Nagarjuna College of Engineering & Technology, Bengaluru

An Autonomous Institute, Affiliated to VTU Belagavi

2022 Batch
Scheme & Syllabus of
V Semester

As per the NEP 2020 Guidelines,
Choice-Based Credit System
&
Outcome-Based Education

CSE (Data Science)

w.e.f.
Academic Year 2024-2025

Vision

To prepare the next generation practitioners and researcher for data centric world by bringing together interdisciplinary faculty across the globe.

Mission

M1: To provide Skill Based Education to master the students in problem solving and analytical skills to enhance their niche expertise in the field Data Science

M2: To educate the students with latest technologies to update their knowledge in the field of Data Science

M3: To enable students to experience the Content Based Learning with premier quality data science education, research and industrial collaboration

M4: To enable students to become leaders in the Industry and Academia Nationally as well as internationally

M5: To guide students in research on Data Science, with the aim of having an ethical impact on society by tackling societal grand challenges

PROGRAM OUTCOMES (POs): Graduates of the Computer Science and Engineering – Data Science Program will be able to achieve the following **POs:**

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and Computer Science and Engineering principles to the solution of complex problems in Computer Science and Engineering.

PO2: Problem Analysis: Identify, formulate, research literature, and analyses complex Computer Science and Engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.

PO3: Design/Development of Solutions: Design solutions for complex Computer Science and 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.

PO4: 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 related to Computer Science and Engineering problems.

PO5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex Computer Science and Engineering activities with an understanding of the limitations.

PO6: 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 Computer Science and Engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional Computer Science and Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the Computer Science and Engineering practice.

PO9: Individual and Team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex Computer Science and 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.

PO11: 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 Computer Science and Engineering projects and in multidisciplinary environments.

PO12: Life Long Learning: Recognize the need for, and have the preparationand ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO)

PSO1: Ability to analyse complex computing issues and apply the principlesto achieve related solution.

PSO2: Ability to design, implement and evaluate computing based solutionsto meet range of computing requirements based in the data science.

PSO3: Ability to effectively communicate within diverse work group relatedto professional framework.

Program Educational Objectives (PEOs)

PEO 1: To make students competent for higher studies and employable, to meet industrial requirements.

PEO 2: To develop students having core competence in science, mathematics and fundamentals of Data Science to address ever changing industrial requirements globally.

PEO 3: To create academically conducive environment to learn engineering skills in the domains such as Data Analytics, Data Modelling, Data Visualization and Allied Technologies.

PEO 4: To enrich students with professional ethics, leadership qualities, and entrepreneurial skills.

PEO 5: An ability to engage in lifelong learning for effective adaptation to technological developments.

NAGARJUNA COLLEGE OF ENGINEERING & TECHNOLOGY, BENGALURU

B.E. in CSE (Data Science)

Scheme of Teaching and Examinations 2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

V SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week					Examination			
					Theory Lecture	Tutorial	Practical / Drawing	Self Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	Credits
					L	T	P	S					
1	HSMS	22CDT51	Entrepreneurship Development and Management Studies	TD: CD PSB : CD	4	0	0		03	50	50	100	4
2	IPCC	22CDI52	Computer Networks	TD: CD PSB : CD	3	0	2		03	50	50	100	4
3	PCC	22CDT53	Theory of Computation	TD: CD PSB : CD	3	2	0		03	50	50	100	4
4	PCCL	22CDL54	Data Visualization using R Lab	TD: CD PSB : CD	0	0	2		03	50	50	100	1
5	PEC	22CDT515*	Professional Elective Course	TD: CD PSB : CD	3	0	0		03	50	50	100	3
6	PROJ	22CDP56	Mini Project	TD: CD PSB : CD	0	0	4		03	100		100	2
7	AEC	22RMP57	Research Methodology and IPR	TD: HSM PSB : HSM	3	0	0		03	50	50	100	3
8	MC	22ENV58	Environmental Studies & E-Waste Management	TD: HSM PSB : HSM	1	0	0		02	50	50	100	1
9	MC	NS59	National Service Scheme (NSS)	NSS coordinator	0	0	2			100		100	0
		PE59	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		YO59	Yoga	Yoga Teacher									
									Total	**550**	**350**	**900**	**22**

Professional Elective Course

22CDT515A	Computer Vision	22CDT515C	No SQL Databases
22CDT515B	Data Mining & Data Warehousing	22CDT515D	Distributed File Systems

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SXX**: Semester End Evaluation. **K :** The letter in the course code indicates common to al the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional ElectiveCourse

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governingthe Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall
not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Mini-project work: Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications etc. Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batches mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of the project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall
not be applicable to cases where the admission to the program is less than 10.

ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT STUDIES

Course Code	**22CDT51**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**4:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**50**	**Total Marks**	**100**
Credits	**04**	**Exam Hours**	**03**

Pre-Requisites: Fundamentals of Management, Communication Skills and Technology Proficiency

Course objectives:

This course will enable students to:

1. Develop Entrepreneurial Mindsets and Skills.
2. Teach Business Planning and Venture Creation.
3. Enhance Financial Literacy and Management Capabilities.
4. Encourage Innovation and Adaptability.
5. Prepare for Real-World Business Challenges.

Course Description

The **Entrepreneurship Development and Management Studies** course is designed to provide students with the foundational knowledge, practical skills, and strategic insights needed to become successful entrepreneurs and effective managers. This course covers the entire entrepreneurial process, from ideation and opportunity recognition to business planning, funding, and scaling ventures. It also integrates core management principles, focusing on leadership, strategic planning, operations, and ethical decision-making.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction to Entrepreneurship

Course Introduction, Profile of the Entrepreneur, Entrepreneurship in Established Firms, Venture Creation’s Role in Society, Types of Enterprises, Technology Entrepreneurship, Impact Entrepreneurship. Motivation and how it is necessary for entrepreneurship.

10 Hours

Module – II

Opportunity Analysis

Opportunities and Uncertainty, Push and Pull and the Sources of Innovation, Customers as Sources of Opportunities, Importance of the Idea (VIDE Model), Assessing Opportunities, The Tournament Approach. SWOT and PESTLE analysis.

10 Hours

Module – III

Markets, Need-Finding and Planning

Defining the Focal Market, Understanding User Needs, Competitive Analysis, Generating Ideas with Individuals and Groups, Planning: Assumptions, Discovery Driven, Discovery Driven Worksheet, Understanding about business plans and its types.

10 Hours

Module – IV

Pitching, Testing, and Prototyping

The Elevator Pitch, testing your idea: Customer Interviews, testing your idea: Surveys, creating a Prototype: Physical Goods, creating a Prototype: Software, Creating a Prototype: Services, Summary and What's Ahead. Market survey, types of secondary data and how primary data can be collected.

10 Hours

Module – V

Management Studies

Fundamentals of Management: Principles of Management, Organizational Behavior and Leadership, Strategic Planning and Decision-Making.

Business Ethics and Corporate Social Responsibility: Ethical Decision-Making in Business, Corporate Governance and Social Responsibility, Sustainability in Business Practices

Innovation and Entrepreneurship: The Role of Creativity in Business, Managing Innovation and Change Entrepreneurial Mindset and New Ventures. Ethics and need for entrepreneurs to be ethical.

10 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

At the end of the course the student will be able to:

CO1. Understanding of Business Fundamentals and Knowledge of Entrepreneurship Processes.
CO2. Apply Financial Literacy, Budgeting Skills and Critical Thinking.
CO3. Analysing Marketing and Customer Relationship Management.
CO4. Evaluating Risk Management and Resilience Building.
CO5. Creating Effective Communication and Negotiation Skills.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Entrepreneurial Development Reprint Edn. 2006 Edition by S S Khanka S Chand; Reprint Edn. 2006 edition (December 1, 2007).
2. Entrepreneurial Development Paperback – 1 September 2014 by Vasant Desai.
3. Dynamics Of Entrepreneurial Development And Management Paperback by Vasant Desai (Author).
4. Business Development For Dummies Paperback – April 20, 2015 by Anna Kennedy (Author).
5. KANISHKA BEDI Vice President (Executive Campus) Professor and Discipline Chair—Operations Management GlobalNxt University.

E-Resources:

1. **https://www.udemy.com/topic/program-management/**

CO PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	-	-	-	1	3	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO3	-	3	-	-	-	-	-	-	-	3	-	3	-	-
CO4	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO5	-	-	-	1	-	-	-	-	3	-	1	3	-	-
AVG	3	3	3	1	-	-	-	-	3	3	1	3	-	-

COMPUTER NETWORKS

Course Code	**22CDI52**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:2:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 hours Theory + 13 Lab slots**	**Total Marks**	**100**
Credits	**04**	**Exam Hours**	**03**

Course Learning Objectives

1. Understand the basics principle and standards for data Communication, Network Types, Topologies and Protocols.
2. Recognize the data link design issues and various data link protocols used for data transmission.
3. Familiarize the design, working and implementation of Internet protocols as well as routing protocols responsible for network layer communication.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I: INTRODUCTION AND PHYSICAL LAYER

Introduction: Data Communications: Components, Data representations, Data flow, Networks: Distributed Processing, Network Criteria, and Physical structures, Network models, Categories of Networks [LAN, WAN, MAN], Protocols and Standards. [1.1,1.2,1.3]

Network Models: The OSI Model: layered architecture, Peer to peer processes, and encapsulation, Layers in the OSI Model: [Brief description of all seven layers], TCP / IP Protocol Suite, Addressing: physical, logical and port addresses and specific address. [2.1,2.2,2.3]

[Fifth Edition Forouzan Textbook] **08 Hours**

Module – II: DATA LINK LAYER AND MEDIUM ACCESS CONTROL SUBLAYER

Data Link Layer: Introduction, Block Coding, Error detection and correction, Linear Block Codes: Simple Parity Check code, Hamming codes, Cyclic codes: Cyclic, Redundancy Check, Checksum. [10.1,10.2,10.3,10.4]

Data link control: Framing, Flow and Error control (Only definition of flow and error control) [11.1,11.2].

Channelization: FDMA, TDMA, CDMA [12.3].

[Fifth Edition Forouzan Textbook] **08 Hours**

Module – III: NETWORK LAYER

Network Layer: Logical Addressing: IPv4 Addresses: Address Space, Notation, Classfull Addressing, Classless Addressing, IPv6 Addresses: Structure, Internet Protocol: IPv4 Datagram, IPv6, Transition from IPv4 to IPv6. [19.1,19.2, 20.1, 20.2,20.3,20.4]

Network Address Mapping: Address Mapping, Error Reporting: ARP, RARP, BOOTP and DHCP. [21.1]

Delivery, Forwarding & Routing: Delivery, Forwarding: Routing Table, Unicast Routing Protocols: Distance Vector Routing. [22.1,22.2.22.3]
[Fourth Edition Forouzan Textbook] **08 Hours**

Module – IV: TRANSPORT LAYER

Transport Layer: Process to Process Delivery: UDP: TCP: TCP services, TCP features, Segment, A TCP connection. SCTP: SCTP services, SCTP features. [23.1,23.2,23.3,23.4]
Congestion Control and Quality of Service: Congestion control: Open loop congestion control and closed loop congestion control. [24.2,24.3]
Quality of Service: Flow Characteristics, Flow Classes, Techniques to improve QoS: Scheduling and Traffic Shaping. [24.5,24.6]
[Fourth Edition Forouzan Textbook] **08 Hours**

Module – V: APPLICATION LAYER

Application Layer: Domain Name System: Name Space, Domain Name Space, DNS In The Internet, Resolution, DNS Messages, Types of Records. [25.1, 25.2, 25.3, 25.4, 25.5, 25.6, 25.7]
Remote Logging, Electronic Mail and File Transfer: Remote logging: Telnet, Electronic mail: Architecture, User Agent, MIME, SMTP POP and IMAP. [26.1, 26.2]
[Fourth Edition Forouzan Textbook] **08 Hours**

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

LIST OF EXPERIMENTS

1	Implement the following data link layer framing methods. i) Character count ii) Character stuffing iii) Bit stuffing
2	Design and develop a program to compute checksum for the given frame 1101011011 using CRC-CCITT 16bits. Display the actual bit string transmitted. Suppose any bit is inverted during transmission. Show that this error is detected at the receiver's end.
3	Implement distance vector routing algorithm to find suitable path for transmission that computes the shortest path from Source to Destination in the network.
4	Using TCP/IP sockets, write a client server program to make the client send the file name to make server sent the back the contents of the requested file if present.
5	Implement three nodes point – to – point network with duplex links between them. Set the queue size, vary the bandwidth and find the number of packets dropped using NS2.
6	Build a LAN with Hubs and Switches and perform Simulation of LAN using packet Tracer.
7	Build a Multi-LAN with Router Configuration and perform Simulation of Multi-LAN using packet Tracer.
8	Implement transmission of ping messages/trace route over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion using NS2.

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

CO1: Gain Knowledge on the principles and standards of Reference Models, types of network topologies, Functions of layers and protocols.
CO2: Analyze Subnetting and routing algorithms for finding optimal paths in networks.
CO3: Develop and Solve problems related to flow control, error control and congestion control in data transmission.
CO4: Simulate the Network Topologies using the Packet Tracer Tool to analyze packet Transmission.
CO5: Apply Ethical principles and standards for developing network-based solutions.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	Total 25 Marks : Reduced to 15 Marks	
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
	Total 25 Marks : Reduced to 10 Marks	
Lab Component	Lab Record and execution of programs	**15 Marks**
	Lab Test at the end of 15th week	**10 Marks**
	Total	**25 Marks**
Grand Total of IAT Marks		**50 Marks**
Obtaining 40% of marks in both theory and lab component is essential for appearing for SEE		

Suggested Learning Resources:

Text Books:

1. Andrew S. Tanenbaum and David J. Wetherall, Computer Networks, Pearson, 5th Edition, 2015.

Reference:

1. Behrouz A. Forouzan, Data Communications and Networking, McGraw Hill, 5th Edition, 2013.
2. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach, Pearson, 7th Edition, 2017.

E-Resources:

1. https://archive.org/details/Data.Communications.and.Networking.5th.Edition
2. https://www.cisco.com/c/en/us/solutions/smallbusiness/resourcecenter/networking/networking-basics.html.
3. http://ptgmedia.pearsoncmg.com/images/9780133814743/samplepages/9780133814743.pdf

CO PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	-	-	2	-	-
CO2	-	1	1	2	1	-	-	-	-	-	-	3	-	-
CO3	1	1	3	1	-	-	1	2	-	-	-	1	2	3
CO4	1	2	1	3	1	-	-	-	-	-	-	3	-	-
CO5	1	1	3	2	-	3	1	1	-	-	-	1	2	2

THEORY OF COMPUTATION

Course Code	**22CDT53**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:2:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**50**	**Total Marks**	**100**
Credits	**04**	**Exam Hours**	**03**

Prerequisites: Prerequisite: Discrete Mathematics, Design and Analysis of Algorithms.

Description of the course: The Theory of Computation is incredibly important as it lays the foundation for computer science by determining what problems can and cannot be solved by computation. It helps in understanding the limits of what computers can do, thereby guiding the design of algorithms, data structures, and software. This course introduces the theory of computation through a set of abstract machines that serve as models for computation - finite automata, pushdown automata, and Turing machines - and examines the relationship between these automata and formal languages. In this course we will introduce various models of computation and study their power and limitations. We will also explore the properties of the corresponding language classes defined by these models and the relations between them.

Course objectives:

This course will enable students to:

This course will enable a student to:

1. Understand abstract computing models.
2. Formalization of the notion of problems via formal languages.
3. Learn Finite Automata, Grammars and Turing Machine.
4. Learn about the theory of computability and its complexity.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction: Alphabet, Power of Alphabet, Strings, Chomsky hierarchy of languages.

Finite Automata: Why Study Automata Theory, Acceptance of a String by a Finite Automaton, Graphical notation of FA, DFA and NFA, Conversion of an NFA to DFA, NFA with ϵ(null)Move, Equivalence of DFA and NFA, Finite Automata with Output, Minimization of Finite Automata Applications and Limitations of FA.

10 Hours

Module – II

Regular Languages: Basics of Regular Expressions, Identities of Regular Expressions, The Arden's Theorem, Construct RE from FA, Construct FA from RE, Equivalence of Two FAs Regular grammars, Pumping Lemma for RLs, Applications of Pumping Lemma, Closure properties of Regular Sets, Applications of Regular Expressions.

10 Hours

Module – III

Context Free Grammar: Definition, Derivation trees, Ambiguity in CFG, Left recursion and Left factoring, Simplification of CFGs, Chomsky Normal Form and Greibach Normal Form, Pumping lemma for Context-free languages, Closure properties of CFLs.

10 Hours

Module – IV

Push Down Automata (PDA): The Formal Definition, Graphical Notation, Instantaneous Description, The Languages of a PDA, Deterministic Push Down Automata, Non-Deterministic Push Down Automata.

10 Hours

Module – V

Turing Machines and Undecidability: The basic model of Turing Machine(TM), Instantaneous Description, Variants of Turing Machines, Transition Diagrams for the turing machines, LBA, Universal Turing Machine, Recursive and Recursively Enumerable Languages.

10 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

At the end of the course the student will be able to:

CO1: Apply the Automata and Grammars for different language classes and become knowledgeable about restricted models of Computation and their relative powers.

CO2: Analyze various Automata models in formal reasoning and reduction of a problem to a formal model, with an emphasis on semantic precision and conciseness.

CO3: Design Compare the different concepts of Theory of computation.

CO4: Engage in independent study as a member of a team and make an effective presentation on the Automata models.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. John E Hopcroft, Rajeev Motwani, Jeffery D Ullman, "Introduction to Automata Theory, Languages and Computation", (Chapter No.: 1.5, 2, 3, 4.1, 4.2, 5, 6, 7.1, 8), 3rd Edition, Pearson Education, 2013, ISBN-13: 978-8131720479.

Reference Books:

1. Peter Linz, "An introduction to Formal languages and Automata", 5th Edition, Cathleen Sether

Publishers, 2012, ISBN-13: 9781449615529.

2. Michael Sipser: "Introduction to the Theory of Computation", 3rd Edition, Cengage learning, 2013.

E-Resources:

1. https://plato.stanford.edu/entries/computational-complexity/#TecDev
2. https://www.cse.iitm.ac.in/~shwetaag/col705.html
3. https://www.cs.ucy.ac.cy/~mavronic/Classes/cs211/index.html
4. https://www.cse.csusb.edu/egomez/cs601.html
5. https://www-e.openu.ac.il/courses/20585.html

CO PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	-	3	-	-	-	-	-	-	-	-	-	2	2	-
CO3	-	-	3	-	-	-	-	-	-	-	-	2	2	-
CO4	-	-	-	-	-	-	-	-	2	2	-	1	2	-

DATA VISUALIZATION USING R LAB

Course Code	**22CDL54**	**CIE Marks**	**50**
Teaching Hours /Week(L:T:P)	**(0:0:2)**	**SEE Marks**	**50**
Total Hours of Pedagogy	**12 Lab slots**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course objectives:

As a student will be able to:

1. Learn how to generate basic visualizations
2. Understand the limitations and advantages of using certain visualizations
3. Develop interactive visualizations and applications
4. Understand various data exploratory functions in R
5. Learn ways of presenting the data to our audience

LIST OF LABORATORY PROGRAMS

1. Generating an interactive Gantt/timeline chart by redefining to the new dataframe.

2. Illustrate the steps for creating the scattered plot with example using legends, text, abline functions using the given dataset.

DATE	Gini	gdp_ann	Presidents	ineql	years
01-01-1967	0.397	861.7	Johnson	2.935356	1967
01-01-1968	0.386	942.5	Johnson	2.974281	1968
01-01-1970	0.394	1075.9	Nixon	3.031772	1970
01-01-1971	0.396	1167.8	Nixon	3.067368	1971
01-01-1972	0.401	1282.4	Nixon	3.108024	1972
01-01-1975	0.397	1688.9	Ford	3.227604	1975
01-01-1976	0.398	1877.6	Ford	3.273603	1976
01-01-1978	0.402	2356.6	Carter	3.372286	1978
01-01-1979	0.404	2632.2	Carter	3.420319	1979
01-01-1988	0.426	5252.6	Reagan	3.720374	1988
01-01-1989	0.431	5657.7	Reagan	3.75264	1989
01-01-1990	0.428	5979.6	G. Bush	3.776672	1990
01-01-1991	0.428	6174	G. Bush	3.790567	1991
01-01-2000	0.462	10289.7	Clinton	4.012403	2000
01-01-2001	0.466	10625.3	Clinton	4.026341	2001
01-01-2010	0.47	14958.3	Obama	4.174882	2010
01-01-2011	0.477	15533.8	Obama	4.191278	2011

3. Generate a heat map with labels for the dataset and mentioning the x label = " Body Count per month", y label = "Years" using the given dataset.

years	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	3	2	3977	3435	546	597	647	794	565	517	486	526
2004	610	663	1004	1303	654	901	825	877	1033	1016	1652	1112
2005	1188	1284	902	1144	1392	1346	1530	2276	1422	1298	1467	1133
2006	1544	1570	1946	1801	2272	2571	3297	2865	2562	2983	3077	2891
2007	3013	2673	2710	2540	2834	2192	2690	2481	1366	1295	1110	987
2008	847	1072	1643	1299	890	747	643	682	606	590	535	582
2009	372	403	426	567	390	501	407	618	333	435	226	475
2010	263	304	336	385	387	385	443	516	254	312	307	218

	2011	389	254	311	289	381	386	308	401	397	366	279	388
	2012	524	356	377	392	304	529	469	422	396	290	253	275
	2013	357	360	403	545	888	659	1145	1012	1221	1095	903	983

4.	Construct a 3D scatter plot for the data to include two additional columns: names and gender and a function to load the data in the active session and save it as a data frame.
5.	Project the 3D histogram with the z variable as well by generating the data for the x and y values x = y = seq(-4,4,by =0.5)
6.	Generate the donut plot for the following dataset by providing the labels ("Army", "Navy","Air Force‖, –Marines") and percentage for the traumatic brain injuries data = c(179718,41370,41914,44280)
7.	Creating a hexbin plot by generating a fake dataset and generating 1000 normally distributed random numbers
8.	Researchers have observed that equity prices or stock returns do not have a normal distribution and the actual distribution of returns contains fat tails. Construct a quantile-quantile plot (QQ plot) to display the data of MSFT and FAKE quantiles.
9.	Generate a correlation plot considering the data : rates=c("USD/EUR","USD/GBP","USD/CHF","USD/JPY","USD/CAD","USD/AUD","US D/IDR")
10.	Considering the inaugural speeches given by President Obama and former president George Bush, two clouds provide us with a great contrast on how these individualsperceive the nation and its citizens. Generate a comparison cloud to eliminate the stop words and project the document matrix.

Course Outcomes:

At the end of the course the student will be able to :

CO1: Implement different methods of Data visualization.

CO2: Describe and design maps and dendrograms using R.

CO3: Create and generate the pie chart and 3D plots.

CO4: Describe and Analyze high dimensional data and visualize continuous data.

CO5: Visualize after analysis of the text and create applications in R.

Text Books:

1. R Data Visualization Cookbook - Atmajitsinh Gohil, Published by Packet Publishing Ltd., January 2015.
2. The Book of R – Tilman M. Davies, No Starch Press, Inc.

References:

1. Data Visualization with R - Rob Kabacof, Opensource publications, 2018
2. R for Dummies - Andrie de Vries and Joris Meys, Published by: John Wiley & Sons, Inc., 2015
3. Data Visualization with R – Thomas Rahlf, Springer publications, 2014

Assessment Details(both IAT and SEE)

Continuous Internal Assessment of Laboratory/Practical Courses		
Lab Test 1	Lab Test 2	Lab Records
15 marks	15 marks	20 marks
Semester End Examination(SEE)		50 marks

Conduct of Practical Examination:

Experiment distribution :

For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity.

For laboratories having PART A and PART B: Students are allowed to pick one experiment from

PART A and one experiment from PART B, with equal opportunity.

- Change of experiment is allowed only once and marks allotted for procedure to be made zero of the changed part only.
- Marks Distribution (Need to change in accordance with university regulations)

a) For laboratories having only one part → Procedure + Execution + Viva-Voce:
15+70+15 = 100 Marks

b) For laboratories having PART A and PART B

i. Part A – Procedure + Execution + Viva = 6 + 28 + 6 = 40 Marks

ii. Part B – Procedure + Execution + Viva = 9 + 42 + 9 = 60 Marks

CO PO Mapping:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	-	-	1	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	2	3	1	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	1	-	-	-
CO5	2	3	-	-	3	-	-	-	2	1	-	-	-	-

COMPUTER VISION

Course Code	**22CDT515A**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Prerequisite: Computer graphics, drawing and animation Image processing techniques

Course Objectives:

Upon Completion of the course, the students will be able to:

1. Recall image processing techniques for computer vision
2. Do shape and region analysis
3. Elucidate Hough Transform and its applications to detect lines, circles, ellipse
4. Apply three-dimensional image analysis techniques
5. Exploit motion analysis

Study real world applications of computer vision algorithms

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Image Processing Foundations: Fundamentals of Image Processing Techniques – Classical Filtering Operations – Thresholding Techniques – Edge Detection Techniques – Corner and Interest Point Detection–Mathematical Morphology –Texture.

08 Hours

Module – II

Shapes and Regions: Binary Shape Analysis –Connectedness –Object Labeling and Counting –Size Filtering –Distance Functions –Skeletons and Thinning –Deformable Shape Analysis –Boundary Tracking Procedures –Active Contours –Shape Models and Shape Recognition –Centroidal Profiles –Handling Occlusion –Boundary Length Measures –Boundary Descriptors –Chain Codes –Fourier Descriptors –Region Descriptors –Moments.

08 Hours

Module – III

Hough Transform: Line Detection –Hough Transform (HT) For Line Detection –Foot-of-Normal Method –Line Localization –Line Fitting –RANSAC for Straight Line Detection –HTBased Circular Object Detection –Accurate Center Location –Speed Problem –Ellipse Detection –Case Study: Human Iris Location –Hole Detection –Generalized Hough Transform –Spatial Matched Filtering –GHT for Ellipse Detection –Object Location –GHT for Feature Collation.

08 Hours

Module – IV

3D Vision and Motion: Methods for 3D Vision –Projection Schemes –Shape From Shading– Photometric Stereo –Shape from Texture –Shape from Focus –Active Range Finding –Surface Representations –Point-Based Representation –Volumetric Representations –3D Object Recognition –3D Reconstruction –Introduction to Motion –Triangulation –Bundle Adjustment –Translational Alignment – Parametric Motion –Spline-Based Motion –Optical Flow –Layered Motion.

08 Hours

Module – V

Applications: Application: Content Based Image Retrieval, Content Based Video Retrieval.

08 Hours

Case Study: Face Recognition, Gait Recognition.

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

At the end of the course the student will be able to:

CO1: Explain the Basic Image Processing Techniques.
CO2: Interpret in–shape, boundary tracking and apply chain codes in region detection.
CO3: Apply Hough transform for detection of geometric shapes like line, ellipse and objects.
CO4: Illustrate 3D Vision process and motion estimation techniques.
CO5: Apply Computer vision in real time scenario.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. E. R. Davies, (2012), ‚Computer & Machine Vision', Fourth Edition, Academic Press.
2. R. Szeliski,(2011), Computer Vision: Algorithms and Applications', Springer 2011.
3. Simon J. D. Prince, (2012) ‚Computer Vision: Models, Learning, and Inference', Cambridge University Press, 2012.
4. Mark Nixon and Alberto S. Aquado, (2012), Feature Extraction & Image Processing for Computer Vision', Third Edition, Academic Press.

Reference Books:

1. D.L.Baggioetal.,(2012),Mastering Open CV with Practical Computer Vision Projects', Packet Publishing,.
2. Jan Erik Solem, (2012),Programming Computer Vision with Python: Tools and algorithms for analyzing images', O"Reilly Media.

DATA MINING AND DATA WAREHOUSING

Course Code	**22CDT515B**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Objectives:

Upon Completion of the course, the students will be able to:

1. To understand the principles of Data warehousing and Data Mining.
2. To be familiar with the Data warehouse architecture and its Implementation.
3. To know the Architecture of a Data Mining system.
4. To understand the various Data preprocessing Methods.
5. To perform classification and prediction of data.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Data Warehousing and Business Analysis: - Data warehousing Components ,Building a Data warehouse ,Data Warehouse Architecture, DBMS Schemas for Decision Support ,Data Extraction, Cleanup, and Transformation Tools ,Metadata ,reporting , Query tools and Applications – Online Analytical Processing (OLAP) – OLAP and Multidimensional Data Analysis.

08 Hours

Module – II

Data Mining: - Data Mining Functionalities – Data Preprocessing – Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation- Architecture Of A Typical Data Mining Systems- Classification Of Data Mining Systems.

Association Rule Mining: - Efficient and Scalable Frequent Item set Mining Methods, Mining Various Kinds of Association Rules ,Association Mining to Correlation Analysis ,Constraint-Based Association Mining.

08 Hours

Module – III

Classification and Prediction: - Issues Regarding Classification and Prediction ,Classification by Decision Tree Introduction , Bayesian Classification, Rule Based Classification ,Classification by Back propagation, Support Vector Machines ,Associative Classification ,Lazy Learners, Other Classification Methods, Prediction, Accuracy and Error Measures.

08 Hours

Module – IV

Cluster Analysis: - Types of Data in Cluster Analysis ,A Categorization of Major Clustering Methods, Partitioning Methods, Hierarchical methods, Density-Based Methods, Grid-Based Methods – Model-Based Clustering Methods

08 Hours

Module – V

Mining Object, Spatial, Multimedia, Text and Web Data: Multidimensional Analysis and Descriptive Mining of Complex Data Objects, Spatial Data Mining

08 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

At the end of the course the student will be able to:

CO1: Assess Raw Input Data and process it to provide suitable input for a range of data mining algorithm

CO2: Design and Modelling of Data Warehouse

CO3: Discover interesting pattern from large amount of data

CO4: Design and Deploy appropriate Classification Techniques

CO5**:** Able to cluster high dimensional data

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Jiawei Han, Micheline Kamber and Jian Pei"Data Mining Concepts and Techniques", Third Edition, Elsevier, 2011

Reference Books:

1. Alex Berson and Stephen J. Smith "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, Tenth Reprint 2007.
2. K.P. Soman, Shyam Diwakar and V. Ajay "Insight into Data mining Theory and Practice", Easter Economy Edition, Prentice Hall of India, 2006.
3. G. K. Gupta "Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.
4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar "Introduction to Data Mining", Pearson Education, 2007.

NO SQL DATABASES

Course Code	**22CDT515C**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Objectives:

Upon Completion of the course, the students will be able to:

1. Define, compare and use the four types of NoSQL Databases (Document-oriented, KeyValue Pairs, Column-oriented and Graph).
2. Demonstrate an understanding of the detailed architecture, define objects, load data, query data and performance tune Column-oriented NoSQL databases.
3. Explain the detailed architecture, define objects, load data, query data and performance tune Document-oriented NoSQL databases.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Why NoSQL? The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, A (Mostly) Standard Model, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL.

Aggregate Data Models; Aggregates, Example of Relations and Aggregates, Consequences of Aggregate Orientation, Key-Value and Document Data Models, Column-Family Stores, Summarizing Aggregate-Oriented Databases.

More Details on Data Models; Relationships, Graph Databases, Schema less Databases, Materialized Views, Modeling for Data Access.

08 Hours

Module – II

Distribution Models; Single Server, Sharding, Master-Slave Replication, Peer-to-Peer Replication, Combining Sharding and Replication.

Consistency, Update Consistency, Read Consistency, Relaxing Consistency, The CAP Theorem, Relaxing Durability, Quorums.

Version Stamps, Business and System Transactions, Version Stamps on Multiple Nodes.

08 Hours

Module – III

Map-Reduce, Basic Map-Reduce, Partitioning and Combining, Composing Map-Reduce Calculations, A Two Stage Map-Reduce Example, Incremental Map-Reduce Key-Value Databases, What Is a Key-Value Store, Key-Value Store Features, Consistency, Transactions, Query Features, Structure of Data, Scaling, Suitable Use Cases, Storing Session Information, User Profiles, Preference, Shopping Cart Data, When Not to Use, Relationships among Data, Multioperation Transactions, Query by Data, Operations by Sets.

08 Hours

Module – IV

Document Databases, What Is a Document Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Event Logging, Content Management Systems, Blogging Platforms, Web Analytics or Real-Time Analytics, Ecommerce Applications, When Not to Use, Complex Transactions Spanning Different Operations, Queries against Varying Aggregate Structure.

08 Hours

Module – V

Graph Databases, What Is a Graph Database?, Features, Consistency, Transactions, Availability, Query Features, Scaling, Suitable Use Cases, Connected Data, Routing, Dispatch, and Location-Based Services, Recommendation Engines, When Not to Use.

08 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

At the end of the course the student will be able to:

CO1: Understanding NoSQL Concepts: Students will be able to explain the fundamental differences between NoSQL and traditional relational databases, including types of NoSQL databases (document, key-value, column-family, and graph).

CO2: Data Modeling: Students will demonstrate the ability to design and implement effective data models for NoSQL databases, taking into account the specific needs of different applications.

CO3: Querying NoSQL Databases: Students will gain proficiency in writing queries and using the query languages specific to various NoSQL databases, including but not limited to MongoDB, Cassandra, and Neo4j.

CO4: Scalability and Performance: Students will analyze the scalability, performance characteristics, and trade-offs of NoSQL databases, including data sharding and replication strategies.

CO5: Integration and Use Cases: Students will evaluate real-world use cases for NoSQL databases, demonstrating the ability to choose the appropriate NoSQL solution for a given application scenario based on requirements and constraints.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Sadalage, P. & Fowler, NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Pearson Addision Wesley, 2012

Reference Books:

1. Dan Sullivan, "NoSQL For Mere Mortals", 1st Edition, Pearson Education India, 2015. (ISBN-

13: 978-9332557338).
2. Dan McCreary and Ann Kelly, "Making Sense of NoSQL: A guide for Managers and the Rest of us", 1st Edition, Manning Publication/Dreamtech Press, 2013. (ISBN-13: 978-9351192022).
3. Kristina Chodorow, "Mongodb: The Definitive Guide- Powerful and Scalable Data Storage", 2nd Edition, O'Reilly Publications, 2013. (ISBN-13: 978-9351102694)

CO PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	-	-	2	1	-
CO2	1	2	3	1	1	-	1	-	-	-	-	3	-	-
CO3	1	2	2	3	2	-	1	1	-	-	-	1	3	2
CO4	1	2	2	3	2	-	-	-	-	-	-	3	-	-
CO5	1	2	2	3	-	3	1	1	-	-	-	1	2	3

DISTRIBUTED FILE SYSTEM			
Course Code	**22CDT515D**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Objectives:

This course will enable students to:

1. Understand the fundamentals of distributed systems.
2. Learn about file file systems and storage.
3. Study distributed file system architectures.
4. Implement and manage distributed file systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Characterization of Distributed Systems: Introduction, Examples of Distributed Systems, Resource Sharing and the Web, Challenges.

System Models: Introduction, Architectural Models, Fundamental Models.

08 Hours

Module – II

Time and Global States: Introduction, Clocks Events and Process States, Synchronizing Physical Clocks, Logical Time and Logical Clocks, Global States, Distributed Debugging.

Coordination and Agreement: Introduction, Distributed Mutual Exclusion, Elections, Multicast Communication, Consensus and Related Problems.

08 Hours

Module – III

Inter Process Communication: Introduction, The API for the Internet Protocols, External Data Representation and Marshalling, Client-Server Communication, Group Communication, Case Study: IPC in UNIX.

08 Hours

Module – IV

Distributed File Systems: Introduction, File Service Architecture, Case Study 1: Sun Network File System, Case Study 2: The Andrew File System. **Name Services:** Introduction, Name Services and the Domain Name System, Directory Services, Case Study of the Global Name Services. **Distributed Shared Memory**: Introduction, Design and Implementation Issues, Sequential Consistency and IVY case study, Release Consistency, Munin Case Study, Other Consistency Models

08 Hours

Module – V

Transactions and Concurrency Control: Introduction, Transactions, Nested Transactions, Locks, Optimistic Concurrency Control, Timestamp Ordering, Comparison of Methods for Concurrency Control. **Distributed Transactions**: Introduction, Flat and Nested Distributed Transactions, Atomic Commit Protocols, Concurrency Control in Distributed Transactions, Distributed Deadlocks, Transaction Recovery.

08 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

At the end of the course the student will be able to:

CO1: Understanding of distributed systems fundamentals.
CO2: Knowledge of file system.
CO3: Proficiency in distributed file system technologies.
CO4: Understanding security in distributed system.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Distributed Systems, Concepts and Design, George Coulouris, J Dollimore and Tim Kindberg, Pearson Education, Edition. 2009.

Reference Books:

1. Distributed Systems, Principles and Paradigms, Andrew S. Tanenbaum, Maarten Van Steen, 2nd Edition, PHI.
2. Distributed Systems, An Algorithm Approach, Sukumar Ghosh, Chapman&Hall/CRC, Taylor & Fransis Group, 2007.

RESEARCH METHODOLOGY AND IPR

Course Code	**22RMP57**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course objectives:

1. To provide an overview of Engineering research and its methodology.
2. To describe the techniques for defining a research problem.
3. To give exposure to various resources supporting the literature survey, statistical tools and plagiarism check.
4. To learn the basics of intellectual property, copy right and Trade mark rights.
5. To educate about developing technical reports and presentations. This shall serve the project work course.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction: Meaning of Research, Objectives, and Motivation in Engineering Research, Criteria for Good Research, Types of Engineering Research, Research Process, Research Problem, Selection and Components of the Research Problem, Techniques Involved in Defining a Problem.

Ethics in Engineering Research- Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship.

08 Hours

Module – II

Reviewing the literature: Importance of the Literature Review, new and existing knowledge, Steps Involved in the Literature Review, Bibliography databases and Search Engines for Research Papers: Web of Science and Google search. Developing a Theoretical and Conceptual Framework, Sample Outline of a Literature Review.

Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions.

08 Hours

Module – III

Interpretation and Report Writing- Meaning of Interpretation, Techniques of Interpretation, Precautions in Interpretation, Significance of Report writing, Different steps in writing report, Layout of the research report, Types of reports, Oral presentation, Mechanics of writing a research report, Precautions for writing research reports.

Technical Writing and Publishing - Free Writing and Mining for Ideas, Attributes and Reasons of

Technical Writing, Patent or Technical Paper, The Choice, Writing Strategies, Journal Paper: Structure and Approach, Language Skills, Writing Style, and Editing, Rules of Mathematical Writing, Publish Articles to Get Cited.

08 Hours

Module – IV

Patent application preparation - Preparing patent applications, Obtaining invention disclosures from Inventors, identifying patentable inventions, Understanding the invention (core inventive concept), Inventorship. Typical parts of the patent Application - Request, Description, Claims, Drawings, Abstract, and Application format.

Copyrights and Related Rights: Classes of Copyrights. Criteria for Copyright. Ownership of Copyright. Copyrights of the Author. Copyright Infringements.

Trademarks: Eligibility Criteria. Acts and Laws. Designation of Trademark Symbols. Classification of Trademarks. Registration and validity of a Trademark. Process for Trademarks Registration. Prior Art Search. Types of Trademark Registered in India.

Famous Case Law: Coca-Cola Company vs. Bisleri International Pvt. Ltd.

08 Hours

Module – V

Industrial Designs: Eligibility Criteria. Acts and Laws to Govern Industrial Designs. Design Rights. Non-Protectable Industrial Designs India. Procedure for Registration of Industrial Designs. Application for Registration. Duration of the Registration of a Design. Importance of Design Registration. Cancellation of the Registered Design. Classification of Industrial Designs. International Treaties.

Geographical Indications: Acts, Laws and Rules Pertaining to GI. Ownership of GI. Rights Granted to the Holders. Registered GI in India and their Identification. Classes of GI.

08 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

At the end of the course the student will be able to:

CO1: **Apply** research concepts and techniques to effectively address research problems.

CO2: **Analyse** literature reviews and databases critically, ensuring proper citation and acknowledgment.

CO3: **Design** and structure internship reports, technical writing, and oral presentations with effective interpretation.

CO4: **Identify** and **discuss** key aspects of intellectual property rights (IPR), emphasizing their importance and processes.

CO5: **Evaluate** case studies and **demonstrate** applying IP laws and ethical standards to real-world engineering and innovation challenges.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Dr. Santosh M Nejakar, Dr. Harish Bendigeri "Research Methodology and Intellectual Property Rights", ISBN 978-93-5987-928-4, Edition: 2023-24.
2. C. R. Kothari, Gaurav Garg, "Research Methodology: Methods and Techniques" New Age ernational, 4th Edition, 2019

Reference Books:

1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488-4
2. Intellectual Property Rights by N.K. Acharya Asia Law House 6th Edition. ISBN: 978-93.
3. Research Methodology by Ranjit Kumar, sage publication 3rd Edition

CO PO Mapping:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	2	-	-	-	-	1	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	1	-	-	-	-	-	-
CO5	-	-	-	-	-	2	2	3	3	-	-	-	-	-

ENVIRONMENTAL STUDIES AND E-WASTE MANAGEMENT

Course Code	**22ENV58**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**1:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**18**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**01**

Course Objectives:

1. To recognize fundamental concepts in environmental science and demonstrate a comprehensive understanding of the environment.
2. To understand the pollution in all fronts at local and global level encompassing the issues of carbon credit, ozone level depletion, global warming, desertification and polar ice cap melting.
3. To expose to students to the problems and mitigation measures concerned to the environmental components like resources, air, water and land.
4. Analyze the impact of issues w. r. t. waste and e-waste management to protect the environment.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only traditional lecture method, but alternative effective Teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes Critical thinking.
5. Adopt Case study Based Learning (CBL), which fosters students' analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.
6. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Ecosystem and Sustainability:

Ecosystem: Structure of ecosystem and their types, including forest, desert, wetland, riverine, and oceanic ecosystems.

Sustainability: Sustainable Development Goals (SDGs) and possible actions, Carbon foot print (CFP), Concept of calculation of CFP and CFP reduction.

Self-Study Component (SSC): Components of the environment.

Textbook 1: CH- 3 **03 Hours**

Module – II

Natural Resources Management and Energy:

Natural Resources: Water resources – Availability & Quality aspects, water induced diseases, Fluoride contamination in drinking water.

Energy: Different types of energy, Conventional sources & Non -Conventional sources of Energy, Solar energy, Wind Energy, Hydrogen as an alternative energy source.

Self-Study Component (SSC): Alternative Energy sources.

Textbook 1: CH- 2 **04 Hours**

Module – III

Environmental Pollution:

Water Pollution, Noise pollution, Air pollution including (Sources, Impacts, Preventive measures and Public Health Aspects). **Environmental Law and policy – Evaluation of environmental acts and policy, Environmental Ethics, Sustainability concept, and Environmental impact assessment**

Self-Study Component (SSC): Case studies of air pollution episodes.

Textbook 1: CH- 5 **04 Hours**

Module – IV

Waste management:

Waste management: Solid Waste Management , types and sources, functional elements of SWM, Biomedical Waste Management - Sources, Characteristics

Environmental Legislation: Solid Waste Management Rules, 2016, Biomedical Waste Management Rules, 2016.

Self-Study Component (SSC): Case studies on waste management options

Textbook 1: CH- 6 **03 Hours**

Module – V

E - Waste Management

E-waste: Composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management.

E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2022 - Salient Features and its implications.

Self-Study Component (SSC): E-Waste (Management) Amendment Rules, 2023, 2024

Textbook 1: e-resource:2 **04 Hours**

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

CO1: Understand the principles of ecology and the environmental issues related to air, land, and water on a global scale.

CO2: Develop observation skills to address environmental problems effectively.

CO3: Apply the basic principles of e-waste management, including collection, recycling, and safe disposal method.

CO4: Able to identify the hazardous effect of e waste and focus on current role.

CO5: To follow the guidelines of environment and e-waste and conduct survey to acquire the knowledge about biomedical waste disposal.

Assessment Details (both IAT and SEE)

Component		**Weightage of %**	
Internal Assessment Tests (IAT)	**IAT 1**	**25**	**25**
	IAT 2	**25**	
Comprehensive Continuous Evaluation (CCE)	**CCE 1**	**25**	**25**
	CCE 2	**25**	
Continuous Internal Evaluation Total Marks: 100. Reduced to 50 Marks			
Semester End Examination (SEE) Total Marks: 100. Reduced to 50 Marks			

Suggested Learning Resources:

Textbooks

1. S M Prakash , "Environmental Studies" 3rd Edition, Elite Publishing House, Mangalore, 2018.
2. Hester R.E., and Harrison R.M, Electronic Waste Management. Science, 2009.

Reference Books:

1. Benny Joseph (2005), "Environmental Studies", Tata McGraw – Hill Publishing Company Limited.
2. R. Rajagopalan, "Environmental Studies- From Crisis to Cure", 2nd Edition, Oxford university press, New Delhi, 2013.
3. G. Tyler Miller Jr., "Environmental Science – working with the Earth", Eleventh Edition, Thomson Brooks/Cole, 2006.

Web links and Video Lectures (e-Resources):

1. https://sdgs.un.org/goals
2. https://kspcb.karnataka.gov.in/waste-management/biomedical-waste
3. E Waste (Management) Rules, 2022: https://kspcb.karnataka.gov.in/sites/default/files/inlinefiles/E%20Waste%20%28Management%29%20Rules%2C%202022.pdf

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Analysis report of case study specified in the Textbooks and reference books (one per student). (10 marks)
- Field Survey (In Team): The students' team of the size of 2 to 4 are expected to visit the organization or Industry understand the waste management, utilization of energy, pollution concerns, e-waste handling and other related suggested best practices specified in the syllabus and then submit a detailed visit report to the concerned staff. (15 marks)

CO PO Mapping:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**
CO1	2	-	-	-	-	1	3	-	-	-	-
CO2	-	1	2	-	-	-	2	-	3	-	-
CO3	-	-	-	-	-	1	2	2	2	1	-
CO4	-	-	-	-	-	1	1	-	-	-	-
CO5	-	-	-	-	-	1	3	-	-	1	-