Nagarjuna College of Engineering & Technology, Bengaluru

An Autonomous Institute, Affiliated to VTU Belagavi

2023 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 2025-2026

Vision:

To build a strong technical environment and foster leadership and problem-solving abilities in the domain of Data Science, creating professionals capable of addressing social and technical challenges.

Mission:

1. To equip and expose students with the latest tools and technologies.
2. To instill critical problem-solving capabilities, leadership qualities, research capabilities and to prepare them for global challenges.
3. To establish state-of-the-art laboratories and foster collaborations with leading industries in the field of Data Science.

PROGRAM OUTCOMES (POs): Graduates of the Computer Science and Engineering – Data Science

Program will be able to achieve the following

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in Washington Accord Knowledge 1 (WK1) to Washington Accord Knowledge 4 (WK4) respectively to develop the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for

i) Independent and life-long learning.
ii) Adaptability to new and emerging technologies and
iii) Critical thinking in the broadest context of technological change. (WK8)

Program Specific Outcome (PSO)

PSO1: Analyze complex computing problems and apply to derive appropriate solutions.

PSO2: Design, implement, and evaluate database-oriented, computing-based solutions that address a broad range of requirements in the field of Data Science.

PSO3: Communicate and work effectively within diverse teams and professional environments.

Program Educational Objectives (PEOs)

PEO1: To work as Data Scientist with an ability to solve wide range of computational problems.

PEO2: To work effectively in a diverse and multi-disciplinary field, as a team member or leader to solve the societal problems.

PEO3: Engage in self-directed and lifelong learning, continuously updating their skills by adapting emerging techniques, advancing in research and higher studies.

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 2025-26)

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	23CDT51	Entrepreneurship Development and Management Studies	TD: CD PSB : CD	4	0	0		03	50	50	100	4
2	IPCC	23CDI52	Computer Networks	TD: CD PSB : CD	3	0	2		03	50	50	100	4
3	PCC	23CDT53	Theory of Computation	TD: CD PSB : CD	3	2	0		03	50	50	100	4
4	PCCL	23CDL54	Data Visualization using R Lab	TD: CD PSB : CD	0	0	2		03	50	50	100	1
5	PEC	23CDT515*	Professional Elective Course	TD: CD PSB : CD	3	0	0		03	50	50	100	3
6	PROJ	23CDP56	Mini Project	TD: CD PSB : CD	0	0	4		03	100		100	2
7	AEC	23RMP57	Research Methodology and IPR	TD: HSM PSB : HSM	3	0	0		03	50	50	100	3
8	MC	23ENV58	Environmental Studies & E-Waste Management	TD: HSM PSB : HSM	1	0	0		01	50	50	100	1
9	MC	23NS59	National Service Scheme (NSS)	NSS coordinator	0	0	2			100		100	0
		23PE59	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		23YO59	Yoga	Yoga Teacher									
									Total	**550**	**350**	**900**	**22**

Professional Elective Course

23CDT515A	Computer Vision	23CDT515C	No SQL Databases
23CDT515B	Data Mining & Data Warehousing	23CDT515D	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	**23CDT51**	**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/**

COMPUTER NETWORKS

Course Code	**23CDI52**	**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

THEORY OF COMPUTATION

Course Code	**23CDT53**	**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 to NFA without ϵ(null)Move, , Minimization of Finite Automata Applications FA.

10 Hours

Module – II

Regular Languages: Basics of Regular Expressions, Algebraic laws 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: The basic model of Turing Machine(TM), Formal definition, Variants of Turing Machines, Design of Turing Machine

Introduction To Compiler Design: Language Processors, Structure of compiler, Role of Lexical Analyzer, Tokens, exemes, Patterns, Syntax Analyzer, top down parsing and bottomup parsing.

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: Acquire fundamental understanding of the core concepts in automata theory and Theory of Computation.

CO2: Apply the fundamentals of automata theory to write DFA, NFA, Epsilon-NFA, Regular Expression(RE) and conversion between them.

CO3: Analyze various Automata models in formal reasoning and reduction of a problem to a formal model, with an emphasis on semantic precision and conciseness.

CO4: Design context-free grammars (CFGs) pushdown automata (PDAs) and Turing Machine(TM) for formal languages.

CO5: Compare the different concepts of Theory of computation and Acquire fundamental understanding of compiler design of core concepts

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

DATA VISUALIZATION USING R LAB

Course Code	**23CDL54**	**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. Understand and apply various visualization techniques using R.
2. Explore datasets visually to detect patterns, anomalies, and trends.
3. Implement statistical and graphical plots using ggplot2 and base R.
4. Customize, annotate, and interpret plots for effective communication.
5. Solve real-world problems using data visualization and storytelling techniques.

LIST OF LABORATORY PROGRAMS

Introduction to R Visualization

Program 1: Plotting with base R: Histogram, barplot, boxplot.

Program 2: Data cleaning and exploratory plots using `plot()` and `pairs()`.

Assignment: Load and clean any small dataset, create basic plots and summarize observations.
Case Study: Visual exploration of COVID-19 dataset to find daily trends and outliers.

ggplot2 Essentials:

Program 3: Using `ggplot2`: Scatter plots, line graphs, bar charts.

Program 4: Faceting and themes for multi-panel plots.

Assignment: Compare `ggplot2` and base R plots on the same dataset.
Case Study: Exploratory analysis of Titanic dataset using layered grammar of graphics.

Advanced Visualization Techniques

Program 5: Heatmaps, correlation plots, and density plots.

Program 6: Time-series visualization with `lubridate`, `zoo`, and `ggplot`.

Assignment: Analyze air quality data using time-series plots.
Case Study: Stock price trend analysis using NSE or BSE dataset.

Interactive and 3D Visualizations

Program 7: Interactive plots using `plotly` and `ggiraph`.

Program 8: 3D plots using `rgl` and `plot3D`.

Assignment: Convert static ggplot2 charts to interactive using `plotly`.
Case Study: Weather pattern visualization using open weather dataset.

Dashboard and Storytelling

Program 9: Building a dashboard using `shiny` and `flexdashboard`.

Program 10: Integrating multiple charts for a single narrative visualization.

Assignment: Create a mini dashboard for any domain (sales, health, etc.).
Case Study: End-to-end visualization report for a public dataset (e.g., WHO data).

Course Outcomes:

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

CO1: Understand and apply basic to advanced visualization techniques in R.

CO2: Perform data cleaning and prepare datasets for visualization.

CO3: Create customized and interactive plots using R libraries.

CO4: Interpret and analyze real-world datasets using effective visualizations.

CO5: Apply data visualization for domain-specific problems through case studies.

Text Books:

1. **Hadley Wickham & Garrett Grolemund** - R for Data Science: Import, Tidy, Transform, Visualize, and Model Data - O'Reilly Media, 2017. ISBN: 978-1491910399.
2. **Karthik Ramasubramanian & Abhishek Singh – Mastering Data Visualization with R, Packt Publishing, 2018. ISBN: 978-1788395792.**

References:

1. **Winston Chang** - R Graphics Cookbook: Practical Recipes for Visualizing Data, 2nd Edition, O'Reilly Media, 2018. ISBN: 978-1491978603
2. **Antony Unwin** - Graphical Data Analysis with R, CRC Press, 2015
3. Thomas Rahlf – Data Visualization with R, 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

COMPUTER VISION

Course Code	**23CDT515A**	**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	**23CDT515B**	**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	**23CDT515C**	**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

Types of Digital data - Classification of Digital data - Structured data, Semi-structured data, Unstructured data.

Introduction to Big Data - Characteristics of data, Evolution of Big Data, Challenges with Big data, What is Big Data, Why Big Data.

Why NoSQL? - The Value of Relational Databases, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL.

08 Hours

Module – II

Aggregate Data Models - Aggregates, 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.

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

08 Hours

Module – III

Consistency - Update Consistency, Read Consistency, Relaxing Consistency, Relaxing Durability, Quorums.
Version Stamps - Business and System Transactions, Version Stamps on Multiple Nodes.
Map-Reduce - Basic Map-Reduce, Partitioning and Combining, Composing Map-Reduce Calculations - A Two stage Map-Reduce Example, Incremental Map-Reduce.

08 Hours

Module – IV

Key-Value Databases - What Is a Key-Value Store, Key-Value Store Features - Consistency, Transactions, Query features, Structure of data, Scaling.
Document Databases - What Is a Document Database?, Features - Consistency , Transactions, Availability, Query Features, Scaling.
Column-Family stores - what is a Column-Family Data Store?, Features - Consistency , Transactions, Availability, Query features, Scaling.

08 Hours

Module – V

Graph Databases - What Is a Graph Database?, Features - Consistency, Transactions, Availability, Query features, Scaling.
Introduction to Machine learning - Introduction to Machine learning , Machine learning Algorithms - Regression Model - Linear regression, Clustering, Collaborative filtering, Association rule mining, Decision Tree

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: Demonstrate an understanding of digital data types and classification, explain the evolution and characteristics of Big Data, and articulate the limitations of traditional databases that led to the emergence of NoSQL systems.

CO2: Explain various aggregate and non-aggregate data models, including key-value, document, column-family, and graph databases, and describe data distribution techniques such as sharding and replication to support scalable data systems.

CO3: Describe consistency models and versioning techniques in distributed systems, and demonstrate an understanding of Map-Reduce programming for large-scale data processing.

CO4: Analyze the characteristics and features of key-value, document, and column-family databases, including their consistency models, transaction support, query capabilities, and scalability.

CO5: Explain the fundamental concepts and features of graph databases and apply basic machine learning algorithms such as regression, clustering, collaborative filtering, association rule mining, and decision trees.

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.
2. Seema Acharya and Subhashini Chellapan, Big Data and Analytics, Wiley, 2nd Edition.

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)

DISTRIBUTED FILE SYSTEM			
Course Code	**23CDT515D**	**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	**23RMP57**	**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 understand the knowledge on basics of research and its types.
2. To learn the concept of literature Review, technical Reading, statistical tools, plagiarism and citations.
3. To learn Ethics in Engineering Research.
4. To discuss the concepts of Intellectual Property Rights, Copy right and Trade mark rights.
5. To learn the basics of intellectual property, copy right and Trade mark rights.
6. To develop proficiency in technical report writing and professional presentation skills. 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

Foundation Of Research: Definitions of Research; Objectives and Motivation in Engineering Research; Criteria for Good Research; Types of Engineering Research; Research Process; Identifying and Solving a Worthwhile Research Problem.

Ethics in Engineering Research: Ethical Practices in Engineering Research; Types of Research Misconduct; Ethical Issues Related to Authorship.

08 Hours

Module – II

Literature Review and Technical Reading: Importance of Literature Review and Technical Reading, New and Existing Knowledge; Analysis and Synthesis of Prior Art; Steps Involved in a Literature Review; Bibliographic Databases — Web of Science, Google, and Google Scholar; Developing a theoretical and conceptual framework; Critical Reading vs. Creative Reading; Taking Notes While Reading.

Attributions and Citations: Giving Credit Wherever Due; Citations — Functions and Attributes; Impact of Title and Keywords on Citations; Knowledge Flow Through Citations; Citing Datasets; Styles for Citations; Acknowledgment and Attribution; Acknowledgements in Books/Dissertation. Dedication of Acknowledgements.

08 Hours

Module – III

Interpretation and Report Writing- Meaning of Interpretation; Techniques of Interpretation; Precautions in Interpretation; Significance of Report Writing; Steps in Writing a Report; Layout of a 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 Principles of Technical Writing; Patent or Technical Paper — Making the Right Choice; Writing Strategies; Journal Paper — Structure and Approach; Language Skills, Writing Style; Publishing Articles to Get Cited**.**

08 Hours

Module – IV

Intellectual Property Rights and IPR - Introduction to IPR, Patents-Preparing Patent Applications; Patentable and non-patentable inventions; Understanding the Invention (Core Inventive Concept); Inventorship; Typical Parts of a Patent Application — Request, Description, Claims, Drawings, Abstract, and Application Format.

Copyrights and Related Rights: Classes of Copyrights; Criteria for Copyright Protection; Ownership of Copyright; Rights of the Author; Copyright Infringement.

Trademarks: Eligibility Criteria; Acts and Laws Related to Trademarks; Designation of Trademark Symbols; Classification of Trademarks; Registration and Validity of a Trademark; Process for Trademark Registration; Prior Art Search; Types of Trademarks 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 Governing Industrial Designs; Design Rights; Non-Protectable Industrial Designs in India; Procedure for Registration of Industrial Designs; Application for Registration; Duration of Design Registration; Importance of Design Registration; Cancellation of Registered Designs; Classification of Industrial Designs; International Treaties.

Geographical Indications: Acts, Laws, and Rules Pertaining to Geographical Indications (GI); Ownership of GI; Rights Granted to GI Holders; Registered GIs in India and Their Identification; Classes of GIs.

Case Studies on Patents: *Case study of Curcuma (Turmeric) Patent; Case study of Neem Patent; Case study of Basmati patent.*

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

ENVIRONMENTAL STUDIES AND E-WASTE MANAGEMENT

Course Code	**23ENV58**	**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

Ecosystems:

Structure and types of ecosystems, including forest, desert, wetland, riverine, and oceanic ecosystems. Ecological succession and interspecific relationships within ecosystems.

Sustainability:

Understanding climate change and its implications for sustainability. Overview of the Sustainable Development Goals (SDGs) and possible actions to achieve them. Concept of carbon footprint (CFP), methods for calculating CFP, and strategies for its 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 concerns, and associated health issues such as waterborne diseases and fluoride contamination in drinking water. Overview of natural resources and the challenges associated with their management. Population dynamics, including birth rate, death rate, immigration, and emigration and their impact on resource consumption.

Energy:

Types of energy sources: conventional and non-conventional. Focus on renewable energy sources such as solar energy, wind energy, and hydrogen as an alternative energy source.

Self-Study Component (SSC): Alternative Energy sources Textbook 1: CH- 2 **04 Hours**

Module – III

Environmental Pollution, Legislation, and Policy

Pollution:

Water, air, soil, and noise pollution — their sources, impacts, preventive measures, and public health implications. Hazards of plastic usage and its impact on ecosystems and human health. Contemporary environmental issues including ozone layer depletion, and acid rain.

Environmental Legislation:

Overview of the Forest Conservation Act and challenges in the enforcement of environmental laws.

Environmental Law and Policy:

Critical evaluation of key environmental acts and policies. Introduction to environmental ethics, the concept of sustainability, and Environmental Impact Assessment (EIA). Role of non-governmental organizations (NGOs) in promoting public awareness and participation in environmental protection.

Self-Study Component (SSC): Case studies of air pollution episodes Textbook 1: CH- 5 **04 Hours**

Module – IV

Waste Management:

Solid Waste Management: Types and sources; functional elements of SWM.

Biomedical Waste Management: Sources and characteristics; biodegradable medical products. AI-powered waste sorting, global perspectives, and future challenges.

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 of e-waste. Global context of e-waste. E-waste pollutants and hazardous properties. Effects of e-waste pollutants on human health and the surrounding environment. Domestic e-waste disposal. Basic principles of e-waste management. Components of e-waste management. Sustainable product design and development. E-waste recycling.

Legislation:

E-Waste (Management and Handling) Rules, 2011, and E-Waste (Management) Rules, 2022 – salient features and their 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