics, Probability and Statistics, Programming Skills, Data Structures and Algorithms, Machine Learning Fundamentals

Module No	Module	Detailed Contents of Module	Hrs.

1	**Introduction to AI in Healthcare**	Overview of AI in Healthcare: definition, history, and applications; AI-enabled healthcare systems: challenges, opportunities, and benefits; Medical Imaging and AI: an overview of medical imaging modalities and AI applications; Introduction to machine learning (ML) and deep learning (DL) concepts.	**5**
2	**Healthcare Data Analytics with AI**	Structure of Healthcare Systems, Types of Healthcare Data, Data preprocessing: data cleaning, normalization, feature scaling; Data visualization: plots, charts, heatmaps; Statistical modeling: regression, decision trees, random forests; AI-powered predictive analytics: clustering, classification, regression.	**6**
3	**Medical Image Analysis with AI**	Basics of Medical Imaging, Medical image analysis without AI, AI in Medical Imaging, Image Analysis and Interpretation, Image classification, segmentation, and registration, 3D Imaging and Reconstruction, Radiomics and quantitative imaging biomarkers, Applications of AI in radiology, pathology, and ophthalmology.	**8**
4	**Disease Prediction with AI**	AI in Diagnostics and Disease Prediction, Predictive modeling for disease risk assessment: Risk Prediction Models, Survival Analysis, and Cox Proportional Hazards Model; Time-Series Analysis for Patient Monitoring, Diagnostic decision support systems, Early detection of diseases using AI algorithms.	**7**
5	**Treatment Planning and Discovery with AI**	AI in Personalized Medicine and Treatment Planning, Pharmacogenomics and precision medicine, Treatment recommendation systems, Drug discovery and repurposing using AI approaches.	**5**
6	**Ethics and Deployment of AI in Healthcare**	Ethical considerations in AI in healthcare: data privacy, bias, fairness; AI Integration with Healthcare Systems: Interoperability and Standards (FHIR, DICOM), Workflow Integration and Automation, User Training and Adoption Strategies; Regulatory frameworks for AI in healthcare: FDA guidelines, EU's GDPR; Case studies of successful deployments of AI in healthcare: successes and challenges; Future directions for AI in healthcare.	**8**

4. Theory Assessment:

A. **Internal Assessment:** Two class tests of 40 marks each. The first class test is to be conducted when

approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5. Books and References:

A. Textbooks:

1. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
2. "Machine Learning Yearning" by Andrew Ng
3. "Artificial Intelligence in Medicine" by William R. Lagakos, Michael J. Pencina, and James M. McCulloch (2nd edition, 2020, CRC Press)
4. "Healthcare Analytics Using Python: How to Analyze and Visualize Health Data" by Anthony Jameson (1st edition, 2020, Packt Publishing)

B. References:

1. "Handbook of Artificial Intelligence for Healthcare" edited by Arun Kumar Sangaiah and S. Sivasubramanian (1st edition, 2020, CRC Press)
2. "Machine Learning in Healthcare: A Survey" edited by Jose M. Ceniceros (1st edition, 2020, Springer)
3. "AI for Medical Imaging" by Xiaobo Zhou and Hongliang Ren (2020)

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE505	DLOC Lab-II	Contact Hours	-	2	-	2
		Credits	-	1	-	1

Course Code	Course Name	Examination Scheme

		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE505	DLOC Lab-II	-	-	-	-	25	-	25	50

DETAILED SYLLABUS:

Detailed Contents :

1 Minimum 4 Laboratory Practical's to be conducted for each of the DLOC subjects as suggested in the subject syllabus.

Modality and Assessment:

1. Each Laboratory assignment will be done by each individual student. The Faculty teaching each DLOC subject will be required to propose and evaluate the respective Laboratory assignments. These will be essentially hands-on practical and not theory / research review types of assignments.

2. End Semester Examination: An oral examination is to be conducted by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
CE506	Dissertation -II	Contact Hours	-	2	-	2
		Credits	-	1	-	1

Course Code	Course Name	Examination Scheme

		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
CE506	Dissertation -II	-	-	-	-	25	-	25	50

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points:

- Quality of Literature survey and Novelty in the problem
- Clarity of Problem definition and Feasibility of problem solution
- Relevance to the specialization or current Research / Industrial trends
- Clarity of objective and scope
- Quality of work attempted or learner contribution
- Validation of results
- Quality of Written and Oral Presentation

o Students should publish at least one or two paper based on the work in reputed International / National Conference/Journal (desirably in Referred Journal should be ISI/Scopus/SCI indexing) (desirably in Refereed Journal)

o **Dissertation II** should be accessed through a presentation jointly by Internal and External Examiners appointed by the Head of the department.

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
CE600	Internship / Relevant Certification	-	16	-	08	08
CE601	Dissertation-III	-	30	-	15	12
TOTAL		-	46	-	23	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
CE600	Internship / Relevant Certification	-	-	-	-	-	50	50	100
CE601	Dissertation-III	-	-	-	-	-	100	100	200
TOTAL		-	-	-	-	-	150	150	300

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
CE602	Dissertation-IV	-	46	-	23	23
		-	46	-	23	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
CE602	Dissertation-IV	-	-	-	-	-	100	100	200
TOTAL		-	-	-	-	-	100	100	200

GUIDELINES

Course Name: Department Level Optional Courses for SEM I and II

- Facilitate students with the same department level electives in UG level with some advances. Ideally 80-85% of UG DLOC and 15-20% of advances in respective subjects .

Course Name: Internship / Relevant Certification

- Students must complete internship or relevant certification (list of organization/certification provided by the department) in Semester III.
- It is expected that students will complete internship or relevant certifications inline with the dissertation topic

Course Name: Course Lab

- Student has to perform course lab I based on DLOC I ,II and III and course lab II based on DLOC IV, V and VI
- Student has to complete lab experiments/lab work/case studies specified respect to the course

Course Name: Dissertation-I

- Students have to select project topics from the repository created by the faculty of the department. The same faculty will be continued as mentors/guide for dissertation I, II, III and IV
- Students should do a literature survey in the identified topic and finalize it with consultation of the Guide/Supervisor.
- Students should use multiple literatures (at least 20 papers from Refereed Journals/conferences) and understand the topic and research gap.
- Compile the report in standard format and present Seminar in front of the Panel of Examiners.
- Note: At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of I semester.

Course Name: Dissertation-II

- Students have to perform complete system analysis, Design and develop a theoretical/mathematical background for the system proposed.
- Students should attempt to solve the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.and Present Seminar in front of Panel of Examiners

Course Name: Dissertation-III

- Students have to create/implement and deploy the project. Critical analysis has to be carried out with conclusion
- The solution to be validated with proper justification and compile the report in standard format and present Seminar in front of Panel of Examiners

Course Name: Dissertation-IV

- Publish the developed work in terms of Research Paper / Patent / Copyright

Back to Scheme