SCHOOL OF ENGINEERING AND TECHNOLOGY

B.Tech (Computer Science & Engineering) with Specialization in Data Science

Undergraduate Course

2023-27

Preamble

Welcome to the School of Engineering and Technology at K. R. Mangalam University!

At the forefront of innovation and academic excellence, the School of Engineering and Technology is a vibrant hub of learning that nurtures aspiring engineers and technologists. Our commitment to fostering a dynamic learning environment, coupled with a passion for pushing the boundaries of knowledge, empowers our students to embark on a transformative educational journey.

With a blend of cutting-edge curriculum, state-of-the-art facilities, and a distinguished faculty, we are dedicated to equipping our students with the skills, insights, and practical experience they need to thrive in a rapidly evolving technological landscape. Our programs are designed not only to impart technical proficiency but also to cultivate critical thinking, creativity, and ethical leadership.

As we embrace the spirit of innovation and discovery, we invite students to engage in hands-on projects, collaborative research endeavors, and experiential learning opportunities. Through industry partnerships, internships, and exposure to real-world challenges, our students gain a holistic understanding of their fields, preparing them to make meaningful contributions to society.

At the School of Engineering and Technology, we believe in fostering a sense of community and camaraderie among students, faculty, and industry professionals. This collaborative ethos encourages the exchange of ideas, the pursuit of excellence, and the development of lifelong connections.

Whether you aspire to be a trailblazing engineer, a tech-savvy entrepreneur, or a visionary researcher, the School of Engineering and Technology is here to nurture your ambitions and empower you to shape a brighter future.

Welcome to a place where innovation knows no bounds, and where your journey towards academic and professional success begins.

Dean,

School of Engineering and Technology,

K. R. Mangalam University.

Preface

The field of Computer Science & Engineering is at the forefront of technological advancements, shaping the world we live in today. It encompasses a diverse range of disciplines, including computer systems, algorithms, software development, networking, artificial intelligence, and more. As technology continues to revolutionize every aspect of our lives, the demand for skilled computer scientists and engineers is ever-increasing

Data Science is a distinctive cross-disciplinary field that combines computer science, computational mathematics, statistics, and management. After the theoretical, computational, and empirical paradigms of science, data science is regarded as the fourth paradigm of science. Due to the widespread use of digital devices, our daily lives generate more data than ever before. The amount of data is expanding exponentially with the introduction of IoT (Internet of Things) and Industry 4.0. Insights that can be used to improve our world are hidden in that plethora of data. Due to this, data science has developed into a discipline that entails gathering, visualizing, analyzing, and modeling huge and complicated data sets from various domains and sources.

The program's main goal is to provide graduates with the skills necessary to acquire and manage all forms of data in order to conduct data-driven investigations and visual and sophisticated analyses. This 4-year undergraduate program trains students to gather, organize, and extract meaning from data for better business decision-making.

The B.Tech. Data Science program's curriculum places a strong emphasis on providing students with hands-on experience through practicums, labs, and experience solving real-world problems. It also introduces students to the fundamentals of applied statistics, applied mathematics, and computer science that are necessary in the context of data science and its applications.

The B.Tech. Data Science course is built around KRMU's basic ideas of offering industry-linked, technology-based, research-driven, and seamless education, just like all of our other flagship programs.

Objectives of the program

After the completion of the degree, students would

- Be prepared with a wide range of knowledge in many data science fields, such as data collecting, visualisation, processing, and modelling of massive data sets.
- Learn how to analyse large data sets coming from a variety of application domains using established data science models based on math and computer science.
- Use the knowledge gained from the curriculum to build models that may be used to tackle current and upcoming difficulties and issues needing extensive data analysis.
- Become better educated professionals to meet the industry's expanding need for data scientists and engineers.

Career Avenues

There is a large scope of B.Tech. Data Science Jobs for graduates in both the private and public sectors. After B.Tech. Data Science Graduation students pursuing the course are not limited to their specific areas resulting in a vast number of jobs.

B.Tech. Data Science Is one of the most diverse courses in terms of, not just employment opportunities across various domains, but also the scope of higher education for graduates. The scope of a B.Tech. Data Science is quite vast whether a graduate chooses to work or study further.

According to the IT industry, there are over 1.5 million jobs that are going unfilled in India right now. This shows that data is the future and so are Data Scientists!

Some of the areas of recruitment are

- Supply Chain.
- Computer Science.
- Advanced Analytics.
- Artificial Intelligence.
- Network Analysis.
- Machine Learning.

- Management Consulting.
- Predictive Modeling.

Prospective Companies

- Amazon
- Flipkart
- Cognizant
- Wipro
- IBM
- Infosys
- Deloitte
- Walmart
- Genpact
- Accenture
- Microsoft
- Reliance

Duration

4 Years (Full-Time)

Eligibility Criteria

The candidate should have passed 10+2 or its equivalent examination from a recognized Board with a minimum of 50% marks in aggregate. The reservation and relaxation for SC/ST/OBC/PWD and other categories shall be as per the rules of central/state government, whichever is applicable.

K.R. MANGALAM UNIVERSITY

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University Vision & Mission

Vision

K.R. Mangalam University aspires to become an internationally recognized institution of higher learning through excellence in inter-disciplinary education, research and innovation, preparing socially responsible life-long learners contributing to nation building.

Mission

- Foster employability and entrepreneurship through futuristic curriculum and progressive pedagogy with cutting-edge technology.
- Instill notion of lifelong learning through stimulating research, Outcomes-based education and innovative thinking;
- Integrate global needs and expectations through collaborative programs with premier universities, research centers, industries and professional bodies;
- Enhance leadership qualities among the youth having understanding of ethical values and environmental realities.

School Vision & Mission

Vision

To create, disseminate, and apply knowledge in science and technology to meet the higher education needs of India and the global society, To serve as an institutional model of excellence in scientific and technical education characterized by integration of teaching, research and innovation.

Mission

- To create an environment where teaching and learning are prioritised, with all support activities being held accountable for their success.
- To strengthen the institution's position as the school of choice for students across the State & Nation.
- To promote creative, immersive, and lifelong learning skills while addressing societal concerns.
- To promote co- and extra-curricular activities for over-all personality development of the students.
- To promote and undertake all-inclusive research and development activities.
- To instill in learners an entrepreneurial mindset and principles.
- Enhance industrial, institutional, national, and international partnerships for symbiotic relationships.
- To help students acquire and develop knowledge, skills and leadership qualities of the 21st Century and beyond.

About School

The School of Engineering and Technology at K. R. Mangalam University started in 2013 to create a niche of imparting quality education, innovation, entrepreneurship, skill development and creativity. It has excellent infrastructure, state of the art Labs, and a team of qualified and research-oriented faculty members.

School of Engineering & Technology (SOET) brings together outstanding academicians, industry professionals, and experienced researchers to impart hands-on and multi-disciplinary learning experience. The curriculum of the programs caters to the ever-changing needs and demands of the industry. The school has state-of-the-art infrastructure and domain-specific labs.

The school is offering undergraduate programs (B.Tech, BCA, B.Sc), postgraduate programs (M.Tech, MCA) and Ph.D (all disciplines). We are offering B.Tech programs in recent areas of specializations like AI & ML, Data Science, Cyber Security, Automotive Designs & Electrical Vehicle, Sustainable Development & Smart Cities, Full stack development, UI/UX development etc.

Our curriculum being one of our highlights has been designed in line with the requirements of new National Education Policy 2020, Pedagogy of Employment, Sustainable Development Goals, IR 4.0 etc. The curriculum focuses on problem-solving, design, development, and application of various emerging technologies with focus on innovative teaching learning methodologies. It is our endeavor to constantly evolve curriculum support, so our students stay abreast with the latest updates in this technologically developed world.

SOET aims at transforming the students into competitive engineers with adequate analytical skills, making them more acceptable to potential employers in the country. There is a great focus on experiential & project-based learning with Industry collaborations. Our

B.Tech programs are in collaborations with Industries like IBM, Siemens, Samatrix, Xebia, ImaginXP etc. Out student's get an opportunity to learn directly by professionals from industry.

Program Outcome (PO)

PO 1 Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO 2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering employability.

PO 7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects through entrepreneurship skills and in multidisciplinary environments.

PO 12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change through skill development.

Program Educational Objectives (PEO)

PEO1 - To prepare graduates to become proficient data scientists by providing a comprehensive understanding of data science concepts and techniques, including statistical analysis, machine learning, and data mining.

PEO2 - To prepare graduates for successful careers in the field of data science by providing hands-on experience in using industry-standard tools and latest technologies.

PEO3 - To develop graduates' critical thinking, problem-solving, and research skills to enable them to apply data science techniques to solve real-world problems and contribute to scientific research in the field of data science.

PEO4 - To nurture graduates' personal and professional growth by instilling ethical values, leadership, effective communication, teamwork, and lifelong learning habits, to prepare them for leadership roles in the field of data science.

Program Specific Outcomes (PSO)

PSO1 - Demonstrate a comprehensive understanding of data science concepts and techniques, including statistical analysis, machine learning, and data mining.

PSO2 - Apply industry-standard tools and the latest technologies in data science to solve practical problems and perform data analysis effectively.

PSO3 - Utilize critical thinking and problem-solving skills to apply data science techniques in solving real-world problems and contribute to scientific research in the field of data science.

PSO4 - Demonstrate ethical values, effective communication, teamwork, leadership abilities, and a commitment to lifelong learning in the context of data science, preparing graduates for leadership roles in the field.

Program Highlights

- Professionally qualified, competent and committed teaching faculty.
- Industry enabled curriculum and training from industry experts.
- Consistent interaction with renowned academicians and experts.
- Emphasis on project-based learning, techno-pedagogy, field projects, research projects, internships, continuous and comprehensive evaluation.
- Access to certification courses, ability & skill development programs, value-added courses besides core curriculum.
- Effective career counselling, guidance and mentoring program to excel in professional and personal spheres of life.
- Special programs for advanced and slow learners with focus on inclusion and student diversity.
- Focus on career progression through training, placements and preparation for higher studies.
- Centre of excellence in AI ,Machine Learning & Data Science

Program Scheme

Semester I

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENMA101	Engineering Calculus	3	1	-	4
2	Minor	ENSP101	Clean Coding with Python	4	0	0	4
3	Major	ENPH101/ENCH101	Engineering Physics / Engineering Chemistry	3	1	-	4
4	SEC	**SEC033**	Engineering Drawing & Workshop Lab	-	-	4	2
5	Minor	ENSP151	Clean Coding with Python Lab	0	0	2	1
6	Major	ENPH151/ENCH151	Engineering Physics lab / Engineering Chemistry lab	-	-	2	1
7	VAC I		Environmental Studies & Disaster Management (Online Moodle)	2	-	-	2
8	SEC	**SEC041**	Data Analysis with Tableau & KNIME	-	-	4	2
TOTAL				17	1	6	21

Semester II

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENMA102	Linear Algebra and Ordinary Differential Equations	3	1	-	4
2	Minor	ENSP104	Data Visualization using Python	4	-	-	4
3	Major	ENCH101/ ENPH101	Engineering Chemistry / Engineering Physics	3	1	-	4
4	Major	ENEE101	Basics of Electrical & Electronics Engineering	4	-	-	4
5	Minor	ENSP154	Data Visualization using Python Lab	-	-	2	1
6	Major	ENCH151/ ENPH151	Engineering Chemistry Lab/Engineering Physics lab	-	-	2	1
7	Major	ENEE151	Basics of Electrical & Electronics Engineering Lab	-	-	2	1
8	VAC II		Extention Activities(community engagement service)	2	-	-	2
TOTAL				19	2	6	24

Semester III

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENCS203	Discrete Mathematics	3	1	-	4
2	Major	ENCS205	Data Structures	3	1	-	4
3	Major	ENCS201	Java Programming	4	-	-	4
4	Minor	ENSP251	R Programming for Data Science and Data Analytics Lab		-	4	2
5	Major	ENCS253	Data Structures Lab	-	-	2	1
6	Major	ENCS251	Java Programming Lab	-	-	2	1
7	Open Elective		Open Elective -II	3	-	-	3
8	VAC III		VAC III	2	-	-	2
9	AEC	AEC011	Life Skills for Professionals-I	3	-	-	3
10	INT/PROJ	ENSI251	Summer Internship/Project-I	-	-	-	2
TOTAL				18	2	8	26

Semester IV

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENMA202	Probability & Statistics	3	1	-	4
2	Major	ENCS202	Analysis and Design of Algorithms	3	1	-	4
3	Major	ENCS204	Database Management Systems	3	1	-	4
4	Minor	ENSP204	Introduction to Data Science	4	-	-	4
5	Major	ENCS256	Analysis and Design of Algorithms Lab	-	-	2	1
6	Major	ENCS254	Database Management Systems Lab	-	-	2	1
7	AEC		Life Skills for Professionals-II	3	-	-	3
8	Open Elective		Open Elective -III	3	-	-	3
9	Minor	ENSP254	Data Science lab	-	-	2	1
10	PROJ	ENSI252	Minor Project-I	-	-	-	2
TOTAL				19	3	6	27

Semester V

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENCS301	Theory of Computation	3	1	-	4
2	Major	ENCS303	Operating Systems	4	-	-	4
3	Minor	ENSP311	Machine Learning with Python	4	0	-	4
4	Major	ENCS351	Operating System Lab	-	-	2	1
5	Minor	ENSP361	Machine Learning with Python Lab	-	-	2	1
6	AEC	AEC013	Life Skills for Professionals-III	3	-	-	3
7	INT/PROJ	ENSI351	Summer Internship/Project-II	-	-	-	2
8	Major	ENCS305	Software Engineering	4	-	-	4
9	VAC IV		VAC IV	2	-	-	2
TOTAL				20	1	4	25

Semester VI

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENCS302	Computer Organization & Architecture	3	1	-	4
2	Minor		Department Elective-I	4	-	-	4
3	Major	ENCS304	Computer Networks	3	1	-	4
4	Major	ENCS306	Introduction of Neural Network and Deep Learning	4	-	-	4
5	Minor		Department Elective-I Lab	-	-	2	1
6	Major	ENCS352	Computer Networks Lab	-	-	2	1
7	Major	ENCS354	Introduction to Neural Networks & Deep Learning Lab	-	-	2	1
8	SEC	**SEC036**	Competitive Coding Lab	-	-	4	2
9	PROJ	ENSI352	Minor Project-II	-	-	-	2
TOTAL				14	2	10	23

	Department Elective I (Artificial Intelligence)						
(i)	Minor	ENSP302	Natural Language Processing	4	-	-	4
	Minor	ENSP352	Natural Language Processing lab	-	-	2	1
(ii)	Minor	ENSP304	Image Processing & Computer Vision	4	-	-	4
	Minor	ENSP354	Image Processing & Computer Vision lab	-	-	2	1
(iii)	Minor	ENSP306	Introduction to Generative AI	4	-	-	4
	Minor	ENSP356	Generative AI lab	-	-	2	1
(iv)	Minor	ENSP308	Transfer Learning	4	-	-	4
	Minor	ENSP358	Transfer Learning lab	-	-	2	1

SN	Category	Course Code	Course Title	L	T	P	C
1	Minor		Department Elective-II	4	-	-	4
2	Minor		Department Elective-III	4	-	-	4
3	Minor		Department Elective-II Lab	-	-	2	1
4	Minor		Department Elective III Lab	-	-	2	1
5	Proj	ENSI451	Minor Project-III	-	-	-	2
TOTAL				8	0	4	12
OR							
1	INT	ENSI453	Professional Internship from Industry	-	-	-	12

Department Elective II (Cyber Security)							
(i)	Minor	ENSP301	Secure Coding and Vulnerabilities	4	-	-	4
	Minor	ENSP351	Secure Coding and Vulnerabilities lab	-	-	2	1
(ii)	Minor	ENSP303	Cyber Crime Investigation & Digital Forensics	4	-	-	4
	Minor	ENSP353	Cyber Crime Investigation & Digital Forensics lab	-	-	2	1
(iii)	Minor	ENSP305	AI in Cyber Security	4	-	-	4
	Minor	ENSP355	AI in Cyber Security Lab	-	-	2	1
(iv)	Minor	ENSP307	Social Media Security	4	-	-	4
	Minor	ENSP357	Social Media Security Lab	-	-	2	1

Department Elective - III (Full Stack Development)							
(i)	Minor	ENSP409	Mobile Application Development using iOS	4	-	-	4
	Minor	ENSP459	Mobile Application Development using iOS Lab	-	-	2	1
(ii)	Minor	ENSP411	DevOps & Automation	4	-	-	4
	Minor	ENSP461	DevOps & Automation Lab	-	-	2	1
(iii)	Minor	ENSP413	.Net FRAMEWORK	4	-	-	4
	Minor	ENSP463	.Net FRAMEWORK Lab	-	-	2	1
(iv)	Minor	ENSP415	New Age Programming languages	4	0	0	4
	Minor	ENSP465	New Age Programming languages Lab	0	0	2	1

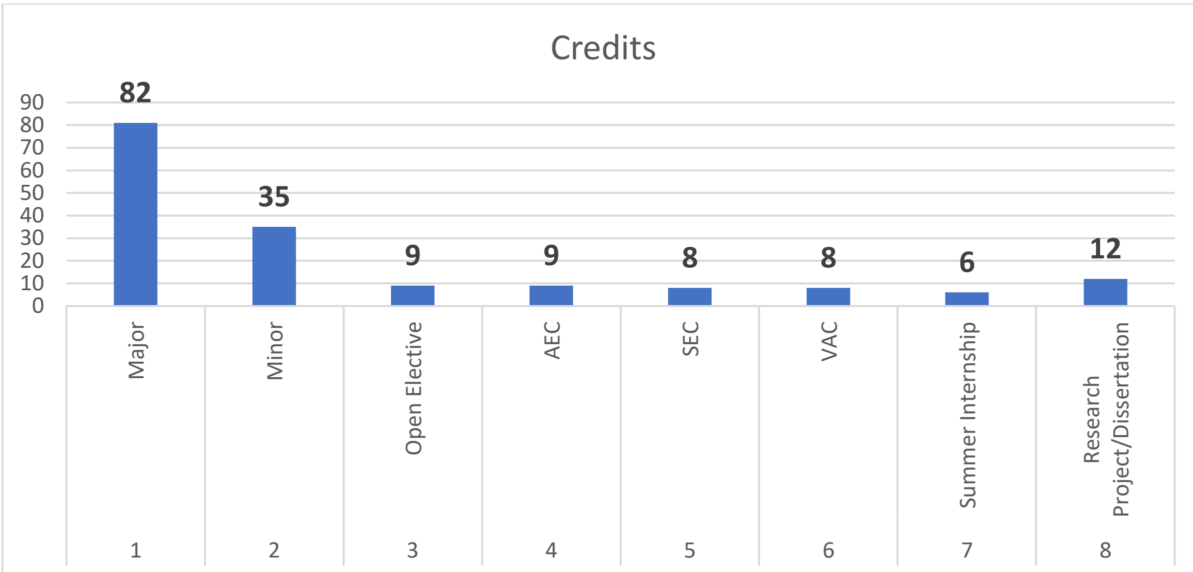
Semester VII

Semester VIII

SN	Category	Course Code	Course Title	L	T	P	C
1	PROJ	ENSI452	Industrial Project/R&D Project/Start-up Project	-	-	-	12
TOTAL							12

Total Credits: 169

Categorization of Courses



Syllabus

Semester: 1

ENGINEERING CALCULUS

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Engineering Calculus	**ENMA101**	3-1-0	4
Type of Course:	Major		
Pre-requisite(s): Calculus knowledge at higher secondary level			
Frequency of offering (check one): Odd			
Total lecture, Tutorial and Practical Hours for this course:			
Lectures: 44	**Practice**		
	Tutorials: 01	**Lab Work: No**	

Course Outcomes (COs)

The objective of this course is to familiarize the graduate engineers with techniques in calculus, multivariate calculus, vector calculus and their applications. It aims to equip the students with standard concepts and tools from intermediate to advanced level that will enable them to tackle more advanced level of mathematics and applications that they would find useful in their disciplines.

COs	The students will learn:
CO 1	To **apply** the knowledge of differential calculus in the field of engineering.
CO 2	To **deal** with functions of several variables that are essential in optimizing the results of real life problems.
CO 3	Multiple integral tools to deal with engineering problems involving centre

	of gravity, volume etc.
CO 4	To **deal** with vector calculus that is required in different branches of Engineering to graduate engineers.
CO 5	Geometrical approach to the mean value theorems and their **application** to the mathematical problems
CO 6	**Evaluation** of surface areas and volumes of revolutions of curves.

UNIT WISE DETAILS

Unit: 1	**Differential Calculus- I**	**No. of hours: 11**

Content Summary: Introduction to limits, continuity and differentiability, Rolle's Theorem, Lagrange's Mean value theorem with their Geometrical Interpretation and applications, Cauchy's Mean value Theorem, Taylor's Series. Applications of definite integrals to evaluate surface areas and volumes of revolutions of curves (Only in Cartesian coordinates), Successive Differentiation (nth order derivatives), Leibnitz theorem and its application, Curve tracing: Cartesian and Polar co-ordinates.

Unit : 2	**Multivariable Calculus (Partial Differentiation and applications)**	**No. of hours: 11**

Content Summary: Partial derivatives, Total derivative, Euler's Theorem for homogeneous functions, Taylor and Maclaurin's theorems for a function of one and two variables, Maxima and Minima of functions of several variables, Lagrange Method of Multipliers, Jacobians.

Unit: 3	**Multivariable Calculus-II (Integration)**	**No. of hours: 11**

Content Summary: Evaluation of Double Integrals (Cartesian and polar coordinates), change of order of integration (only Cartesian form), Evaluation of Triple Integrals: Change of variables (Cartesian to polar) for double and (Cartesian to Spherical and Cylindrical polar coordinates) for triple integrals. Applications: Areas (by double integrals) and volumes (by double integrals and triple integrals), Center of mass and center of gravity (Constant and variable densities).

Unit: 4	**Vector Calculus**	**No. of hours: 11**

Content Summary: Vector differentiation: Gradient, Curl and Divergence and their Physical interpretation, Directional derivatives, Tangent and Normal planes. Vector Integration: Line integral, Surface integral, Volume integral, Gauss's Divergence theorem, Green's theorem, Stoke's theorem (without proof) and their applications.

Contents beyond Syllabus: NO

Text Books:-

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9thEdition,Pearson, Reprint, 2002.

Reference Books:-

1. B. V. Ramana, Higher Engineering Mathematics, Tata Mc Graw-Hill Publishing Company Ltd., 2008.

2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publisher, 2005.

3. R K. Jain & S R K. Iyenger, Advance Engineering Mathematics, Narosa Publishing House 2002

4. E. Kreyszig, Advance Engineering Mathematics, John Wiley & Sons, 2005.

5. Ray Wylie C and Louis C Barret, Advanced Engineering Mathematics, Tata Mc-Graw-Hill; Sixth Edition.

Other useful resource(s):

1. Link to NPTEL course contents: https://onlinecourses.nptel.ac.in/noc18_ma05/preview

2. Link to topics related to course: https://www.whitman.edu/mathematics/calculus_online/chapter14.html

Define Course Outcomes (CO)

COs	Statements
CO 1	To apply the knowledge of differential calculus in the field of engineering.
CO 2	To deal with functions of several variables that are essential in optimizing the results of real life problems.
CO 3	Multiple integral tools to deal with engineering problems involving centre of gravity, volume etc.
CO 4	To deal with vector calculus that is required in different branches of Engineering to graduate engineers.
CO 5	Geometrical approach to the mean value theorems and their application to the mathematical problems
CO 6	Evaluation of surface areas and volumes of revolutions of curves.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1	-	P1
CO2	C2	-	P2
CO3	C2	-	P2

CO4	C3, C4	-	P3
CO5	C5	-	P4, P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	2	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	-	3
CO3	3	-	-	-	-	-	2	-	-	-	-	2
CO4	-	-	3	-	-	-	-	-		-	2	3
CO5	3	2	-	3	-	-	-	-	-	-	-	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	-
CO2	-	3	-	-
CO3	3	-	-	-
CO4	-	-	2	-
CO5	-	-	-	3

Clean Coding with Python

Department:	**Department of Computer Science and Engineering**			
Course Name: Clean Coding with Python	**Course Code**	**L-T-P**	**Credits**	
	ENSP101	3-0-2	4	
Type of Course:	Minor			
Pre-requisite(s), if any:				
Frequency of offering (check one): Odd				

Brief Syllabus:

1. Master the fundamentals of writing Python scripts
2. Learn core Python scripting elements such as variables and flow control structures
3. Discover how to work with lists and sequence data
4. Write Python functions to facilitate code reuse
5. Use Python to read and write files
6. Make their code robust by handling errors and exceptions properly
7. Work with the Python standard library
8. Explore Python's object-oriented features
9. Work on the GUI programming using Tkinter.

Total lecture, Tutorial and Practical Hours for this course:

Lectures: 40	**Practice**	
	Tutorials:	**Lab Work:**

Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.

COs	
CO 1	**Work** with user input to create fun and interactive programs.

CO 2	**Develop**, run and manipulate Python programs using Core data structures like Lists, Dictionaries, and use of Strings Handling methods.
CO 3	**Develop**, run and manipulate Python programs using File Operations and searching pattern using regular expressions.
CO 4	**Determine** the need for scraping websites and working with CSV, JSON and other file formats.
CO 5	**Create** simple games with images, animations, and audio using our custom beginner-friendly programming library.

12. UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to Python**	**No. of hours: 8**
Python Introduction and Setup: Command Line Basics, Installation of Python. Text Editor (VS Code, PyCharm, Anaconda) **Python basics and control structures:** Python data types,Numbers, Variables, Getting input from the user, Operators,Statements (If, else, elif), Nested statements, Loops and loop control statements (Break, continue and pass), Strings (Indexing, slicing and formatting).		
Unit Number: 2	**Title: Python Data Structure**	**No. of hours: 8**
Content Summary: Python Data Structures Lists, Tuples, Sets, Dictionaries. Methods and Functions: Introduction to functions, def keyword, *args and **kwargs in python, exercise on functions, Lambda expressions, Map and Filter functions		
Unit Number: 3	**Title: Python Decorators and generators**	**No. of hours: 8**

<table>
<tr><td colspan="3">Content Summary:
Modules and Package : Installation using pip
Errors and Exception Handling: Errors, Exceptions, Try and Except Statement, Catching Specific Exception, Try with else, Finally, Keyword, Raising an exception.
File Handling using Python</td></tr>
<tr><td>Unit Number: 4</td><td>Title: Python advanced modules</td><td>No. of hours: 8</td></tr>
<tr><td colspan="3">Content Summary:
Python advanced modules: Datetime module, Math and Random module, OS module
Regular Expressions: re module
Web Scraping using Python: Web Scraping libraries and practical implementation
Working with images using python</td></tr>
<tr><td>Unit Number: 5</td><td>Title: Working with Excel sheets and CSV files</td><td>No. of hours: 8</td></tr>
<tr><td colspan="3">Content Summary:
Python GUI programming: Tkinter, Adding Widgets, Buttons etc.SQL queries (DDL, DML, DCL, TCL) – Joins, Sub-Queries, Constraints and Inbuilt functions (Date, String, Math)Database handling in python using MySQL db. – Fetching and Inserting data using MySQL db</td></tr>
<tr><td colspan="3">Self-Learning Components:
PyTorch, PyCharm
Please Note:
1)Students are supposed to learn the components on self-basis
2)Mention open-source tools/ new concepts/technologies that students will be required to learn and present through presentations in class
3) At least 5-10 % syllabus will be asked in end term exams from self-learning components</td></tr>
</table>

Reference Books:

1. J. Peterson, A. Silberschatz, and P. Galvin, "Operating System Concepts", Addison Wesley. 2012

2. A. V. Aho, R. Sethi, and J. D. Ullman, "Compilers: Principles, Techniques and Tools", Addison-Wesley. 2013

3. R. El. Masri and S. B. Navathe, "Fundamentals of Data Base Systems", Benjamin Cummings. 2013

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	3	1	1	1	2	3	1	2	2
CO2	2	2	1	2	1	2	2	1	2	1	3	1
CO3	1	1	3	3	1	1	1	3	3	1	3	3
CO4	2	2	3	2	2	2	2	3	2	2	2	2
CO5	1	1	3	3	1	1	1	3	3	1	2	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PO1	PO2	PO3	PSO4
CO1	1	2	3	1
CO2	2	1	2	2
CO3	1	3	3	3
CO4	2	3	2	2
CO5	1	3	3	1

Relevance of the Syllabus to various indicators

Unit I	Introduction to Python
Local	Addresses local understanding of the Internet and its impact on society

Regional	Addresses regional internet connectivity and network infrastructure requirements
National	Government and Policy Development: Python supports evidence-based policymaking by providing tools for analysing government data, conducting surveys, and evaluating policy interventions. It assists in monitoring and evaluating public programs, assessing their impact, and identifying areas for improvement. Python open-source nature allows governments to leverage existing resources, reducing costs associated with proprietary software.
Global	-
Employability	Lead to positions such as data visualization specialist, data scientist, business intelligence analyst, or data engineer
Entrepreneurship	-
Skill Development	Helps data scientists perform complex data analysis, recognizing patterns, and understanding datasets
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Python Data Structure**
Local	
Regional	-

National	Research and Development: Python is widely used in academic research, contributing to advancements in various fields such as social sciences, economics, healthcare, and environmental studies. Its flexibility and extensive statistical capabilities make it an invaluable tool for researchers and scientists to analyze complex data and generate reliable research outcomes
Global	
Employability	Lead to positions such as data visualization specialist, data scientist, business intelligence analyst, or data engineer
Entrepreneurship	-
Skill Development	
Professional Ethics	Collaboration and Knowledge Sharing:-The Python community is vibrant and globally connected. By embracing R, nations can tap into this collaborative ecosystem, enabling researchers, analysts, and policymakers to share knowledge, exchange best practices, and collaborate on solving complex problems.
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Python decorators and generators**
Local	
Regional	-

National	Research and Development: Python is widely used in academic research, contributing to advancements in various fields such as social sciences, economics, healthcare, and environmental studies. Its flexibility and extensive statistical capabilities make it an invaluable tool for researchers and scientists to analyze complex data and generate reliable research outcomes
Global	Cost Savings: Python is an open-source programming language, which means it is freely available to use. This can result in cost savings for government entities, educational institutions, and businesses that rely on data analysis. The availability of numerous R packages and libraries further enhances the cost-effectiveness of data analysis tasks
Employability	Python programming skills are in high demand in the job market, particularly in fields such as data science, analytics, and research. By promoting the use of python, nations can foster the development of a skilled workforce capable of performing data analysis tasks, thereby driving economic growth and attracting investment in data-driven industries.
Entrepreneurship	-
Skill Development	Develops knowledge and skills in client-server programming and network security
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-Helps students to work on social issues

Unit IV	Python Advanced modules
Local	
Regional	Infrastructure Planning and Optimization: Python can be utilized in infrastructure planning and optimization tasks. It can help analyze large datasets related to transportation, energy, and urban planning to identify patterns, make predictions, and optimize resource allocation, leading to more efficient and sustainable infrastructure development
National	
Global	
Employability	Python is extensively used in economic research and business analytics. Its statistical modeling and machine learning capabilities enable economists and analysts to study economic indicators, forecast market trends, and optimize business strategies. R's visualization capabilities also aid in presenting complex economic data in a clear and meaningful manner, facilitating evidence-based decision-making.
Entrepreneurship	-
Skill Development	Python programming skills are in high demand in the job market, particularly in fields such as data science, analytics, and research. By promoting the use of R, nations can foster the development of a skilled workforce capable of performing data analysis tasks, thereby driving economic growth and attracting investment in data-driven industries.
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	Public Health and Epidemiology: Python plays a vital role in public health and epidemiological studies. It is extensively used for analysing health-related data, tracking disease outbreaks, modelling infectious diseases, and conducting statistical studies to inform public health policies and interventions.
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO

ENGINEERING PHYSICS

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Engineering Physics</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENPH101</td><td>3-1-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Major</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: Integration/Differentiation</td></tr>
<tr><td colspan="4">Brief Syllabus:

This course provides an introduction to the principles and applications of optoelectronics, as well as an overview of new engineering materials. The course is divided into four units, each focusing on different aspects of the subject matter. By the end of the course, students will have a solid foundation in optoelectronics principles, including lasers and fiber optics, as well as an understanding of new engineering materials and their applications</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Mechanics</td><td>No. of hours: 10</td></tr>
<tr><td colspan="4">Content Summary:

Centre of mass, centre of mass of two particle system and a rigid body, Rotational motion, Moment of Inertia and its physical significance, Radius of gyration, Acceleration due to gravity, simple harmonic motion, differential equation of S.H.M., Examples of S.H.M. (simple and compound pendulum)</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Optics</td><td>No. of hours: 10</td></tr>
<tr><td colspan="4">Content Summary:

Light: Introduction of light, properties of light, Dual Nature of light, refraction, Refraction by prism, Interference of light, interference by divison of wavefront (Young's double slit experiment), Interference by division of wave amplitude (Newton's ring), difference between diffraction and interference, types of diffraction,</td></tr>
</table>

Fraunhoffer diffraction (single and double slit), theory of plane diffraction grating, determination of wavelength of a spectral line using transmission grating **Laser**: Introduction, principle of Laser, stimulated and spontaneous emission, Ruby laser, He-Ne Laser, Application of Lasers.		
Unit Number: 3	**Title: Polarization**	**No. of hours: 10**
Content Summary: **Polarization:** Polarization by reflection and refraction, Brewster's law, double refraction, nicol prism, quarter and half-wave plates, Production and analysis of circularly and elliptically polarized light		
Unit Number: 4	**Title: New Engineering Materials**	**No. of hours: 10**
Content Summary: **Dielectric materials**: Definition – Dielectric Breakdown – Dielectric loss – Internal field – Claussius Mossotti relation. **Superconducting materials**: Introduction – Properties- Meissner effect – Type I & Type II superconductors – BCS theory-Applications. **Nanomaterials**: Introduction – Synthesis of nano materials – Top down and Bottom-up approach- Ball milling- PVD method- Applications. Smart materials: Shape memory alloys-Biomaterials (properties and applications)		
***Self-Learning Components**: Crystal Structure - https://youtu.be/UXqWixel_f8 [1] Classification of solids [2] Types of crystal systems [3] Bonding in solids **Please Note:** 1)Students are supposed to learn the components on self-basis 2) At least 5-10 % syllabus will be asked in end term exams from self-learning		

components
Reference Books: 1. N. Subrahmanyam, B. Lal, M.N.Avadhanulu,Optics (S.Chand). 2. A Text Book of Engineering Physics, M.N.Avadhanulu, P.G. Kshirsagar (S.Chand) 3. Ajoy Ghatak, Optics (Tata McGraw Hill). 4. http://www.gpcet.ac.in/wp-content/uploads/2018/09/UNIT-1-EP-PDF.pdf 5. https://fractory.com/fibre-lasers-explained/ 6. https://www.brainkart.com/article/Modern-Engineering-Materials_6830/

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the principles and applications of lasers, fiber optics, and electromagnetic waves.
CO2	**Apply** the concepts of polarization to analyze and manipulate light in various optical systems.
CO3	**Evaluate** the properties and applications of dielectric materials, superconducting materials, and nanomaterials in engineering contexts.
CO4	**Design** and propose innovative applications of lasers, fiber optics, and smart materials for specific engineering challenges.
CO5	**Analyze and solve** problems related to the behavior of electromagnetic waves, polarization, and optical communication systems**.**

COs Mapping with Levels of Bloom’s taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1	-	P5
CO2	C3	-	P2
CO3	C5	-	P4
CO4	C6	-	P3
CO5	C4	-	P3

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	2	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	-	-
CO3	3	-	--	-	-	-	2	-	-	-	-	-
CO4	-	-	3	-	-	-	-	-		-	2	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	2			
CO2		3		
CO3	3			
CO4			2	
CO5				3

Relevance of the Syllabus to various indicators

Unit I	**Mechanics**
Local	Mechanics is essential for understanding local physical structures, infrastructures, and natural phenomena.
Regional	Relevant to regional infrastructure, architectural planning, and transportation systems.
National	Contributes to national standards in construction, engineering, and transportation.
Global	Integral to global physics research, technological advancements, and architectural standards.
Employability	Fundamental for careers in engineering, physics, automotive design, and other technical fields.
Entrepreneurship	Essential knowledge for any startup in the tech, automotive, or engineering sector.
Skill Development	Helps in enhancing problem-solving, analytical skills, and understanding of physical systems.
Professional Ethics	Understanding and applying mechanics ethically is crucial, especially in construction and tech.

Gender	Mechanics as a subject doesn't directly address gender issues. However, promoting gender equality in mechanical fields is vital.
Human Values	Mechanics fosters an appreciation for the natural laws and the intricacies of the physical world.
Environment & Sustainability	Understanding mechanics can lead to the development of more efficient and sustainable machinery and technologies.
Unit II	**Optics**
Local	The understanding of light and its properties directly affects numerous local tools and technologies, such as eyeglasses, microscopes, and various optical tools. Laser technologies can also be employed in local surgeries, treatments, and commercial applications.
Regional	Optics plays a significant role in regional optical communication systems, architectural designs considering light, and in regional healthcare for surgeries and treatments involving lasers.
National	At the national level, optics becomes integral in broader research initiatives, national defense optics, and broader communication infrastructures. Laser technologies might be used in defense, medical surgeries, and other state-of-the-art applications.
Global	On a global scale, advances in optics, especially laser technologies, play a pivotal role in surgeries, communications, entertainment, research, and defense applications that have international implications.
Employability	Proficiency in optics is essential for careers in optometry, photonics, engineering, research, and more. Understanding laser technology is beneficial for professions in medical technology, defense, entertainment tech, etc.
Entrepreneurship	Innovations in optical technologies present numerous startup opportunities, especially with the rise of augmented reality (AR), virtual reality (VR), and other advanced optical applications. Lasers also offer entrepreneurial opportunities in

	medical, tech, and cosmetic sectors.
Skill Development	Studying optics boosts the understanding of light behavior, vital in many technical professions. Lasers add an advanced layer to optical understanding.
Professional Ethics	Using optics, especially lasers, requires ethical considerations, especially when used in surveillance, medical, and defense applications to ensure privacy, safety, and correct use.
Gender	While the subject itself doesn't differentiate, there's a broader need to ensure gender equality in optical and laser research, application, and professions.
Human Values	Optics, being a manifestation of natural phenomena, helps instill a sense of wonder and appreciation for the natural world and the intricacies of light. Lasers bring to fore the debate about responsible use vs. misuse.
Environment & Sustainability	Efficient and environmentally conscious use of optical technologies can aid in energy conservation. The sustainable use and disposal of laser equipment also have environmental implications.
Unit III	**Polarization**
Local	Local institutions and organizations involved in optical research or communications can benefit from the understanding and application of polarization, especially in fields like photography and telecommunication.
Regional	Polarization has implications for regional optical communication systems, educational institutions teaching advanced optics, and in medical applications where certain optical tools are used.
National	Polarization plays a role in the national telecommunication infrastructure, defense optics, and broader optical research initiatives.
Global	In the global arena, polarization is integral for cutting-edge optical research, international communications systems, and advanced technologies involving light manipulation.

Employability	Understanding polarization is crucial for careers in photonics, telecommunications, optical research, and other technical fields that involve advanced optics.
Entrepreneurship	Startups or businesses dealing with advanced optical tools, communication systems, or optical research might benefit from innovations in polarization techniques.
Skill Development	Studying polarization aids in honing analytical skills, enhances understanding of light behavior, and offers hands-on experience with optical tools.
Professional Ethics	Correct and ethical application of polarization, especially in surveillance, medical, or defense contexts, ensures the safety and privacy of individuals and data.
Gender	The topic of polarization doesn't inherently address gender issues, but there's an importance to promote gender inclusivity in optical research and professions.
Human Values	Studying the intricacies of polarization can instill a sense of wonder and appreciation for the complexities of the natural world. It underscores the importance of objective observation and the pursuit of knowledge.
Environment & Sustainability	Sustainable use and manufacturing of materials/tools that utilize polarization can contribute to environmental conservation.
Unit IV	**New Engineering Materials**
Local	Local manufacturing and industries can benefit from the understanding and application of new materials for enhanced product quality and efficiency.
Regional	Regional tech hubs, educational institutions, and manufacturing zones can incorporate advanced materials for better product outcomes, innovative research, and technology development.
National	At a national level, understanding and producing these new materials can lead to advanced infrastructure, defense capabilities, health technologies, and improved national R&D standings.

Global	New engineering materials contribute to global advancements in tech, medicine, defense, and more. Countries or entities leading in material research can have a global influence.
Employability	Knowledge in this field opens doors in R&D departments, high-tech industries, medical tech, and more.
Entrepreneurship	Innovations in material science present numerous startup opportunities, from tech gadgets to medical tools, to sustainable solutions.
Skill Development	It aids in the development of research skills, analytical thinking, and hands-on laboratory skills.
Professional Ethics	Correct and ethical applications of new materials, especially in medical and defense, are crucial. Ensuring materials are safe and don't infringe on privacy or security rights is vital.
Gender	While the material itself doesn't differentiate by gender, ensuring gender equality in material research, application, and professions is essential.
Human Values	Developing new materials fosters a sense of curiosity, wonder, and appreciation for technological advancements and their positive implications for human life.
Environment & Sustainability	Sustainable production and utilization of these materials, especially nanomaterials, are vital. The development of eco-friendly materials can revolutionize sustainable tech and industries.
SDG	SDG 4
NEP 2020	-
POE/4th IR	-

ENGINEERING DRAWING & WORKSHOP LAB

Department:	**Department of Mechanical Engineering**		
Course Name: **Engineering Drawing and Workshop Lab**	**Course Code**	**L-T-P**	**Credits**
	SEC033	0-0-4	2
Type of Course:	SEC		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

COs	Statements
CO1	**Understand** the polygons, circles and lines with different geometric conditions
CO2	**Draw** the projection of points, lines and planes under different conditions and orthographic views from isometric views of simple objects
CO3	**Determine** manufacturing methods in different fields of engineering and Practical exposure to different fabrication techniques
CO4	**Creation** of simple components using different materials
CO5	**Exposure** to some of the advanced and latest manufacturing techniques being employed in the industry.

Ex. No	Experiment Title	Mapped CO/COs
Engineering Drawing		
1	To study Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning line conventions and free hand practicing, AUTO CAD Commands.	CO1
2	Orthographic Projection: Introduction, Definitions - Planes of projection, reference line and conventions employed, Projections of points in all the four quadrants.	CO1
3	Study of Projections of straight lines True and apparent lengths, True and apparent inclinations to reference planes.	CO1
4	To study orthographic projection of plane surfaces.	CO2
5	To study orthographic projection of solids with examples.	CO2
6	To study sections and development of surfaces of solids with examples.	CO1
7	To study conversion of pictorial views into orthographic projections with examples.	CO1, CO2
8	To study isometric projections of solids with examples.	CO1, CO2
Workshop		
9	To make Different types of joints in carpentry shop.	CO, CO4
10	To make Double V-Butt and Lap joint in welding shop.	CO3, CO4
11	To prepare a Job on Lathe machines with step turning and chamfering operation.	CO3, CO4
12	To prepare a Job on Shaper/milling/grinding for finishing of a job.	CO3
13	To prepare a practice job in fitting shop.	CO3
14	To Study about the various machine tools	CO5
15	To make saw - cut filling V-cut taper at the corners, circular	CO4

	cut in fitting shop.	

CLEAN CODING WITH PYTHON LAB

Department:	Department of Computer Science and Engineering		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Clean Coding with Python Lab	ENSP151	0-0-2	1
Type of Course:	Minor		
Pre-requisite(s), if any: Integration/Differentiation			

Defined Course Outcomes

COs	
CO 1	Develop, run and manipulate Python programs using Core data structures like Lists, Dictionaries, and use of Strings Handling methods.
CO 2	Develop, run and manipulate Python programs using File Operations and searching pattern using regular expressions.
CO 3	Determine the need for scraping websites and working with CSV, JSON and other file formats.
CO 4	Create simple games with images, animations, and audio using our custom beginner-friendly programming library.

Ex. No	Experiment Title	Mapped CO/COs
1	Write a program to print a poem.	1
2	Write a program to add two numbers using the input function numbers.	2

3	Write a program to find the reminder when divided by 2	2
4	Using all operators perform the practical on it and also write its data types.	1
5	Write a program to find the square root using input function	1
6	Write a program of string function and type casting.	2
7	Write a program to calculate the grade of student.	2
8	Write a program to print a table using for and while loop.	3
9	Write a program to find whether the student is pass or fail A) if it require 40% to pass. B) if atleast 33% in each subject to pass.	3
10	Write a program to input 8 numbers from the user and display all unique numbers.	3
11	Create an empty dictionary allow 4 students to enter their favorite subject as value and use key as their name.	3
12	Write a program to find greatest of four number enter by user.	3
13	Write a program to find a number is prime or not.	2
14	Write a program to find the sum of first 10 natural number using for and while loop.	2
15	Write a program to print the name in a list and write in a sorted common list.	2
16	Use for, .split(), and if to create a statement that will print out words that start with 's'. St= "print only the words that start with s in this sentence".	1
17	Use list comprehension to create a list of all numbers between 1 to 50 that are divisible by 5.	3

18	Go through the string below and if the length of a word is even print "even!" St= "print every word in this sentence that has an even number of letters"	3
19	Write a program using function to find greatest of three numbers.	2
20	Write a program using function to convert Celsius to Fahrenheit.	1
21	Write a program using function to print good morning +"name".	1
22	Write a program using lambda, find the square and cube.	2
23	Write a program using function and to find the length of a variable using arguments.	2
24	Write a program using arguments, key arguments to find out the sum, multiplication of n numbers.	2
25	Write a program using map, lambda, and filter to find the even numbers from the list.	3

Projects to be covered: (atleast 4-5 projects). Please provide objectives of the project

1. To understand why Python is a useful scripting language for developers.
2. To learn how to design and program Python applications.
3. To learn how to use lists, tuples, and dictionaries in Python programs.
4. To learn how to identify Python object types.
5. To learn how to use indexing and slicing to access data in Python programs.
6. To learn how to write loops and decision statements in Python.
7. To learn how to write functions and pass arguments in Python.
8. To learn how to read and write files in Python.
9. To learn how to design object-oriented programs with Python classes.
10. To learn how to use exception handling in Python applications for error handling

Projects Title:

- Weather Forecasting App
- Web scraping Facebook bot
- Tic tac toe game
- Snake and ladder game
- Multiplayer Game - Connect4

K.R. MANGALAM UNIVERSITY

ENGINEERING PHYSICS LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **Engineering Physics Lab**	**Course Code**	**L-T-P**	**Credits**
	ENPH151	0-0-2	1
Type of Course:	Major		
Pre-requisite(s), if any: Integration/Differentiation			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Understand** the principles and concepts related to the experiments involving bar pendulum, flywheel, Kater's pendulum, Newton's ring apparatus, plane diffraction grating, spectrometer, and half shade polarimeter.
CO 2	**Apply** the principles and concepts learned to conduct experiments and analyze experimental data, plot graphs, and interpret the results to determine various physical quantities.
CO 3	**Evaluate** the accuracy and reliability of experimental measurements and results obtained from the conducted experiments.
CO 4	**Apply** critical thinking and problem-solving skills to troubleshoot experimental setups, identify sources of errors, and propose solutions to improve the accuracy and precision of measurements

Ex. No	**Experiment Title**	**Mapped CO/COs**
1	To plot a graph between the distance of the knife edge from the centre of gravity and the time period of the bar pendulum. From the graph, find the acceleration due to gravity, the radius of gyration and the moment of inertia of the bar about an axis.	CO2, CO3
2	To determine the moment of inertia of a flywheel about its own axis of motion.	CO1, CO2, CO3, CO4
3	To determine the value of acceleration due to gravity using Kater`s pendulum.	CO1, CO2, CO3, CO4
4	To determine the wavelength of sodium light using Newton`s ring apparatus.	CO1, CO2, CO3
5	To determine the wavelength of prominent lines of mercury by plane diffraction grating.	CO1, CO2, CO3
6	To determine the refractive index of the material of the prism for the given colours (wavelengths) of mercury light with the help of spectrometer.	CO1, CO2, CO3
7	To determine the specific rotation of cane sugar solution with the help of half shade polarimeter.	CO1, CO2, CO3, CO4
8	To determine the wavelength of He-Ne LASER using transmission diffraction grating.	CO1, CO2, CO3

K.R. MANGALAM UNIVERSITY

DATA ANALYSIS WITH TABLEAU & KNIME

Department:	**Department of Computer Science and Engineering**		
Course Name	**Course Code**	**L-T-P**	**Credits**
Data Analysis with Tableau & KNIME	**SEC041**	0-0-4	2
Type of Course:	**SEC**		
Pre-requisite(s), if any:			
Frequency of offering (check one): Odd			

Brief Syllabus:

Introduction to data analysis, Data processing, Fundamental of Data Visualization Compare and Contrast, Business Intelligence, Introduction to Tableau, Tableau Desktop, Connecting to Data, Organizing and Simplifying Data, Creating Visualizations, Working with Calculations and Dates, Mapping Data Geographically, Analysing Data with Tableau, Dashboards and Stories Building a Dashboard, Level of Details, Animations, Info graphics, Sharing Your Work

Introduction to KNIME Analytics Platform, KNIME workbook, Data Access and Manipulation, Data Exploration and Visualization, Data Transformation and Cleaning, modelling and reporting in KNIME, Database operation, web, date and time, loops in KNIME, advance reporting, Introduction to SQL, Joins, sub queries, store routine, SQL and Tableau problems, Deployment and Collaboration.

Total lecture, Tutorial and Practical Hours for this course:

40 Hrs

Lectures:40	**Practice**	
	Tutorials:	**Lab Work: 2hrs per lab class**

Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.

CO 1	Demonstrate the ability to use technical skills in descriptive analytics to

	support business decision- making.
CO 2	Develop proficiency using Tableau software for data visualisation at a basic level.
CO 3	use Tableau to load and visualise data to produce insightful and helpful reports from the data.
CO 4	Design, create, test, and evaluate predictive models utilising KNIME Analytics and Create effective Machine Learning workflows.

UNIT WISE DETAILS

Unit Number: 1	**Title: Title: Introduction to Business Analytics and Business Intelligence**	**No. of hours: 6**

Content Summary:

Brief Introduction of course, Introduction to Data Analysis, Types of Business Analytics, Business Intelligence, Business Analytics and Intelligence in decision making process, What is Data Visualization and why is it important?, Visual Perception, Brief History of Data Visualization, Design Principles – Pre-attentive Attributes and Thinking Systems, Data Processing, Descriptive statistics introduction for problem solving, correlation, Statistical test.

Unit Number: 2	**Title: Information Design using Tableau Software**	**No. of hours: 10**

Content Summary:

Content Summary: Visualization Introduction, Data Visual Analytic Pipeline, Types of Data Visualization, Installation and configuration of Tableau Desktop, The Fundamental of Data Visualization – Reviewing the Halloween Exercise, Compare and Contrast, Data Quality, User Interface –Tableau Desktop. Dashboards and Stories Building a Dashboard, Dashboard Layouts and Formatting, Exploratory vs. Explanatory, Pre-processing

Unit Number: 3	**Title: Advanced Visualization**	**No. of hours: 12**

Content Summary:

Multidimensional Visualization, Infographics, Level of Details, Building Gapminder in Tableau, Basic Geo-Coding for Tableau, Animations, Capstone Calculated Field, Capstone Story UK Bank, Capstone Nyc Salary Viz, Capstone Grouping		
Unit Number: 4	**Title: Data Analytics Using KNIME Analytics Platform**	**No. of hours: 12**
Content Summary: Type of Analytics, Predictive analytics, regression, classification and clustering, Introduction to KNIME Analytics Platform, data blending, Data manipulation and aggregation, data mining, KNIME workbook, Data exploration, modeling and reporting in KNIME, Database operation, web, date and time, Flow Variable, loops in KNIME, advance reporting. Introduction to SQL, Joins, subqueries, store routine, SQL and Tableau problems, Case Study		
Contents beyond Syllabus: **Demonstration of WEKA Data mining tool**		

Supplementary MOOC Courses

- **https://www.tableau.com/learn/training/20203**
- **https://www.knime.com/knime-courses**
- **https://www.coursera.org/learn/code-free-data-science**
- **https://www.coursera.org/learn/analytics-tableau**

Reference Books:

Text Books:

1. James Evans, *Business Analytics*, Global Edition, Pearson, 2nd Edition , 2016

Reference Books:

1. U Dinesh Kumar, *Business Analytics: The Science of Data-Driven Decision Making*, WILEY INDIA, First Edition, 2017
2. Donabel Santos, *Tableau 10 Business Intelligence Cookbook*, Packt Publishing Limited, First Edition, 2016
3. Gábor Bakos, *KNIME Essentials*, Packt Publishing Limited, First Edition, 2013
4.

Reference Websites: (nptel, swayam, coursera, edx, udemy, lms, official documentation weblink)

https://swayam.gov.in/nd1_noc20_mg11/preview

Proposed Lab Experiments

Experiment Number	Experiment Title	Description	COs
1	Data Visualization	Create various visualizations from a dataset to explore trends and patterns.	CO1
2	Interactive Dashboards	Build interactive dashboards with filters and parameters for dynamic data exploration.	CO1
3	Geospatial Analysis	Visualize and analyze geographical data, such as maps and spatial patterns.	CO1
4	Custom Calculations and Expressions	Create calculated fields and custom expressions to derive insights from the data.	CO2
5	Advanced Visualizations	Explore advanced chart types like tree maps, heatmaps, and network diagrams.	CO3
6	Storytelling with Data	Combine visualizations and insights into a coherent data-driven story.	CO3
7	Parameterized Reports	Generate dynamic reports with parameterized inputs for flexible reporting.	CO2
8	Trend Analysis	Analyze data trends over time using line charts, area charts, and other time-based visualizations.	CO3
9	Cohort Analysis	Explore user behavior patterns over specific time intervals or events.	CO2
10	Joining and Blending Data	Combine data from multiple sources using joins and data blending techniques.	CO3
11	Hierarchical Drilldown	Create hierarchies and drilldowns to navigate through different levels of data detail.	CO3
12	Clustering and Segmentation	Apply clustering algorithms to group similar data points and uncover patterns.	CO4
13	Forecasting	Use time series forecasting to predict future trends based on historical data.	CO4
14	Set Actions and Highlighting	Implement set actions and highlighting to provide user interaction with visualizations.	CO4
15	Data Annotations	Add annotations, callouts, and labels to highlight important data points on visualizations.	CO3
16	Data Cleaning	Clean and preprocess data by handling	CO3

Experiment Number	Experiment Title	Description	COs
	and Preprocessing	missing values, outliers, and formatting issues.	
17	Feature Engineering	Generate new features and transform existing ones to enhance model performance.	CO4
18	Text Analytics	Perform sentiment analysis, text classification, and word frequency analysis on textual data.	CO4
19	Time Series Analysis	Analyze time-based data for trends, seasonality, and forecasting.	CO3
20	Machine Learning Workflow	Build and evaluate machine learning models for classification or regression tasks.	CO4
21	Data Integration and Transformation	Combine data from multiple sources, perform transformations, and load into a target format.	CO4
22	Ensemble Learning	Implement ensemble techniques like random forests and gradient boosting for improved predictions.	CO4
23	Web Data Scraping	Extract data from websites and APIs for analysis.	CO3
24	Interactive Reports	Create dynamic reports with interactive elements like filters and drilldowns.	CO4
25	Image Processing	Process and analyze images using various techniques like filters, segmentation, and object detection.	CO4
26	Network Analysis	Analyze and visualize complex networks and relationships within data.	CO3
27	Anomaly Detection	Detect anomalies and outliers in data using statistical and machine learning methods.	CO4
28	Optimization and Simulation	Perform optimization tasks and simulate scenarios using mathematical models.	CO3
29	Database Interaction	Connect and interact with databases to retrieve, manipulate, and analyze data.	CO3
30	Geospatial Analysis	Perform geospatial analysis and visualize spatial patterns using GIS data.	CO1

Semester: 2

LINEAR ALGEBRA AND ORDINARY DIFFERENTIAL EQUATIONS

<table>
<tr><td>Department:</td><td colspan="4">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Linear Algebra and Ordinary Differential Equations</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENMA102</td><td>3-1-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="4">Major</td></tr>
<tr><td colspan="5">Pre-requisite(s): single variable calculus, Matrices, differentiation and integration</td></tr>
<tr><td colspan="5">Frequency of offering (check one): Even semester</td></tr>
<tr><td colspan="5">Brief Syllabus:

The purpose of the course Linear Algebra and Ordinary Differential Equations is to provide students with a foundational understanding of key concepts and techniques in linear algebra and differential equations. The course helps students develop a strong mathematical foundation by studying fundamental topics in linear algebra and differential equations. These areas of mathematics are essential in various scientific, engineering, and mathematical disciplines. This course is to equip students with the mathematical tools, problem-solving skills, and foundational knowledge required to understand and apply linear algebra and differential equations in various academic and professional settings.</td></tr>
<tr><td colspan="5">Total lecture, Tutorial and Practical Hours for this course:</td></tr>
<tr><td rowspan="2">Lectures: 40</td><td colspan="4">Practice</td></tr>
<tr><td colspan="2">Tutorials: 01</td><td colspan="2">Lab Work: NO</td></tr>
<tr><td colspan="5">Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.</td></tr>
</table>

COs	The students will learn
CO 1	Identify and analyze the properties of various types of matrices, such as symmetric, skew-symmetric, Hermitian, skew Hermitian, unitary, and orthogonal matrices.
CO 2	Analyze quadratic forms and apply eigenvalues and eigenvectors in practical situations.
CO 3	Define and comprehend vector spaces, subspaces, linear independence, and basis.
CO 4	Determine the dimension of vector spaces and compute row space, column space, and null space of matrices.
CO 5	Solve first-order linear, separable, exact, and homogeneous differential equations.
CO 6	Apply differential equations to real-life applications.

UNIT WISE DETAILS

Unit: 1	Matrices and Systems of Linear Equations	No. of hours: 10

Content Summary: Matrix with operation, Types of Matrix (Symmetric and skew symmetric matrix, Hermitian and skew Hermitian matrix, unitary and orthogonal matrix), Determinant of Matrix, Inverse and transpose of matrices, Elementary row operations, Systems of Linear Equations, Homogeneous and non-homogeneous systems, Solutions of linear systems Gaussian, elimination and row echelon form, Rank of matrix.

Unit: 2	Eigenvalues and Eigenvectors	No. of hours: 10

Content Summary: Definition and properties of eigenvalues and eigenvectors, Diagonalization of matrices, Eigenvalues and eigenvectors of symmetric, skew symmetrix, hermition, skew hermition, unitary and orthogonal matrices, Calyey Hamilton Theorem, Rank and nullity of a matrix, Diagonalization of matrices, Minimal polynomial, characteristic polynomial, and generalized eigenvectors. The Jordan

<table>
<tr><td colspan="3">Normal Form Theorem for linear operators on a finite dimensional complex vector space, Quadratic forms, Applications of eigenvalues and eigenvectors.</td></tr>
<tr><td>Unit: 3</td><td>Vector Spaces</td><td>No. of hours: 10</td></tr>
<tr><td colspan="3">Content Summary: Introduction to vector spaces, Subspaces and spanning sets, Linear independence and basis, Dimension of vector spaces, Row space, column space, and null space, Linear transformations, Matrix representation of linear transformations, Inner Product Spaces,Inner products and orthogonality, Orthonormal bases and Gram-Schmidt process, Orthogonal projections and least squares approximations, Applications of Linear Algebra, Markov chains and transition matrices.</td></tr>
<tr><td>Unit: 4</td><td>Ordinary Differential Equations</td><td>No. of hours: 10</td></tr>
<tr><td colspan="3">Content Summary: Introduction to ordinary differential equations, Definition and classification of differential equations, First-order linear differential equations, Separable differential equations, Exact differential equations, Integrating factors, Applications of first-order differential equations, Second-order linear differential equations, Homogeneous differential equations, Method of undetermined coefficients, Variation of parameters, Applications of second-order differential equations</td></tr>
<tr><td colspan="3">Contents beyond Syllabus</td></tr>
<tr><td colspan="3">Reference Books:
• Christian Constanda, Differential Equations. Second Edition, Springer 2017, ISBN-13: 978-3-319-50223-6.
• We will use the book by Sheldon Axler, Linear Algebra Done Right, third edition, Springer Nature, ISBN 978-3-319-30765-7
• Elementary Linear Algebra: Applications Version, Howard Anton and Chris Rorres, 11/E Wiley
• Elementary Linear Algebra w/Applications (Classic Verson), Kolman & Hill, 9/E, Pearson
• Linear Algebra and Its Applications, Lay, Lay and McDonald, 5/E, Pearson.</td></tr>
</table>

K.R. MANGALAM UNIVERSITY

DATA VISUALIZATION USING PYTHON

<table>
<tr><td>1. Department:</td><td colspan="4">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2" colspan="2">2. Course Name: Data Visualization Using Python</td><td>3. Course Code</td><td>4. L-T-P</td><td>5. Credits</td></tr>
<tr><td>ENSP104</td><td>4-0-0</td><td>4</td></tr>
<tr><td>6. Type of Course:</td><td colspan="4">Minor</td></tr>
<tr><td colspan="5">7. Pre-requisite(s), if any:</td></tr>
<tr><td colspan="5">8. Frequency of offering (check one): Even semester</td></tr>
<tr><td colspan="5">9. Brief Syllabus:

This course will help to work with many Data Visualization tools and techniques and helps to create various types of basic and advanced graphs and charts like: Waffle Charts, Area Plots, Histograms, Bar Charts, Pie Charts, Scatter Plots, Choropleth Maps, and many more. Creating interactive dashboards that allow to better understand data, and make more effective and informed decisions. Creating Maps and Visualizing Geospatial Data to practice and apply the many aspects and techniques of Data Visualization using Jupyter Notebooks</td></tr>
<tr><td colspan="5">10.Total lecture, Tutorial and Practical Hours for this course:</td></tr>
<tr><td rowspan="2">Lectures: 40</td><td colspan="4">Practice</td></tr>
<tr><td colspan="2">Tutorials</td><td colspan="2">Lab Work</td></tr>
<tr><td colspan="5">11. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.</td></tr>
</table>

COs	By the end of this course, the learners will be able to
CO 1	Understand python libraries for data visualization including Matplotlib, Seaborn
CO 2	Understand basic visualization tools, including area plots, histograms, and bar charts

CO 3	Understand specialized visualization tools, including pie charts, box plots, scatter plots, and bubble plots
CO 4	Able to make effective, customized data visualizations in Python
CO5	Able to create maps and visualize geospatial data

12. UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to Visualization Tools**	**No. of hours: 8**
Content Summary: Introduction to Data Visualization, Understanding Data Visualization, history and Architecture of Matplotlib, Basic Plotting with Matplotlib		
Unit Number: 2	**Title: Visualization with Matplotlib library**	**No. of hours: 8**
Content Summary: Basic plots: Line Plots, Bar plot, Histograms, Scatter plot, pie chart, Area Plots, Pie Charts, Box Plots, Bubble Plots, Pyplot in Matplotlib: Line Plot, Histogram, Scatter, 3DPlot, Image, Matplotlib – Axes Class: axes () function, add_axes () function, ax. Legend () function, ax. plot (),Multiple Subplot: Create multiple subplots, add title to subplots, set single main title for all subplots		
Unit Number: 3	**Title: Advance Data Visualization**	**No. of hours: 8**
Content Summary: Visualizing the content of a 2D array, adding a colormap legend to figure, Visualization nonuniform 2D data, Visualizing contour lines, Polar charts, Plotting log charts for research		
Unit Number: 4	**Title: Creating Maps and Visualizing Geospatial Data**	**No. of hours: 8**
Content Summary: Creating Maps and Visualizing Geospatial Data		

Introduction to Folium Maps with Markers Choropleth Maps Dynamic charts - Dynamic maps - Animation types - 2D, 3D Export Feature – Data Visualization Generating a PNG picture Generating PDF documents Multiple graphs plotting and export Inserting sub figure		
Unit Number: 5	**Title: Visualization by using Seaborn Library**	**No. of hours: 8**
Content Summary: Relational plot: Dist Plot, Line Plot, Lmplot Categorical plot: Stripplot, Swarmplot, Barplot, Countplot, Boxplot, Violinplot, Stripplot Distribution plot: Joinplot, Distpot, Pairplot, Rugplot Regression plot: Simple Linear plot with additional parameters (hue and markers), Setting size and color of the plot, Displaying multiple plots, Size and aspect ratio of plots Matrix plot: Heatmaps, Cluster Maps Style and Color:Set the background to be white, Set the background to be ticks, Set the background to be darkgrid, Set the background to be whitegrid		
Self-Learning Components: • Exploring 1-D data • Exploring 2-D data • Bubble chart representation • Data Munging **Please Note:**		

1)Students are supposed to learn the components on self-basis

2)Mention open-source tools/ new concepts/technologies that students will be required to learn and present through presentations in class

3) At least 5-10 % syllabus will be asked in end term exams from self-learning components

Reference Books:

1.“Data visualization with python” byMario Dobler

2. Fundamental of Data Visualization” by Claus O. Wilke

3. Data Visualization in Python” by David Landup

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	1	2	2	2	1	2	3	2	2
CO2	1	2	2	2	1	3	1	2	1	2	1	1
CO3	2	2	3	2	2	2	2	2	2	1	1	3
CO4	3	2	2	1	3	1	3	1	3	2	2	2
CO5	3	1	1	3	1	2	1	2	1	2	1	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PO1	PO2	PO3	PSO4
CO1	2	1	3	1
CO2	1	2	2	2
CO3	2	2	3	2
CO4	3	2	2	1
CO5	3	1	1	3

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Relevance of the Syllabus to various indicators

Unit I	**Introduction to Visualization Tools**
Local	-
Regional	-
National	-
Global	Make it easier to identify patterns, trends and outliers in large data sets
Employability	Lead to positions such as data visualization specialist, data scientist, business intelligence analyst, or data engineer
Entrepreneurship	-
Skill Development	Helps data scientists perform complex data analysis, recognizing patterns, and understanding datasets
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Visualization with Matplotlib library**
Local	
Regional	-
National	
Global	
Employability	Lead to positions such as data visualization specialist, data scientist, business intelligence

	analyst, or data engineer
Entrepreneurship	-
Skill Development	Helps data scientists perform complex data analysis, recognizing patterns, and understanding datasets
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Advance Data Visualization**
Local	Addresses local network security needs and practices
Regional	-
National	Contributes to national network security strategies and protocols
Global	Aligns with global trends in network security techniques and protocols
Employability	Develops skills in network programming and network security techniques
Entrepreneurship	-
Skill Development	Develops knowledge and skills in client-server programming and network security
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit IV	**Creating Maps and Visualizing Geospatial Data**
Local	Addresses local understanding and implementation of internet-based services
Regional	-
National	Contributes to national digital communication strategies and multimedia applications
Global	Aligns with global trends in internet telephony, multimedia applications, and SEO
Employability	Develops skills in internet telephony, multimedia applications, and SEO
Entrepreneurship	-
Skill Development	Develops knowledge and skills in internet telephony, multimedia applications, and SEO
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO

K.R. MANGALAM UNIVERSITY

DATA VISUALIZATION USING PYTHON LAB

Department:	**Department of Computer Science Engineering**		
Course Name: **Data Visualization using Python Lab**	**Course Code**	**L-T-P**	**Credits**
	ENSP154	0-0-2	1
Type of Course:	Minor		

Proposed Lab Experiments

Defined Course Outcomes

COs	By the end of this lab, the learners will be able to
CO 1	Decision-centred Visualization begins with understanding the purpose, data and context
CO 2	Use common graphs like Bar chats, treemaps, line charts, radars, bubble charts and heatmaps.
CO 3	Design and implement data models on their own using techniques.
CO 4	Analyze and Select visualization using accuracy techniques for data shape and flow

Ex. No	Experiment Title	Mapped CO/COs
1	To study and implement line plot and multiple line chart using Matplotlib	2
2	To study and implement bar plot using Matplotlib	2
3	To study and implement stacked bar plot using	2

	Matplotlib	
4	To study and implement histogram plot using Matplotlib	2
5	To study and implement two histograms together using Matplotlib	1
6	To study and implement scatter plot using Matplotlib	2
7	To study and implement pie chart using Matplotlib	2
8	To study and implement tree map using Matplotlib	2
9	To study and implement box plot using Matplotlib	2
10	To study and implement area plot using Matplotlib	2
11	To study and implement Three-dimensional Plotting in Python using Matplotlib	2
12	To study and implement 3D Scatter Plotting in Python using Matplotlib using Matplotlib	2
13	To study the functions of axes and subplots in Matplotlib	2
14	Working with Images in Python using Matplotlib	4
15	To study and plotting graph using Seaborn	1
16	To study and implement relation plot using seaborn	1
17	To study and implement categorial plot using seaborn	1
18	To study the concept of kdeplot, distplot and joint plot using Seaborn.	1
19	To study and perform the combination plots using seaborn.	1
20	To study and implement distribution plot using seaborn	1
21	To study and provision Watson Studio and its API	3
22	To study and understand the Raw Data, Preparation of	3

	Data in a project using Watson Studio.	
23	To study and implementation of data-on-Data Refinery.	3
24	To study Model selection manual and automated using datasets	4
25	Study Data pre-processing through tools and techniques using Watson Studio	4

Projects to be covered: (atleast 4-5 projects). Please provide objectives of the project

Project Titles

1. Jupyter Book: Creating Beautiful Reports
2. Analyzing Spreadsheet Data with Python
3. Exploratory Data Analysis with Python
4. Statistical Analysis and Visualization for Marketing

ENGINEERING CHEMISTRY

Department:	**Department of Computer Science and Engineering**		
Course Name: **ENGINEERING CHEMISTRY**	**Course Code**	**L-T-P**	**Credits**
	ENCH101	3-1-0	4
Type of Course:	Major		
Pre-requisite(s), if any: Nil			

Brief Syllabus:

Engineering Chemistry is a course that aims to provide engineering students with a foundational understanding of various chemical principles and their practical applications in engineering.

UNIT WISE DETAILS

Unit Number: 1	**Title: Water technology**	**No. of hours: 10**

Content Summary:

Introduction, water analysis: Hardness-determination by EDTA method-, Alkalinity-determination by double indicator method, Treatment of boiler feed water: Internal treatment (Phosphate,Colloidal and Calgon conditioning). External treatments: Ion exchange and lime-soda process, Zeolite processes. Determination of dissolved oxygen by Winkler's method and Determination of chemical oxygen demand, Boiler scales formation and ill effects, methods of prevention of scales. Numerical problems.

Unit Number: 2	**Title: Chemical Fuels**	**No. of hours: 10**

Content Summary:

Fuels: Introduction, classification, calorific value (HCV & LCV), Determination of calorific value of fuel using Bomb calorimeter.

Solid fuel: Coal- its analysis by proximate and ultimate analysis, Numerical problems.

Liquid fuels: Refining of petroleum, Petroleum cracking, Reformation of petrol- explanation with reactions, Knocking in IC engine, its ill effects and prevention of knocking. Anti-knocking agent: Leaded and unleaded petrol. Power alcohol and its advantages. Synthetic petrol - Bergius process.

Gaseous fuels: LPG, CNG and their applications.

Unit Number: 3	**Title: Battery Technology**	**No. of hours: 10**

Content Summary:

Introduction - Galvanic cell, electrode potential, EMF of the cell and cell representation. Batteries and their importance, Classification of batteries- primary, secondary and reserve batteries with examples. Battery characteristics - voltage, capacity, energy density, power density, energy efficiency, cycle life and shelf life.

Basic requirements for commercial batteries. Construction, working and applications of: Ni-Cd, and Lithium-ion battery.

Fuel Cells- Differences between battery and a fuel cell, Classification of fuel cells - based on type of fuel, electrolyte and temperature.

Unit Number: 4	**Title: Polymer**	**No. of hours: 10**

Content Summary:

Basic concepts of polymer, Types of polymers, Thermoplastic & thermosetting plastics, Preparation and application of some industrially important polymers (Natural rubber, Buna S, Buna-N, Neoprene, Isoprene, Nylon-6, nylon-6,6, Decron and Terylene). Conducting and biodegradable polymers.

***Self-Learning Components**:

Basics of electrochemistry:

https://mrcet.com/downloads/digital_notes/HS/4%20ENGINEERING%20CHEMISTRY.pdf

Basics of polymer:

https://gnindia.dronacharya.info/APS/Downloads/SubjectInformation/Chemistry/Unit2/Lecture_1_13022019.pdf

Please Note: 1)Students are supposed to learn the components on self-basis 2) At least 5-10 % syllabus will be asked in end term exams from self-learning components
Reference Books: 1. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, S. Nagin Chand and Co. 2. Text book of Physical Chemistry by Soni and Dharmatha, S. Chand & Sons. 3. Text book of Polymers science by Gowarikar and Vishwanathan. 4. Corrosion Engineering by M. G. Fontana, Mc Graw Hill Publications. 5. Engineering Chemistry by Jain and Jain.

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the methods for water hardness and alkalinity testing, and the basics of boiler water treatment.
CO2	**Explain** the process of dissolved oxygen determination and chemical oxygen demand analysis.
CO3	**Determine** various methods to enhance the quantity & quality of Fuel.
CO4	**Identify** between hard and soft water, solve the related numerical problems on water purification and its significance in industry and daily life.
CO5	**Articulate** basic concepts of chemistry in daily life.
CO6	**Design** efficient process for water analysis and purification

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	-	P1
CO2	C3	-	P5
CO3	C2	-	-
CO4	C3	-	P3
CO5	C6	-	P4
CO6	C6	-	P4

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	3
CO2	-	-	3	-	2	-	-	-	-	-	-	2
CO3	-	3	-	-	-	-	-	-	-	-	-	2
CO4	-	3	-	-	-	-	2	-	-	-	-	3

CO5	3	-	-	-	-	-	-	-	-	-	-	2
CO6	3	3	-	-	-	-	-	-	-	-	-	3

Justification for mapping must be relevant.

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-
CO2	2	-	-	3
CO3	2	-	-	-
CO4	2	-	2	-
CO5	-	1	-	-
CO6	2	-	3	3

Relevance of the Syllabus to various indicators

Unit I	**Water technology**
Local	Address the evaluation of water characteristics like dissolved oxygen, hardness, alkalinity for specific water bodies such as lakes, rivers, and groundwater sources.
Regional	Address the evaluation of water characteristics like dissolved oxygen, hardness, alkalinity for specific water bodies within a particular geographic area
National	Addresses national problem of water pollution and its impact on society at the national level by analyzing water quality data from various regions across the country.
Global	Addresses transboundary water issues and global water challenges.
Employability	Professionals in the field of water management, environmental science, and sustainability

Entrepreneurship	-
Skill Development	Develops basic knowledge of characteristics of water and methods to remove the hardness
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	To assess and address water-related challenges at various levels for a sustainable environment
Unit II	**Chemical Fuels**
Local	Addresses the immediate consequences of fuel-related pollution and environmental degradation in local region
Regional	-
National	Exploration, extraction, and management of fossil fuel resources, as well as the development and deployment of non-renewable and renewable energy sources,
Global	Aligns with global trends for exploration, extraction, and management of fossil fuel resources, as well as the development and deployment of non-renewable and renewable energy sources,
Employability	Develops skills to use semiconductor photochemistry in energy harnessing and optical sensors
Entrepreneurship	-
Skill Development	Develops basic knowledge about the characteristics of good fuels
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	Assess environmental impact, emissions, and contribution of fuels to climate change to encourage the adoption of

	renewable and sustainable alternatives.
Unit III	**Battery Technology**
Local	To address the application of fuel cells for power buildings, homes, and small-scale distributed energy systems at local level.
Regional	-
National	To address the applications of battery technology include powering electric vehicles (EVs), storing renewable energy generated from solar panels or wind turbines, and backup power for homes and businesses at national level.
Global	To address the international efforts to reduce greenhouse gas emissions and address climate change challenges.
Employability	Develops skills to fabricate fuel cell-related technologies and their applications
Entrepreneurship	-
Skill Development	Develops knowledge and skills in fuel cell tecchnologies
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Polymer**
Local	Addresses local application of polymer such as for packaging materials, household products, textiles, and construction materials
Regional	-
National	Contributes to synthesis and application of polymer at national level
Global	Aligns with global trends in to synthesis and application of

	polymer
Employability	Develops skills in synthesis of polymer and its applications
Entrepreneurship	-
Skill Development	Develops knowledge and skills in synthesis and application of polymer
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	

BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING

<table>
<tr><td>Department:</td><td colspan="3">Department of Electrical & Electronics Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Basics of Electrical & Electronics Engineering</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENEE101</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Major</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: NA</td></tr>
<tr><td colspan="4">Frequency of offering (check one): Either semester</td></tr>
<tr><td colspan="4">Brief Syllabus:

The subject deals with the study and application of basic electrical and electronics devices in daily life and technology integration level. It encompasses various principles and concepts related to electronic devices and systems. Analysis of circuits using theorems for both AC and DC types. Also, it includes familiarization with CRO, function generator and power supplies, electrical measuring meters and different components. Lastly the concept of Integrated circuit and role of semiconductors in major industrial segments are conceptualized with examples.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
</table>

<table>
<tr><td>Unit Number: 1</td><td>Title: Circuit Analysis:</td><td>No. of hours: 10</td></tr>
<tr><td colspan="3">Content Summary:

Ohm's Law, KCL, KVL Mesh and Nodal Analysis, Circuit parameters, energy storage aspects, Superposition, Thevenin’s, Norton's, Reciprocity, Maximum Power Transfer Theorem, Millman's Theorem, Star-Delta Transformation. Application of theorem to the Analysis of D.C. circuits.</td></tr>
<tr><td>Unit Number: 2</td><td>Title: A.C. Circuits & CRO</td><td>No. of hours: 8</td></tr>
</table>

<table>
<tr><td colspan="3">Content Summary:

A.C. Circuits: R-L, R-C, R-L-C circuits (series and parallel), Time Constant, Phasor representation, Response of R-L, R-C and R-L-C circuit to sinusoidal input Resonance-series and parallel R-L-C Circuits, Q-factor, Bandwidth.

Cathode Ray Oscilloscope: Basic CRO circuit (Block Diagram), Cathode ray tube (CRT) & its component</td></tr>
<tr><td>Unit Number: 3</td><td>Title: Semiconductor Physics</td><td>No. of hours: 8</td></tr>
<tr><td colspan="3">Content Summary:

Semiconductor Physics: Basic concepts, Intrinsic and extrinsic semiconductors, diffusion and drift currents. P-N junction diode: Ideal diode, P-N junction under open-circuit and closed-circuit, Diode Current Equation, Diode Resistance, Transition and Diffusion Capacitance, Effect of Temperature, Carrier Life Time, Continuity Equation. Special Diodes: Zener Diode, Photodiode, Light Emitting Diodes, applications of Diodes.</td></tr>
<tr><td>Unit Number: 4</td><td>Title: Digital Electronics</td><td>No. of hours: 8</td></tr>
<tr><td colspan="3">Content Summary:

Digital Electronics: Boolean algebra, Truth tables of logic gates (AND, OR, NOT), NAND, NOR as universal gates. Bipolar junction transistor: Introduction to transistors: construction, transistor operations, BJT characteristics, load line, operating point, leakage currents. Application of BJT: CB, CE configurations, Introduction to FETs and MOSFETs.</td></tr>
<tr><td colspan="3">Self-Learning Components:

Students will be capable of recognizing the small electronics components utilized in their daily households. Also, better classification practices can be developed in students over the types of devices working on AC or DC current. Even inbuilt structures of household devices can also be illustrated all along with studies

Mini Project: Small circuits can be built up using components identified initially and afterword’s testing using the mustimeter and CRO can be carried out to justify the working feasibility of components studied in the syllabus.

Please Note:</td></tr>
</table>

1)Students are supposed to learn the components on self-basis 2) At least 5-10 % syllabus will be asked in end term exams from self-learning components
Reference Books: 1. D.P. Kothari & I J Nagrath, Basic Electrical Engineering, Tata McGraw Hill , New Delhi. 2. B L Thareja – A text book of Electrical Technology 3. Boylestad & Nashelsky, "Electronic Devices & Circuits", Pearson Education, 10th Edition. 4. V. K. Mehta & Rohit Mehta, "Principles of Electronics", S. Chand Publishers, 27th Edition. **Web References:** 1. https://onlinecourses.nptel.ac.in/noc22_ee113/preview 2. https://www.edx.org/learn/electrical-engineering 3. https://www.classcentral.com/course/youtube-electrical-engineering-basics-54532 4. https://www.electronics-tutorials.ws/

Define Course Outcomes (CO)

Course Outcomes (COs)

Possible usefulness of this course after its completion i.e., how this course will be practically useful to him once it is completed.

COs	Statements
CO 1	**Describe** and learn the basic Knowledge of AC and DC Circuits in making real-time projects to solve engineering difficulties of real time.
CO 2	**Understands its** utilization in day-to-day work dealing with pure AC circuits. R L and basic C circuits effect over-voltage and ac wave will be studied.

CO 3	**Compare** and **Contrast** various logic gates. Demonstrate the ability to identify series, parallel complex circuits. Utilization of the preliminary knowledge gained to obtain real existing power-related problems.
CO 4	**Differentiate** about the understanding of semiconductor devices application to existing apparatuses
CO 5	**Distinguish** the devices used in multipurpose electronics devices.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	-	1	-	-	-	-
CO2	-	1	1	-	-	-	1	-	1	1	1	-
CO3	2	2	-	2	2	3	2	-	-	-	-	-
CO4	-	-	-	2	2	-	-	2	1	2	2	-
CO5	3	-	-	-	-	-	-	2	-	3	3	-

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	-	-	1	-
CO2	-	2	2	-
CO3	1	-	2	-
CO4	1	-	3	-
CO5	2	-	-	-

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1		
CO2	C2		
CO3	C3	A4	
CO4	C6		P5
CO5			

Relevance of the Syllabus to various indicators

Unit I	**Circuit Analysis:**
Local	In the local context, circuit analysis plays a role in electrical infrastructure, power distribution, and ensuring safe electrical connections within a community. It is crucial for local electricians, engineers, and technicians to understand circuit analysis principles to maintain and troubleshoot electrical systems efficiently.
Regional	In the regional context, circuit analysis is applied to larger electrical networks and power grids that serve multiple cities or areas. Engineers and policymakers use circuit analysis to design and optimize the regional power distribution, taking into account factors like load balancing, transmission losses, and system reliability.
National	At the national level, circuit analysis becomes even more critical for the stability and efficiency of the entire electrical grid. National power grids require careful planning, monitoring, and maintenance, making circuit

	analysis indispensable for energy security and sustainability.
Global	In the global context, circuit analysis is essential for understanding international power interconnections and the challenges of exchanging electricity across borders. Engineers and researchers collaborate to create harmonized standards and protocols for global power transmission.
Employability	Circuit analysis skills are highly sought after in various industries, especially in electrical engineering, electronics, telecommunications, and renewable energy. Proficiency in circuit analysis enhances one's employability, enabling individuals to contribute to the development and maintenance of cutting-edge technologies.
Entrepreneurship	For entrepreneurs in the electronics or renewable energy sector, a solid understanding of circuit analysis is essential. This knowledge allows them to design innovative products, optimize energy-efficient systems, and develop sustainable solutions to real-world problems.
Skill Development	Learning circuit analysis helps individuals develop critical analytical and problem-solving skills. It fosters logical thinking and the ability to approach complex challenges systematically, which is valuable not only in the field of engineering but also in various other domains.
Professional Ethics	Circuit analysis professionals must adhere to ethical principles while designing, implementing, and maintaining electrical systems. Ethical considerations include ensuring safety standards, complying with regulations, and prioritizing the well-being of end-users.
Gender	Encouraging gender diversity and inclusion in circuit analysis and electrical engineering is essential for creating a more balanced and innovative workforce. Efforts to promote equality and eliminate gender biases in STEM fields, including circuit analysis, are crucial for societal progress.
Human Values	Circuit analysis contributes to human values by improving

	the quality of life through efficient power distribution, renewable energy solutions, and advancements in electronic devices that enhance communication and connectivity.
Environment & Sustainability	Understanding circuit analysis is vital for designing energy-efficient systems and integrating renewable energy sources into the power grid. By optimizing energy consumption and promoting sustainable practices, circuit analysis can contribute to environmental preservation.
Unit II	**A.C. Circuits & CRO**
Local	AC Circuits: In the local context, AC circuits are used in various electrical devices and systems found in homes, offices, and local infrastructure. They power lights, appliances, and other electronics, ensuring daily convenience and functionality. CRO: Local technicians and engineers may use CROs to diagnose and troubleshoot electronic equipment and electrical systems in the community, ensuring their proper functioning.
Regional	• AC Circuits: At the regional level, AC circuits are utilized in larger-scale electrical installations, such as power distribution networks, substation systems, and regional electrical infrastructure, ensuring efficient and reliable electricity supply. • CRO: Regional engineering teams might use CROs to analyze complex waveforms in power distribution systems, helping to identify irregularities and optimize electrical performance.
National	• AC Circuits: Nationally, AC circuits play a crucial role in the power generation, transmission, and distribution systems across the country, contributing to the stability and security of the national power grid. • CRO: National laboratories and research institutions may use high-end CROs for advanced studies in electronics, communications, and signal processing, contributing to technological advancements on a national scale.

Global	• AC Circuits: At the global level, AC circuits connect countries through intercontinental power transmission lines, enabling the exchange of electricity across borders and promoting international collaboration in energy distribution. • CRO: Cutting-edge research and development in CRO technology may have global impacts on various fields, such as telecommunications, electronics, and high-tech industries.
Employability	• AC Circuits: Knowledge of AC circuits is essential for electrical engineers, technicians, and electricians in various industries. Employers seek professionals who can design, analyze, and troubleshoot AC circuits efficiently. • CRO: Understanding CRO operation and waveform analysis is valuable for professionals working in electronics, telecommunications, and research fields, making them more employable.
Entrepreneurship	• AC Circuits: Entrepreneurs may explore opportunities in renewable energy solutions, energy-efficient products, or smart grid technologies, which heavily rely on AC circuits for efficient power distribution. • CRO: Entrepreneurs with innovative ideas in electronic instrumentation or specialized CRO applications may start their ventures to cater to niche markets.
Skill Development	• AC Circuits: Learning about AC circuits fosters expertise in electrical engineering, enhancing analytical and problem-solving skills for professionals in the field. • CRO: Skill development in CRO usage enables engineers and researchers to gain insights from complex waveforms, facilitating advanced studies and product development.
Professional Ethics	• AC Circuits: Practicing electrical engineers must adhere to professional ethics to ensure the safety, reliability, and compliance of AC circuit installations. • CRO: Ethical considerations in CRO use involve

	respecting intellectual property rights, conducting honest research, and handling sensitive data responsibly.
Gender	• AC Circuits: Efforts to promote gender diversity and inclusion in electrical engineering professions, including AC circuit design and analysis, contribute to a more balanced and diverse workforce. • CRO: Encouraging women's participation in STEM fields, including electronics and instrumentation (such as CRO technology), helps bridge the gender gap in the industry.
Human Values	• AC Circuits: AC circuits improve human life by providing electricity for everyday needs, enhancing living standards, and facilitating technological advancements that benefit society. • CRO: CRO technology supports various scientific and engineering endeavors that contribute to human knowledge, healthcare, and technological progress.
Environment & Sustainability	• AC Circuits: The efficient design and implementation of AC circuits in renewable energy systems contribute to environmental sustainability by reducing reliance on fossil fuels. • CRO: CROs aid in the development of energy-efficient electronic devices, which align with sustainability goals and eco-friendly practices.
Unit III	Semiconductor Physics
Local	Semiconductor Physics: In the local context, semiconductor physics may be relevant to industries and businesses that use electronic devices and components. Local electronics manufacturers and technology companies may utilize semiconductor physics to design, produce, and troubleshoot electronic devices commonly used in the community.
Regional	Semiconductor Physics: At the regional level, research and development centers and academic institutions may

	delve into semiconductor physics to develop advanced materials, devices, and technologies. Collaborations among regional industries and research institutions can lead to regional technological advancements.
National	• Semiconductor Physics: Nationally, semiconductor physics plays a vital role in the semiconductor industry, which is critical for various sectors, including electronics, telecommunications, and renewable energy. National investments in semiconductor research can lead to technological breakthroughs and economic growth.
Global	• Semiconductor Physics: Globally, semiconductor physics drives the semiconductor industry, which has significant impacts on various aspects of modern life. It is a foundation for global technological innovation and the development of cutting-edge electronic devices
Employability	• Semiconductor Physics: Understanding semiconductor physics is highly sought after in industries related to electronics, semiconductor manufacturing, telecommunications, and integrated circuit design. Professionals with expertise in semiconductor physics are in demand for various research and development roles.
Entrepreneurship	• Semiconductor Physics: Entrepreneurs can explore opportunities in the semiconductor industry by starting companies that develop novel semiconductor materials, manufacturing processes, or semiconductor-based devices.
Skill Development	• Semiconductor Physics: Skill development in semiconductor physics is crucial for researchers, engineers, and scientists working in the semiconductor and electronics fields. It involves understanding semiconductor properties, band theory, carrier dynamics, and quantum mechanics.
Professional Ethics	• Semiconductor Physics: Professionals working in semiconductor research and development must adhere to ethical principles concerning safety, environmental protection, and responsible use of semiconductor technology.
Gender	• Semiconductor Physics: Encouraging gender diversity and inclusion in semiconductor physics

	and related fields is essential for creating a more balanced and diverse workforce. Efforts to promote gender equity in STEM fields help increase representation and opportunities for women. •
Human Values	• Semiconductor Physics: The advancements in semiconductor technology have improved human life through various electronic devices, communication systems, medical equipment, and energy-efficient solutions. •
Environment & Sustainability	• Semiconductor Physics: Research in semiconductor physics contributes to the development of energy-efficient electronic devices, renewable energy technologies, and environmental monitoring systems, which align with sustainability goals.
Unit IV	**Digital Electronics**
Local	• Digital Electronics: In the local context, digital electronics is used in everyday electronic devices found in homes and businesses. Local electronics retailers and repair services utilize digital electronics knowledge to provide and maintain electronic products in the community. •
Regional	• Digital Electronics: At the regional level, digital electronics plays a role in the development of regional technology hubs and manufacturing centers. Collaboration among regional industries and research institutions may lead to advancements in digital electronics applications. •
National	• Digital Electronics: Nationally, digital electronics is vital for the electronics industry, contributing to the design and production of integrated circuits, microprocessors, and electronic systems. National investments in research and development can lead to technological innovations and economic growth. •

Global	• Digital Electronics: Globally, digital electronics is at the heart of the information age, enabling global communication, computing, and connectivity. Global collaborations and standardizations shape the advancement and implementation of digital technologies worldwide. •
Employability	• Digital Electronics: Understanding digital electronics is essential for professionals in the electronics, computer hardware, and telecommunications industries. Skills in digital logic design, microprocessor programming, and digital system troubleshooting are highly sought after.
Entrepreneurship	• Digital Electronics: Entrepreneurs can explore opportunities in digital electronics by starting companies that develop innovative digital products, embedded systems, or IoT devices. •
Skill Development	• Digital Electronics: Skill development in digital electronics involves learning about binary systems, logic gates, digital circuit design, FPGA programming, and microcontroller applications. These skills are valuable for engineers and technologists in various industries. •
Professional Ethics	• Digital Electronics: Professionals working with digital electronics must adhere to ethical principles concerning data privacy, cybersecurity, and responsible use of digital technology. •
Gender	• Digital Electronics: Efforts to promote gender diversity and inclusion in digital electronics and related fields aim to bridge the gender gap in STEM professions, creating more opportunities for women in technology. •
Human Values	• Digital Electronics: Digital electronics contributes to human values by enabling efficient communication, improved healthcare through medical devices, and enhanced quality of life through various electronic innovations. •
Environment &	• Digital Electronics: Advancements in digital

Sustainability	electronics have led to energy-efficient computing and power management systems, contributing to environmental sustainability by reducing energy consumption and electronic waste.
SDG	SDG 4, SDG 8
NEP 2020	-
POE/4th IR	Aligns with concept of making energy efficient devices and sensor building approaches

ENGINEERING CHEMISTRY LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **ENGINEERING CHEMISTRY LAB**	**Course Code**	**L-T-P**	**Credits**
	ENCH151	0-0-2	1
Type of Course:	Major		

Proposed Lab Experiments

Defined Course Outcomes

CO1	Students will learn and **apply** various experimental techniques commonly used in chemistry labs, such as titrations, distillations, extractions, chromatography, spectroscopy, and electrochemical methods.
CO2	Students will **acquire** proficiency in handling and operating laboratory equipment, including but not limited to balances, pipettes, burettes, spectrophotometers, pH meters, and other analytical instruments.
CO3	Students will **develop** skills in recording and analysing experimental data, including data interpretation of results.
CO4	Students will gain hands-on experience in synthesizing various chemical compounds and organic polymers
CO5	Students will learn to write **concise** and accurate laboratory reports, including experimental procedures, observations, results, and conclusions.
CO6	Students will **understand** the ethical responsibilities and laboratory safety protocols associated with conducting experiments.

Ex. No	**Experiment Title**	**Mapped CO/COs**

1	Determination of temporary and permanent hardness in water sample using EDTA.	CO1, CO3, CO5
2	Determination of alkalinity in the given water sample.	CO1, CO3, CO5
3	Determination of viscosity of given liquid.	CO2, CO3, CO5
4	Determination of surface tension of given liquid.	CO2, CO3, CO5
5	Determination of pH by pH-metric titration.	CO1, CO3, CO5
6	Preparation of Phenol-formaldehyde and Urea-formaldehyde resin	CO4, CO5, CO6
7	To determine the iron concentration in the given water sample by Spectrophotometer using potassium thiocyanate as colour developing agent.	CO1, CO3, CO5
8	Determination of chloride content in water sample.	CO1, CO3 CO5, CO6
9	Estimation dissolved oxygen (DO) content in the given water sample by Winkler's method.	CO1, CO3,CO5
10	Determination of iron content in the given solution by Mohr's method.	CO1, CO3, CO5
11	Determination of rate constant of hydrolysis of esters.	CO3, CO5
12	To determine the Iron content in the given salt by using external indicator	CO1, CO3, CO5
13	Determination of wavelength of absorption maximum and colorimetric estimation of Fe^{3+} in solution	CO2, CO3, CO5
14	Determination of molar absorptivity of a compound ($KMnO_4$ or any water-soluble food colorant).	CO2, CO3, CO5
15	Preparation of a nickel complex $[Ni(NH_3)_6]Cl_2$ and estimation of nickel by complexometric titration.	CO4, CO5, CO6

16	Synthesis of drug like Aspirin, /Paracetamol etc.	CO4, CO5, CO6

BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING LAB

Department:	**Department of Electrical & Electronics Engineering**		
Course Name: **Basics of Electrical & Electronics Lab**	**Course Code**	**L-T-P**	**Credits**
	ENEE151	0-0-2	1
Type of Course:	Major		

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	To **learn** using basic instruments for measuring real time values.
CO 2	To **implement** learned theorems in separate Dc and AC Circuits
CO 3	Capability to **perform** small circuit-based experiments using digital logics
CO 4	Desire to **obtain** wave forms of various device to analyse its actual functioning.

Ex No	**Experiment Title**	**Mapped CO/COs**
1	To get familiar with the working knowledge of the following instruments: a) Cathode ray oscilloscope (CRO) b) Multimeter (Analog and Digital) c) Function generator d) Power supply	CO4 CO1
2	To measure phase difference between two waveforms using CRO To measure an unknown frequency from Lissajous figures using CRO	CO4 CO1

3	To Verify the Thevenin' s and Norton's theorem	CO2
4	To Verify the Superposition theorem	CO2
5	To measure voltage, current and power in an A.C. circuit by LCR impedance method	CO3
6	To study the frequency response curve in series and parallel-L-C circuit	CO3
7	a) Plot the forward and reverse V-I characteristics of P-N junction diode b) Calculation of cut-in voltage B.Tech. c) Study of Zener diode in breakdown region	CO3
8	To plot and study the input and output characteristics of BJT in common-emitter configuration.	CO2
9	Verification of truth tables of logic gates (OR, AND, NOT, NAND, NOR).	CO1 CO4
10	To get familiar with the working and use of seven-segment display.	CO4

Semester: 3

JAVA PROGRAMMING

DEPARTMENT:	**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**			
COURSE NAME: **JAVA PROGRAMMING**		**COURSE CODE**	**L-T-P**	**CREDITS**
		ENCS201	4-0-0	4
TYPE OF COURSE:	Major			
PRE-REQUISITE(S), IF ANY: C PROGRAMMING				
FREQUENCY OF OFFERING (CHECK ONE): ODD				

BRIEF SYLLABUS:
The objective is to impart programming skills used in this object-oriented language java. The course explores all the basic concepts of core java programming like object, classes, data types, features, operators, control structures, interfaces, packages, applets, AWT, swings. The students are expected to learn it enough so that they can develop the basic applications as well as web solutions like creating applets etc.

TOTAL LECTURE, TUTORIAL AND PRACTICAL HOURS FOR THIS COURSE:

LECTURES:40	**PRACTICE**	
	TUTORIALS:	**LAB WORK:**

UNIT WISE DETAILS

UNIT NUMBER: 1	**TITLE: INTRODUCTION TO JAVA**	**NO. OF HOURS: 12**

CONTENT SUMMARY:

Concepts of OOP, features of java, how java is different from C++, environmental

setup, basic syntax, objects and classes, basic data types, variable types, modifier types, basic operators, loop control, decision making, strings and arrays, methods, i/o. Introducing classes, objects and methods: defining a class, adding variables and methods, creating objects, constructors.		
UNIT NUMBER: 2	**TITLE: ARRAYS AND STRINGS**	**NO. OF HOURS: 8**
CONTENT SUMMARY: Classes: string and string buffer classes, wrapper classes: basics types, using super, multilevel hierarchy, abstract and final classes, object class, access protection, inheritance, overriding, polymorphism, abstraction, encapsulation, interfaces, packages, exploring java.util package.		
UNIT NUMBER: 3	**TITLE: EXCEPTIONAL HANDLING & MULTITHREADING**	**NO. OF HOURS: 12**
CONTENT SUMMARY: Exception hierarchy, exception methods, catching exceptions, multiple catch clauses, uncaught exceptions java's built-in exception. Creating, implementing and extending thread, thread priorities, synchronization suspending, resuming and stopping threads, multi- threading.		
UNIT NUMBER: 4	**TITLE: INPUT/OUTPUT PROGRAMMING & EVENT HANDLING**	**NO. OF HOURS: 8**
Basics streams, byte and character stream, predefined streams, reading and writing from console and files. Event handling mechanism, event model, event classes, sources of events, event listener interfaces, java gui programming: Introduction to swing, swings components, generics and collections: generics and type parameters, collections framework (list, set, map)		
***SELF-LEARNING COMPONENTS:** Students should explore platforms like leetcode, hackerrank for java and java ide like eclipse, netbeans etc.		

Students can refer the following courses as per the open source university curriculum 1. "java programming masterclass for software developers" on udemy by tim buchalka 2. "java fundamentals: the java language" on pluralsight by jesse liberty,
REFERENCE BOOKS: 1. HERBERT SCHILDT, ―JAVA – THE COMPLETE REFERENCE‖, ORACLE PRESS. 2. CAY S. HORSTMANN, ―CORE JAVA VOLUME – I FUNDAMENTALS‖, PEARSON.

DEFINE COURSE OUTCOMES (CO)

COS	STATEMENTS
CO1	**Recognize** features of object-oriented design such as encapsulation, polymorphism inheritance and composition of systems based on object identity.
CO2	**Articulate** re-usable programming components using abstract class, interfaces and other permitted ways in packages.
CO3	**Apply** access control mechanism to safeguard the data and functions that can be applied by the object.
CO4	**Design** GUI applications using pre-built frameworks available in java.

COs MAPPING WITH LEVELS OF BLOOM'S TAXONOMY

CO	COGNITIVE LEVELS© 1. KNOWLEDGE 2. UNDERSTAND 3. APPLY 4. ANALYZE 5. EVALUATE 6. CREATE	AFFECTIVE LEVELS(A) 1. RECEIVING 2. RESPONDING 3. VALUING 4. ORGANIZING 5. CHARACTERIZING	PSYCHOMOTOR LEVELS(P) 1. IMITATION 2. MANIPULATION 3. PRECISION 4. ARTICULATION 5. IMPROVING
CO1	C2	A1	P1
CO2	C3	A2	P2
CO3	C3	A5	P5
CO4	C6	A5	P5

CO-PO MAPPING

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	2	-	2	-	-	-	-	2
CO2	1	2	-	-	3	-	1	-	-	-	-	2
CO3	-	-	-	-	3	-	2	1	-	3	-	2
CO4	-	-	-	-	3	-	2	-	-	3	-	2

1=WEAKLY MAPPED
2= MODERATELY MAPPED
3=STRONGLY MAPPED

CO-PSO MAPPING

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1
CO2	2	3	2	1
CO3	2	3	2	1
CO4	2	3	2	1

RELEVANCE OF THE SYLLABUS TO VARIOUS INDICATORS

UNIT I	INTRODUCTION TO JAVA
LOCAL	-
REGIONAL	-
NATIONAL	-
GLOBAL	Java is widely used worldwide, and the skills gained from the course have global relevance in software development.
EMPLOYABILITY	Understanding object-oriented programming and java is valuable in the job market, as many industries and organizations rely on java for software development.
ENTREPRENEURSHIP	Contribute to entrepreneurship by providing individuals with the skills and knowledge needed to develop software applications or start a technology-related business
SKILL DEVELOPMENT	Contributes to skill development, particularly in programming, object-oriented design, and java development
PROFESSIONAL ETHICS	Encourages ethical programming practices, such as writing clean code, following best practices, and respecting intellectual property rights
GENDER	These concepts are equally applicable and accessible to individuals of all genders pursuing careers in software development.
HUMAN VALUES	Promotes human values such as teamwork, collaboration, and effective communication, which are essential in the software development industry.
ENVIRONMENT & SUSTAINABILITY	Promoting efficient programming practices and emphasizing code optimization
UNIT II	Arrays and strings
LOCAL	-
REGIONAL	-

NATIONAL	It contributes to the development of software infrastructure, applications, and systems that support national industries, governance, and public services.
GLOBAL	Java is widely used worldwide, and the skills gained from the course have global relevance in software development.
EMPLOYABILITY	Understanding object-oriented programming and java is valuable in the job market, as many industries and organizations rely on java for software development.
ENTREPRENEURSHIP	Contribute to entrepreneurship by providing individuals with the skills and knowledge needed to develop software applications or start a technology-related business
SKILL DEVELOPMENT	Contributes to skill development, particularly in programming, object-oriented design, and java development
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GENDER	These concepts are equally applicable and accessible to individuals of all genders pursuing careers in software development.
HUMAN VALUES	Promotes human values such as teamwork, collaboration, and effective communication, which are essential in the software development industry.
ENVIRONMENT & SUSTAINABILITY	Promoting efficient programming practices and emphasizing code optimization
UNIT III	**Exceptional handling & multithreading**
LOCAL	-
REGIONAL	-
NATIONAL	It contributes to the development of software infrastructure, applications, and systems that support national industries, governance, and public services.
GLOBAL	Java is widely used worldwide, and the skills gained from

	the course have global relevance in software development.
EMPLOYABILITY	Understanding object-oriented programming and java is valuable in the job market, as many industries and organizations rely on java for software development.
ENTREPRENEURSHIP	Contribute to entrepreneurship by providing individuals with the skills and knowledge needed to develop software applications or start a technology-related business
SKILL DEVELOPMENT	Contributes to skill development, particularly in programming, object-oriented design, and java development
PROFESSIONAL ETHICS	Encourages ethical programming practices, such as writing clean code, following best practices, and respecting intellectual property rights
GENDER	These concepts are equally applicable and accessible to individuals of all genders pursuing careers in software development.
HUMAN VALUES	Promotes human values such as teamwork, collaboration, and effective communication, which are essential in the software development industry.
ENVIRONMENT & SUSTAINABILITY	Promoting efficient programming practices and emphasizing code optimization
UNIT IV	**Input/output programming & event handling**
LOCAL	-
REGIONAL	-
NATIONAL	-
GLOBAL	Java is widely used worldwide, and the skills gained from the course have global relevance in software development.
EMPLOYABILITY	Understanding object-oriented programming and java is valuable in the job market, as many industries and organizations rely on java for software development.
ENTREPRENEURSHIP	Contribute to entrepreneurship by providing individuals with the skills and knowledge needed to develop software

	applications or start a technology-related business
SKILL DEVELOPMENT	Contributes to skill development, particularly in programming, object-oriented design, and java development
PROFESSIONAL ETHICS	Encourages ethical programming practices, such as writing clean code, following best practices, and respecting intellectual property rights
GENDER	These concepts are equally applicable and accessible to individuals of all genders pursuing careers in software development.
HUMAN VALUES	Promotes human values such as teamwork, collaboration, and effective communication, which are essential in the software development industry.
ENVIRONMENT & SUSTAINABILITY	Promoting efficient programming practices and emphasizing code optimization
SDG	SDG 4
NEP 2020	-
POE/4TH IR	Aligns with the concepts of design, efficiency, problem solving, abstraction and system analysis

K.R. MANGALAM UNIVERSITY

JAVA PROGRAMMING LAB

<table>
<tr><td>DEPARTMENT:</td><td colspan="4">DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING</td></tr>
<tr><td rowspan="2" colspan="2">COURSE NAME:
JAVA PROGRAMMING LAB</td><td>COURSE CODE</td><td>L-T-P</td><td>CREDITS</td></tr>
<tr><td>ENCS251</td><td>0-0-2</td><td>1</td></tr>
<tr><td>TYPE OF COURSE:</td><td colspan="4">Major</td></tr>
<tr><td colspan="5">PRE-REQUISITE(S), IF ANY: C PROGRAMMING</td></tr>
<tr><td colspan="5">FREQUENCY OF OFFERING (CHECK ONE): ODD</td></tr>
</table>

PROPOSED LAB EXPERIMENTS

DEFINED COURSE OUTCOMES

COS	
CO 1	**Apply** the concepts learned of operators, if-else, loops and arrays to java-based application development.
CO 2	**Demonstrate** the use of various types of inheritances, polymorphisms, class objects, inheritances, packages and other concepts to basic and complex java programming problems.
CO 3	**Demonstrate** graphical applications based on java applets, swings and event handling
CO 4	**Apply** knowledge of event handling and awt controls to create some new dynamic graphical applications.

EX NO	EXPERIMENT TITLE	MAPPED CO/COS
1	Sample programs using objects and classes, variable types, modifier types, operators, loops decision making, strings and arrays, (a) Wap to display "hello, it's a first program in java". (b) Wap to find sum of two integers taken as input from user at runtime. (c) Wap to find sum of two float numbers taken as command line arguments (d) Wap to find changed case of entered character. (e) Wap to find maximum of 3 integer numbers taken as input from user at runtime.	CO1
2	Sample programs using inheritance, overriding, polymorphism, interfaces, packages a. Wap in java to illustrate the concept of interfaces. b. Write a program in java to showcase uses of super keyword	CO1
3	Sample programs using exception handling and threads a) Write a program to demonstrate the use of nesting of try-catch block b) Wap in java to illustrate the concept of using multiple catch clauses to handle different types of exceptions. c) Wap in java to create a user defined exception and throw it explicitly.	CO2
4	Sample programs using event handling and awt controls	CO1
5	Sample programs using swings write an applet which will display "happy" and "deepavali" as: the word "happy" will roll from top to bottom and "deepavli" from bottom to "top" . Both will run at the same speed and stop simultaneously at the center of the applet.	CO3

6	Wap in java to create a frame with various awt controls (like choice, list, textfield and buttons) and handle the events thrown by them.	CO3
7	Wap in java to create a frame with awt controls (like label, push buttons, checkbox, checkbox group) and handle various events generated by them.	CO4
8	Wap to create a package as mypack having a class with three methods: max, fact and show. Use it in other folder with setting classpath and without setting class path.	CO2
9	Wap to create a frame and illustrate the concept of using an adapter class in place of interfaces for handling various mouse events generated over frame window.	CO3
10	Write a program to display "hello" in different color where user clicks left mouse button and "world" where right mouse button is clicked. Use black background.	CO2
11	a) Demonstrate thread using thread class and runnable interface b) Demonstrate various thread methods using a program	CO3
12	Write a java program to create an abstract class named shape that contains two integers and an empty method named printarea(). Provide three classes named rectangle, triangle and circle such that each one of the classes extends the class shape. Each one of the classes contain only the method printarea( ) that prints the area of the given shape.	CO4
13	(a) Wap to create class with "name" as string and "age" as integer data members. The class should have two methods to take input from user and display the data. (b) Wap to find factorial of a number using class and object.	CO3
14	Write a java program that implements a multi-thread application that has three threads. First thread generates random integer every 1 second and if the value is even,	CO4

	second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of cube of the number.	
15	Create an frame with one single button with caption “click”. On clicking the button will open a new frame with title “factorial”. The frame will have two three controls :textfield, label and button. On clicking button calculate the factorial entered in textfield control.	CO4
16	Project 1: simple calculator: build a basic calculator application that performs arithmetic operations like addition, subtraction, multiplication, and division. You can add a user interface using java swing or javafx for a more interactive experience.	CO4
17	Project 2: tic-tac-toe game: implement the classic tic-tac-toe game where two players take turns marking x or o on a 3x3 grid. Allow players to play against each other.	CO4
18	Project 3: quiz application: design a quiz application that presents multiple-choice questions to users and keeps track of their scores. Include features like a timer, question randomization, and a scoring system.	CO4
19	Project 4: hangman game: create a hangman game where players guess letters to uncover a hidden word. Include features such as displaying the word's progress, tracking incorrect guesses, and providing hints.	CO4

DISCRETE MATHEMATICS

Department:	**Department of Computer Science and Engineering**		
Course Name: **Discrete Mathematics**	**Course Code**	**L-T-P**	**Credits**
	ENCS203	3-1-0	4
Type of Course:	Major		
Pre-requisite(s), if any: Basic of Mathematics			
Brief Syllabus: This course will discuss fundamental concepts and tools in discrete mathematics with emphasis on their applications to computer science. Topics include logic and Boolean circuits, sets, functions, relations, deterministic algorithms and randomized algorithms, analysis techniques based on counting methods and recurrence relations, trees and graphs etc.			
UNIT WISE DETAILS			
Unit Number: 1	**Propositional Logics & Relations**	**No. of hours: 12**	
Content Summary: **Mathematical Logic:** Introduction to Mathematical Thinking , Propositional and Predicate Logic, Propositional Equivalences, Sets, Binary Relation, Equivalence Relation, Logical operations, Conditional Statements, Tautologies, Contradictions, Logical Equivalence, The use of Quantifiers, Normal Forms, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference. Sets **and Relations**: Set Operations, Representation and Properties of Relations & Functions, Equivalence Relations, Partially Ordering.			
Unit Number: 2	**Title: Counting, Mathematical Induction and Discrete Probability**	**No. of hours: 12**	
Content Summary: Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Inclusion-Exclusion Principle, Mathematical Induction, Probability, Bayes' Theorem, Discrete Probability Theory, Discrete Structures in Computing,			

Counting Principles, Permutations and Combinations, Probability Theory, Discrete Random Variables, Discrete Optimization - Optimization Problems and Algorithms, Linear Programming, Integer Programming, Algebraic Structures - Groups (Definition, Properties, Subgroups, Cyclic Groups), Rings (Definition, Properties, Integral Domains, Fields), Isomorphisms and Homomorphisms, Counting and combinatorics.		
Unit Number: 3	**Title: Group Theory & Discrete Probability**	**No. of hours: 8**
Content Summary: Groups, Subgroups, Semi Groups, Product and Quotients of Algebraic Structures, Isomorphism, Homomorphism, Automorphism, Rings, Integral Domains, Fields, Applications of Group Theory, Combinatorial optimization: basic concepts and algorithms, Sample spaces, events, and probability axioms, Conditional probability and Bayes' theorem.		
Unit Number: 4	**Title: Graph Theory**	**No. of hours: 8**
Content Summary: Simple Graph, Multigraph, Weighted Graph, Paths and Circuits, Shortest Paths in Weighted Graphs, Eulerian Paths and Circuits, Hamiltonian Paths and Circuits, Planner graph, Graph Coloring, Bipartite Graphs, Trees and Rooted Trees, Prefix Codes, Tree Traversals, Spanning Trees and Cut-Sets, digraphs, Graph Coloring, Euler's formulae, Graph Theory, Networks and Flows.		
***Self-Learning Components**: **Topics (with book references):** 1. Applications of Graph Coloring: Time table Scheduling ("Discrete Mathematics and Its Applications" by Kenneth H. Rosen: Chapter 10.3: Graph Coloring) 2. Network Analysis, Routing & Optimization, using graph theory.(Introduction to Graph Theory" by Richard J. Trudeau) 3. Combinatorial Optimization & Error Detection & correction using The Pigeonhole Principle ("Combinatorial Optimization: Algorithms and Complexity" by Christos H. Papadimitriou and Kenneth Steiglitz) 4. Scheduling and Task Prioritization, using Partial ordering. ("Introduction to Scheduling" by Yves Robert and Frederic Vivien) 5. Rules based system and Algorithm design using conditional statements. (Chapter 10, 22, 23, of Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig). **Online Certification Courses for Discrete Mathematics (With Links):** 1. Discrete Mathematics: https://www.coursera.org/learn/discrete-mathematics		

2. Mathematics For Computer Science, https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-fall-2010/
3. Introduction to Discrete Mathematics for Computer Science Specialization, https://www.coursera.org/specializations/discrete-mathematics
4. Discrete Math Series : Propositional Logic masterclass https://www.udemy.com/course/discretemathematics/
5. Master Discrete Mathematics: Sets, Math Logic, and More: https://www.udemy.com/course/master-discrete-mathematics/
6. Master Math by Coding in Python: https://www.udemy.com/course/math-with-python/
7. Discrete Mathematics for Computer Science in C, Java, Python: https://www.udemy.com/course/discrete-mathematics-and-its-applications/
8. Discrete Mathematics - Complete Course: https://www.udemy.com/course/discrete-mathematics-complete-course/
9. Discrete Optimization: https://www.coursera.org/learn/discrete-optimization
10. Introduction to Discrete Mathematics for Computer Science Specialization: https://www.coursera.org/specializations/discrete-mathematics

NPTEL Lecture Links for Discrete Mathematics (With Links):

1. Discrete Mathematics _ IIITB, IIIT Bangalore, Prof. Ashish Choudhury: https://nptel.ac.in/courses/106108227
2. Discrete Mathematics, IIT Ropar: https://nptel.ac.in/courses/106106183

1)Students are supposed to learn the components on self-basis

2) At least 5-10 % syllabus will be asked in end term exams from self-learning components

Reference Books of Discrete Mathematics:

1. Elements of Discrete Mathematics, C. L Liu, McGraw-Hill Inc, 1985. Applied Combinatorics, Alan Tucker.
2. Concrete Mathematics, Ronald Graham, Donald Knuth, and Oren Patashnik, 2nd Edition - Pearson Education Publishers.
3. Combinatorics: Topics, Techniques, Algorithms by Peter J. Cameron, Cambridge University Press.
4. Topics in Algebra, I.N. Herstein, Wiley.
5. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata McGraw – Hill
6. Satinder Bal Gupta: A Text Book of Discrete Mathematics and Structures, University Science Press, Delhi.

E-Books of Discrete Mathematics (with Links):

1. Discrete Mathematics: An open Introduction, by Oscar Levin, 3rd Edition: https://discrete.openmathbooks.org/pdfs/dmoi-tablet.pdf

2. Lecture Notes on Discrete Mathematics, IITK, https://home.iitk.ac.in/~arlal/book/mth202.pdf
3. Mathematical Foundations And Aspects of Discrete Mathematics, Jean Gallier and Jocelyn Quaintance, https://www.cis.upenn.edu/~jean/discmath-root-b.pdf
4. Discrete Mathematics for Computer Science, Gary Haggard, John Schlipf, Sue Whitesides, https://www2.cs.uh.edu/~arjun/courses/ds/DiscMaths4CompSc.pdf
5. DISCRETE MATHEMATICS FOR COMPUTER SCIENCE, Herbert Edelsbrunner and Brittany Fasy, https://courses.cs.duke.edu/spring09/cps102/Lectures/Book.pdf
6. Discrete Mathematics and its Applications, Rosen, https://faculty.ksu.edu.sa/sites/default/files/rosen_discrete_mathematics_and_its_applications_7th_edition.pdf

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** foundational concepts: Gain a solid understanding of fundamental concepts in discrete mathematics, including logic, sets, relations, and functions
CO2	**Express** proficiency in logical reasoning and constructing mathematical proofs using various proof techniques such as direct proofs, proof by contradiction, and mathematical induction.
CO3	**Determine** methods to Explore various discrete structures, such as sets, sequences, functions, relations, and formal languages. Understand the properties and applications of these structures.
CO4	**Identify** and develop problem-solving skills by applying discrete mathematics concepts to solve mathematical problems and real-world scenarios. Enhance logical thinking and analytical reasoning abilities.
CO5	**Articulate** real-world applications of discrete mathematics in computer science, cryptography, network analysis, optimization problems, scheduling, and decision-making.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A1	P1
C02	C3	A2	P2
CO3	C3	A5	P5
CO4	C6	A5	P5
CO5	C2	A5	P1

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	2	-	2	-	-	-	-	2
CO2	1	2	-	1	3	2	1	-	-	-	-	2
CO3	-	-	-	1	3	-	2	-	-	3	-	2
CO4	-	2	-	-	3	1	2	-	-	3	-	2
CO5	-	2	-	-	3	-	2	-	-	3	-	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PO1	PO2	PO3	PSO4
CO1	3	2	2	1
CO2	2	3	2	1
CO3	2	3	2	1
CO4	2	3	2	1
CO5	2	3	2	1

K.R. MANGALAM UNIVERSITY

Relevance of the Syllabus to various indicators

Unit I	Introduction
Local	-
Regional	-
National	-
Global	It lays a solid foundation for further studies in mathematics, computer science, and related fields while fostering critical thinking and analytical skills.
Employability	Equips with problem-solving techniques to analyse and process data, design algorithms, and make informed decisions.
Entrepreneurship	-
Skill Development	Discrete mathematics allows students to think abstractly, develop formal mathematical arguments, and engage in rigorous problem-solving.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Counting, Mathematical Induction and Discrete Probability
Local	-
Regional	-
National	-
Global	Probability, Bayes' theorem, and statistical analysis provide a framework for understanding and interpreting real-world phenomena that involve uncertainty and data.
Employability	It is beneficial in areas such as probability theory, statistics,

	optimization, cryptography, and network analysis
Entrepreneurship	skills obtained are valuable in various fields, including computer science, mathematics, law, and philosophy.
Skill Development	Enhances your ability to analyze problems logically, identify patterns, and draw logical conclusions. These skills are valuable in various fields, including computer science, mathematics, law, and philosophy.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Group Theory
Local	-
Regional	-
National	-
Global	Group theory is widely used in physics, chemistry, crystallography, and other fields where symmetry is a fundamental concept.
Employability	This develops ability to think conceptually, make connections between different mathematical structures, and develop a broader perspective on mathematics as a whole.
Entrepreneurship	-
Skill Development	Group theory, in particular, is essential for studying symmetry and transformations. It provides a framework for analysing the symmetries of objects, understanding transformational properties, and solving problems related to symmetry.
Professional Ethics	-

Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Graph Theory
Local	-
Regional	-
National	-
Global	By studying these topics, the students will gain the ability to model and analyse various real-world scenarios, including social networks, transportation networks, communication networks, and data dependencies.
Employability	Understanding concepts such as shortest paths, network connectivity, and digraphs allows students to design efficient and reliable routing algorithms, analyze network performance, and ensure optimal data
Entrepreneurship	-
Skill Development	Graph theory provides a powerful framework for representing and analyzing relationships between objects or entities.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 9
NEP 2020	-
POE/4th IR	Aligns with the concepts of Design, Efficiency, Problem Solving

DATA STRUCTURES

Department:	**Department of Computer Science and Engineering**		
Course Name: **Data Structure**	**Course Code**	**L-T-P**	**Credits**
	ENCS205	3-1-0	4
Type of Course:	Major		

Pre-requisite(s), if any: Basics of Computer Programming

Brief Syllabus:

Solving computational problems requires the knowledge of efficient data organization and the ability to make effective choices among multiple solutions. In this course, we will explore several fundamental data structures in computer science and learn to implement them. The course aims to teach the fundamentals of data structures, their design, implementation and effective use in problem solving approach. With the knowledge of data structures and practical experience in implementing them, students can become much more effective designer and developer. The course will start with the basic introduction of linear such as arrays, stack and queues as well as non-linear data structures such as trees and graphs. They will further proceeds with the programming intensive task of implementing them.

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to Data Structure**	**No. of hours: 12**

Content Summary:

Introduction to Data Structures: Definition of data structures and abstract data types, Static and Dynamic implementations, Examples and real life

<table>
<tr><td colspan="3">applications; Arrays: ordered lists, representation of arrays in memory

Basic Analysis: Differences among best, average, and worst case behaviours of an algorithm, Asymptotic analysis of upper and expected complexity bounds, Big O notation: formal definition and use, big omega and big theta notation , Complexity classes, such as constant, logarithmic, linear, quadratic, and exponential, Time and space trade-offs in algorithms, Recurrence relations , Analysis of iterative and recursive algorithms.</td></tr>
<tr><td>Unit Number: 2</td><td>Title: Stacks, Queues and Linked List</td><td>No. of hours: 12</td></tr>
<tr><td colspan="3">Content Summary:

Stacks: ADT Stack and its operation, Array based implementation of stacks, Examples: Infix, postfix, prefix representation, Conversions of an arithmetic expression from Infix to postfix, Applications: Tower of Hanoi Problem, Algorithms and their complexities

Queues: ADT Queue and its operation, Array based implementation of linear Queues, Circular Queues, Priority queues, Application of queues: Process Scheduling.

Linked List: Definition, Components of linked list, Representation of linked list, Advantages and Disadvantages of linked list. Types of linked list: Singly linked list, Doubly linked list, Circular linked list and circular doubly linked list. Operations on different types of linked list : creation, insertion, deletion, search and display (based on the different position as specified by the user).Linked representation of Stacks & Queues, Algorithms and their complexities</td></tr>
<tr><td>Unit Number: 3</td><td>Title: Trees and Graphs</td><td>No. of hours: 12</td></tr>
</table>

Content Summary:

Trees: Basic Terminology, Binary Trees and their representation, expression evaluation, Complete Binary trees, Extended binary trees, traversing binary trees, Searching, Insertion and Deletion in binary search trees. AVL trees, Threaded trees, algorithms and their analysis.

Graphs: Terminology and Representations, Graphs & Multigraphs, Directed Graphs, Sequential representation of graphs, Adjacency matrices, Transversal Connected Component and Spanning trees, algorithms and their analysis.

Unit Number: 4	Title: Sorting and Searching	No. of hours: 8

Content Summary:

Sorting Algorithms: Introduction, Sorting by exchange, selection sort, insertion sort, Bubble sort, Selection sort, Efficiency of above algorithms, Shell sort, Performance of shell sort, Merge sort, Quick sort Algorithm analysis, Heap sort: Heap Construction, Heap sort, bottom – up, Top – down Heap sort approach

Searching Algorithms: Straight Sequential Search, Binary Search (recursive & non–recursive Algorithm

***Self-Learning Components**:

1. Students should explore Platforms like LeetCode, HackerRank for Data structure
2. Students can refer the following courses as per the **Open Source University Curriculum**

- "Algorithms, Part I" by Robert Sedgewick and Kevin Wayne (available on Coursera)
- "Algorithms, Part II" by Robert Sedgewick and Kevin Wayne (available on Coursera)

Reference Books:
1. E. Horowitz and S. Sahani, "Fundamentals of Data Structures", Galgotia Book source Pvt. Ltd. 2. Data Structures & Algorithms in Python by John Canning, Alan Broder, Robert Lafore Addison-Wesley Professional ISBN: 9780134855912. 3. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. 4. Problem Solving with Algorithms and Data Structures Using Python" by Brad Miller and David Ranum.

Define Course Outcomes (CO)

COs	Statements
CO1	**Analyze** the algorithms to determine the time and space complexity and justify the correctness.
CO2	**Design** a given Search problem (Linear Search and Binary Search).
CO3	**Articulate** Data Structure concepts such as Stack, Queue, Linked list, Graph and traversal techniques and their use in programs
CO4	**Design & implement** the algorithm for Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap sort. Compare their performance in term of Space and time complexity

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1	A3	P5
C02	C2	A3	P4
CO3	C3,C4	A4	P3
CO4	C5	A2	P2

***Please Note:**
Map only 1 or 2 Levels in each category. If a higher level is given, no need to mention lower level

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	1	-	-	-	-	-	3
CO2	3	3	2	-	-	-	-	-	-	-	-	3
CO3	3	3	3	-	-	-	-	-	-	-	-	3
CO4	3	3	3	-	-	-	-	-	-	-	-	3

Please Note:
- Refer to POs while mapping each CO.
- Mark " – " if not applicable
- If attainment of a CO is strongly mapped with a PO , Mark 3
- If attainment of a CO is moderately mapped with a PO , Mark 2
- If attainment of a CO is weakly mapped with a PO , Mark 1

Justification for mapping must be relevant

1=weakly mapped

2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-
CO2	3	3	1	-
CO3	3	3	-	-
CO4	3	3	-	-

Relevance of the Syllabus to various indicators

Unit I	**Introduction to Data Structure**
Local	-
Regional	-
National	It provides foundational knowledge in data structures and algorithm analysis, which are fundamental concepts in computer science and software engineering.
Global	The principles taught in this course are applicable worldwide and form the basis of software engineering practices globally.
Employability	Understanding these concepts is crucial for technical interviews and can enhance job prospects in various technology companies.
Entrepreneurship	It helps in developing efficient and scalable software solutions, which are essential for building successful tech startups or innovative ventures.
Skill Development	Develop skills that are fundamental to computer science and software development and can be applied in various programming languages and contexts.
Professional Ethics	Applying good coding practices and software engineering principles align with professional ethics in the field.
Gender	-

Human Values	It encourages students to approach problems analytically and develop efficient solutions that can positively impact human lives.
Environment & Sustainability	-
Unit II	**Stacks, Queues and Linked List**
Local	-
Regional	-
National	These data structures are used extensively in computer science and software engineering, and the skills learned in this course can be applicable to various industries and sectors across the country.
Global	The principles taught in this course are applicable worldwide and form the basis of software engineering practices globally.
Employability	Understanding these data structures and their operations is important for solving problems efficiently and implementing optimized algorithms, which are highly sought after skills in the job market.
Entrepreneurship	Knowledge of data structures like stacks, queues, and linked lists is valuable for entrepreneurship in the technology sector.
Skill Development	Understanding and applying concepts related to stacks, queues, and linked lists enhances programming skills and helps in developing efficient algorithms to solve real-world problems.
Professional Ethics	-
Gender	-
Human Values	Fostering critical thinking, problem-solving skills, and logical reasoning, which are important qualities in a technology-driven society which can improve productivity and streamline processes, thus positively impacting human lives.
Environment &	-

Sustainability	
Unit III	**Trees and Graphs**
Local	-
Regional	-
National	The skills learned in this course can be applicable to various industries and sectors across the country.
Global	The principles taught in this course are applicable worldwide and form the basis of software engineering practices globally.
Employability	Knowledge of data structures such as trees and graphs is highly relevant to employability in the field of software development and computer science.
Entrepreneurship	These data structures are commonly used in designing and developing software solutions, and understanding their implementation and applications can help entrepreneurs build innovative and scalable products.
Skill Development	Understanding and applying concepts related to trees and graphs enhances programming skills and helps in developing efficient algorithms to solve real-world problems.
Professional Ethics	Following best practices in data structure implementation and algorithm design promotes code readability, maintainability, and overall software quality.
Gender	-
Human Values	Understanding data structures like trees and graphs enables students to develop efficient algorithms that can improve productivity, streamline processes, and positively impact human lives.
Environment & Sustainability	-
Unit IV	**Sorting and Searching**
Local	

Regional	Understanding and applying these algorithms are fundamental to computer science and software development, making them relevant at a regional level.
National	It provides foundational knowledge in sorting and searching algorithms.
Global	Sorting and searching algorithms are fundamental building blocks in computer science and software development, used globally.
Employability	Understanding these algorithms and their efficiency helps in developing optimized software solutions, which are highly sought-after skills in the job market.
Entrepreneurship	These algorithms are used extensively in data processing, information retrieval, and optimization problems, which are essential in building innovative and scalable software products.
Skill Development	Understanding and applying sorting and searching algorithms enhances programming skills and helps in developing efficient algorithms to solve real-world problems.
Professional Ethics	Following best practices in algorithm design and implementation promotes code readability, maintainability, and overall software quality.
Gender	-
Human Values	Understanding sorting and searching algorithms enables students to develop efficient solutions that improve productivity, streamline processes, and positively impact human lives.
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of Design, Efficiency ,Problem Solving, Abstraction and System Analysis

DATA STRUCTURES LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **Data Structure lab**	**Course Code**	**L-T-P**	**Credits**
	ENCS253	0-0-2	1
Type of Course:	Major		
Pre-requisite(s), if any: Basics of Computer Programming			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	Equip the students with knowledge of algorithms and analysis of space and time complexity of the algorithms
CO 2	Demonstrate the use of stack, queues and linked list
CO 3	Equip the students with tree and graph data structures and their practical applications
CO 4	Implementing and analysing searching and sorting algorithms

Ex No	Experiment Title	Mapped CO/COs
1	To design, implement and analyze the complexity of Linear search algorithm	CO4
2	To design, implement and analyze the complexity of Binary search algorithm	CO4

3	Implement and compare the time complexity of bubble sort, insertion sort and selection sort. Calculate their running times for best, worst & best cases. Draw the three cases in a single graph to justify its observed time complexities.	CO4
4	Implement and analyse the working of Recursive Algorithms	CO1
5	Implement Quick sort algorithm and calculate its running times for best, worst & best cases. Draw the three cases in a single graph to justify its observed time complexities.	CO4
6	Implement the linear data structure: Stack by performing Push and Pop operation	CO2
7	Implement Postfix and Prefix Expression using Stack	CO2
8	Implement reverse of a String using Stack	
9	Implement the linear data structure: Queue by performing Insertion and Deletion operation	CO2
10	Implement Circular Queue by performing Insertion and Deletion operation	
11	Implement the dynamic data structure: single linked list also analyse their time complexities in three cases: a) Inserting a new node at the beginning b) Inserting a new node at the end c) Deleting a node from the beginning	CO2
12	Consider a linked list L reverse the linked list	CO2
13	Implement the dynamic data structure : doubly linked list also analyse their time complexities in three cases: a) Inserting a new node at the beginning b) Inserting a new node in the middle c) Deleting a node from the end	CO2
14	Implement the dynamic data structure : circular linked list also analyse their time complexities in three cases: a) Inserting a new node at the beginning b) Inserting a new node in the middle c) Deleting a node from the end	CO2

15	Implement and analyse Stack implementation using Linked list	CO2
16	Implement and analyse Queue implementation using Linked list	
17	Implement and analyse the tree traversal algorithms 1) Inorder 2) Preorder 3) Post order	CO3
18	Implement and analyse the following operations of Binary Search tree. a) Creating and inserting a new node b) Searching a node c) Deleting an existing node from BST	CO3
19	Implement AVL tree with insertion, deletion and searching operation	CO3
20	Implement the graph traversal techniques: Depth First search and Breadth First search algorithms	CO3
21	To understand and implement the minimum spanning tree in Graphs using Kruskal Algorithm	CO3
22	To understand and implement the minimum spanning tree in Graphs using Prims Algorithm	CO3
23	Implement Merge sort algorithm and calculate its running times for best, worst & best cases. Draw the three cases in a single graph to justify its observed time complexities.	CO4
24	Implement Heap sort algorithm and calculate its running times for best, worst & best cases. Draw the three cases in a single graph to justify its observed time complexities.	CO4
25	Implement a priority queue using a heap and calculate its running times for best, worst & best cases. Draw the three cases in a single graph to justify its observed time complexities.	CO4
	Mini Project 1: Create a student management system that stores and manages student records using various	

	data structures. The system should allow users to perform operations such as adding new students, searching for students, deleting students, and displaying all student records.	
	Mini Project 2: Implement a maze solver using data structures like stacks or queues. The program should take an input maze, find a path from the starting point to the goal, and output the solution. You can use depth-first search (DFS) or breadth-first search (BFS) algorithms to solve the maze.	
	Mini Project 3: Implement a social network analysis tool using data structures like graphs. The tool should be able to read a network of users and their connections and perform operations like finding the shortest path between two users, identifying influential users, or recommending friends.	

R PROGRAMMING FOR DATA SCIENCE AND DATA ANALYTICS LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: R Programming for Data Science and Data Analytics Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP251	3-0-2	4
Type of Course:	Minor		
Pre-requisite(s), if any:			
Frequency of offering (check one): Odd			

Brief Syllabus:

This course provides students with the knowledge and skills necessary to create effective and visually appealing data visualizations using the R programming language. Students will learn how to transform raw data into meaningful and informative visual representations that facilitate data analysis and communication. Through hands-on exercises and practical examples, students will gain proficiency in various data visualization techniques and tools available in R

10.Total lecture, Tutorial and Practical Hours for this course:

Lectures:	Practice	
	Tutorials:	**Lab Work: 4**

11. Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.

COs	By the end of this course, the learners will be able to
CO 1	Develop a strong foundation in R programming: The course aims to provide students with a solid understanding of the fundamentals of the R programming language.

CO 2	Apply statistical analysis using R: R is widely used for statistical analysis, and this course intends to equip students with the necessary skills to perform data analysis tasks using R. Students will learn how to import, clean, and preprocess data, apply statistical techniques, and interpret the results obtained through R's extensive library of statistical functions.
CO 3	Implement data manipulation and wrangling techniques: R provides several tools and packages for data manipulation and wrangling, which are essential skills for any data scientist or analyst. This course will cover topics such as data reshaping, merging, subsetting, and transforming data frames. Students will gain hands-on experience in cleaning messy data, extracting relevant information, and preparing data for analysis.
CO 4	Create data visualizations and graphical representations: Data visualization is crucial for effective communication and analysis. In this course, students will learn how to create visualizations and graphs using R's powerful plotting capabilities.
CO 5	They will explore various packages such as ggplot2 and lattice to generate insightful visual representations of data and gain the ability to present data effectively.

12. UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to R Programming**	**No. of hours: 10**
Understand the role of R in data analysis and statistical computing. Familiarize with the R environment, RStudio, and basic R syntax. Learn how to write and execute R scripts and work with the R console. Explore the different data types in R, including numeric, character, logical, and factors. Understand the concept of vectors, matrices, arrays, data frames, and lists in R. Learn how to manipulate and subset data structures using indexing techniques		
Unit Number: 2	**Title: Control Structures and Functions**	**No. of hours: 10**
Gain proficiency in using control structures like loops and conditional statements in R. Understand the concept of functions and how to create and use user-defined functions.		

Learn about built-in functions in R and their application in data analysis.		
Unit Number: 3	**Title: Data Manipulation and Statistical Techniques**	**No. of hours: 10**
Master the dplyr package for efficient data manipulation in R. Learn how to perform tasks such as filtering, sorting, grouping, and summarizing data. Explore techniques for data cleaning, missing data handling, and data reshaping Apply statistical techniques using built-in functions and packages in R.		
Unit Number: 4	**Title: Data Visualization with R**	**No. of hours: 10**
Utilize R's visualization packages, such as ggplot2 and lattice, to create informative plots. Learn how to create scatter plots, bar charts, histograms, box plots, and more. Customize plot aesthetics and annotations to enhance the visual impact of data visualizations. Work with geographic data and create maps using packages like ggplot2, leaflet, and mapview. Generate choropleth maps, point maps, and bubble maps to represent spatial information effectively.		
Unit Number: 5	**Title: Data Visualization Best Practices and Communication**	**No. of hours: 6**
Understand principles of effective data visualization, including data-ink ratio, color choice, and visual hierarchy. Apply storytelling techniques to construct narratives and convey insights through visualizations. Critically evaluate and improve existing visualizations for better data communication.		
Self-Learning Components: Data Wrangling Dashboarding using shiny or plotly Exploring 3-D data Storytelling **Please Note:** **1)Students are supposed to learn the components on self-basis** **2)Mention open-source tools/ new concepts/technologies that students will be required to learn and present through presentations in class**		

3) At least 5-10 % syllabus will be asked in end term exams from self-learning components
Reference Books: 1. R for Data Science by Hadley Wickham , Garrett Grolemund 2. Storytelling with Data : Book by Cole Nussbaumer Knaflic

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	1	2	2	2	1	2	3	2	2
CO2	1	2	2	2	1	3	1	2	1	2	1	1
CO3	2	2	3	2	2	2	2	2	2	1	1	3
CO4	3	2	2	1	3	1	3	1	3	2	2	2
CO5	3	1	1	3	1	2	1	2	1	2	1	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PO1	PO2	PO3	PSO4
CO1	2	1	3	1
CO2	1	2	2	2
CO3	2	2	3	2
CO4	3	2	2	1
CO5	3	1	1	3

Relevance of the Syllabus to various indicators

Unit I	Introduction to R
Local	-
Regional	-
National	Government and Policy Development: R supports evidence-based policymaking by providing tools for analyzing government data, conducting surveys, and evaluating policy interventions. It assists in monitoring and evaluating public programs, assessing their impact, and identifying areas for improvement. R's open-source nature allows governments to leverage existing resources, reducing costs associated with proprietary software.
Global	-
Employability	Lead to positions such as data visualization specialist, data scientist, business intelligence analyst, or data engineer
Entrepreneurship	-
Skill Development	Helps data scientists perform complex data analysis, recognizing patterns, and understanding datasets
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Control Structure and Functions
Local	
Regional	-
National	Research and Development: R is widely used in academic research, contributing to advancements in various fields

	such as social sciences, economics, healthcare, and environmental studies. Its flexibility and extensive statistical capabilities make it an invaluable tool for researchers and scientists to analyze complex data and generate reliable research outcomes
Global	
Employability	Lead to positions such as data visualization specialist, data scientist, business intelligence analyst, or data engineer
Entrepreneurship	-
Skill Development	
Professional Ethics	Collaboration and Knowledge Sharing:-The R community is vibrant and globally connected. By embracing R, nations can tap into this collaborative ecosystem, enabling researchers, analysts, and policymakers to share knowledge, exchange best practices, and collaborate on solving complex problems.
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Data Manipulation and Statistical Techniques
Local	
Regional	-
National	Research and Development: R is widely used in academic research, contributing to advancements in various fields such as social sciences, economics, healthcare, and environmental studies. Its flexibility and extensive statistical capabilities make it an invaluable tool for researchers and scientists to analyze complex data and generate reliable research outcomes

Global	Cost Savings: R is an open-source programming language, which means it is freely available to use. This can result in cost savings for government entities, educational institutions, and businesses that rely on data analysis. The availability of numerous R packages and libraries further enhances the cost-effectiveness of data analysis tasks
Employability	R programming skills are in high demand in the job market, particularly in fields such as data science, analytics, and research. By promoting the use of R, nations can foster the development of a skilled workforce capable of performing data analysis tasks, thereby driving economic growth and attracting investment in data-driven industries.
Entrepreneurship	-
Skill Development	Develops knowledge and skills in client-server programming and network security
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-Helps students to work on social issues
Unit IV	Data Visualization with R
Local	
Regional	Infrastructure Planning and Optimization: R can be utilized in infrastructure planning and optimization tasks. It can help analyze large datasets related to transportation, energy, and urban planning to identify patterns, make predictions, and optimize resource allocation, leading to more efficient and sustainable infrastructure development
National	

Global	
Employability	R is extensively used in economic research and business analytics. Its statistical modeling and machine learning capabilities enable economists and analysts to study economic indicators, forecast market trends, and optimize business strategies. R's visualization capabilities also aid in presenting complex economic data in a clear and meaningful manner, facilitating evidence-based decision-making.
Entrepreneurship	-
Skill Development	R programming skills are in high demand in the job market, particularly in fields such as data science, analytics, and research. By promoting the use of R, nations can foster the development of a skilled workforce capable of performing data analysis tasks, thereby driving economic growth and attracting investment in data-driven industries.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-Public Health and Epidemiology: R plays a vital role in public health and epidemiological studies. It is extensively used for analyzing health-related data, tracking disease outbreaks, modeling infectious diseases, and conducting statistical studies to inform public health policies and interventions.

Proposed Lab Experiments

Defined Course Outcomes

COs	By the end of this lab, the learners will be able to

CO 1	write and execute basic R scripts, manipulate data structures, and understand key programming concepts specific to R
CO 2	equip students with the necessary skills to perform data analysis tasks using R. Students will learn how to import, clean, and preprocess data, apply statistical techniques, and interpret the results obtained through R's extensive library of statistical functions.
CO 3	gain hands-on experience in cleaning messy data, extracting relevant information, and preparing data for analysis.
CO 4	Data visualization is crucial for effective communication and analysis. In this course, students will learn how to create visualizations and graphs using R's powerful plotting capabilities

Ex. No	Experiment Title	Mapped CO/COs
1	To set up R studio in local system	2
2	To study different operators in R	2
3	To study variable creation and datatypes	2
4	To Implement a for loop in R to print the square of numbers from 1 to 10.	2
5	To Write a while loop in R to calculate the factorial of a given positive integer.	1
6	Use an if-else statement in R to classify numerical values into different categories based on a specified condition	2
7	Define a user-defined function in R that calculates the factorial of a given positive integer.	2
8	To study package installation in R	2
9	Write R code to calculate the mean and standard deviation of a numeric variable in a given data frame.	2

10	Conduct a t-test in R to compare the means of two independent groups and interpret the results.	2
11	To Install the dplyr package in R and load it into your R session	2
12	Provide an example of how to use the readr package in R to import a CSV file into a data frame.	2
13	To add a new column to an existing data frame in R, derived from an existing column using a mathematical operation?	2
14	To filter a data frame in R to select rows where a specific condition is met?	4
15	To rename a specific column in a data frame in R	1
16	To Find missing values in data	1
17	To detect outliers in dataset	1
18	To create a scatter plot in R to visualize the relationship between two numeric variables from a given data frame.	1
19	To create a line plot in R to visualize the trend of a numeric variable over time.	1
20	Write R code to add titles, labels, and a legend to a bar chart created using the base plotting system.	1
21	To Generate a bar chart in R to display the frequency distribution of a categorical variable in a given data frame.	3
22	To study how to change the color and size of data points in a scatter plot created using ggplot2 in R.	3
23	To Generate a heat map in R using the heatmap() function to visualize the correlation matrix of a dataset.	3
24	To study the use the plotly package in R to create an interactive scatter plot with tooltips displaying	4

	additional information when hovering over data points	
25	Generate a thematic map in R to represent population density using colors and choropleth techniques.	4

Projects to be covered: (at least 4-5 projects). Please provide objectives of the project

Project Titles

Climate Trends: A project that uses R to analyze climate data, detect trends, and model climate change impacts

Healthcare Analytics: An R project focused on analyzing healthcare data, identifying patterns, and improving patient outcomes through data-driven insights.

Environmental Sustainability: A project in R that focuses on analyzing environmental data, monitoring sustainability indicators, and suggesting eco-friendly practices.

LIFE SKILLS FOR PROFESSIONALS-I

Department:	**Department of Computer Science and Engineering**		
Course Name: **Life Skills for Professionals - I**	**Course Code**	**L-T-P**	**Credits**
	AEC011	3-0-0	3
Type of Course:	AEC		
Pre-requisite(s), if any:			

Brief Syllabus:

Through this comprehensive course, the learners will develop a solid foundation in communication skills, enabling them to express themselves confidently, listen actively, and build strong relationships in personal and professional contexts.

UNIT WISE DETAILS

Unit Number: 1	**Title: Communication: An Introduction**	**No. of hours: 4**

Content Summary:

Definition, Nature and Scope of Communication, Importance and Purpose of Communication, Process of Communication, Types of Communication, Barriers to Communication, Essentials of Effective Communication

Unit Number: 2	**Non-Verbal Communication**	**No. of hours: 8**

Content Summary:

Personal Appearance, Gestures, Postures, Facial Expression, Eye Contacts, Body Language (Kinesics) Time language, Tips for Improving Non-Verbal Communication

Unit Number: 3	Title: Basic number system	No. of hours: 8
Content Summary: Divisibility • Unit digit • Last two digit • Remainder • Number of zero • Factor • LCM & HCF • Simplification • Mixture • Average • Ratio • Partnership		
Unit Number: 4	**Title: Number system**	**No. of hours: 8**
Content Summary: Factor • LCM & HCF • Simplification • Mixture • Average • Ratio • Partnership		
Unit Number: 5	**Title: Time Management**	**No. of hours: 4**
Content Summary: Time management strategies, Setting goals, organizing, and planning ahead, Making the most of your time Deal with distractions, Procrastination and Avoiding distractions		
***Self-Learning Components:** https://onlinecourses.nptel.ac.in/noc21_hs02/preview **Please Note:** **1) Students are supposed to learn the Interactive Learning Modules on the internet.** **2) Webinars and Podcasts/ Self-Assessment Tools/Case Studies and Projects** **3) At least 5-10 % syllabus will be asked in end term exams from self-learning components**		
Reference Books: Aggarwal, R. S. (2014). Quantitative aptitude (Revised edition). Gladwell, M. (2021). Talking to strangers. Scott, S. (2004). Fierce conversations.		

Define Course Outcomes (CO)

COs	Statements
CO1	**Perform** calculations related to number systems, percentages and averages, quickly and accurately.
CO2	**Exhibit** confidence in tackling multiple-choice questions, time-constrained tests and competitive examinations.
CO3	**Demonstrate** active listening techniques, including attentive listening and reflection
CO4	**Articulate** and speak with confidence and express ideas clearly and coherently.
CO5	**Improve** confidence and display open and positive non-verbal communication.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C3		-
C02	C2		-
CO3	C2		P4
CO4	C6		-
CO5	C6		P5

CO-PO Mapping

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	2	-	-	-	-	-	1		1	3
CO 2	-	3	-	-	1	-	-	-	-	-	-	3
CO 3	-	1	-	1	-	-	2	-	-	-	1	3
CO 4	-	2	-	-	2	-	-	-	-	3	-	3
CO 5	-	-	3	2			1	-	-	-	1	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Relevance of the Syllabus to various indicators

Unit I	**Communication: An Introduction**
Local	Improve number sense, enhance basic communication skills.
Regional	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
National	Practice time management strategies for solving problems within time constraints, as in competitive exams.
Global	Aligns with global trends in employment
Employability	Develop skills in real-life situations, such as academic exams, job interviews, and problem-solving scenarios.
Entrepreneurship	Learn to share ideas, listen to others, build consensus, and manage conflicts to achieve common goals in collaborative settings.
Skill Development	Develops Skills in public speaking, interpersonal communication, professional writing, and persuasive communication.
Professional Ethics	-

Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Non-Verbal Communication**
Local	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Regional	Practice attentive listening techniques, such as paraphrasing and asking clarifying questions.
National	Attentively listen to others, understand their perspectives, and respond appropriately while exhibiting techniques such as maintaining eye contact, asking clarifying questions, and paraphrasing.
Global	Aligns with global trends in employment
Employability	Develop skills in participating and contributing to group discussions, meetings, or presentations.
Entrepreneurship	Learn to share ideas, listen to others, build consensus, and manage conflicts to achieve common goals in collaborative settings.
Skill Development	Apply skills in real-life situations, such as academic exams, job interviews, and problem-solving scenarios.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Number system
Local	Improve number sense, enhance basic arithmetic skills and strengthen mental math abilities and speed.

Regional	-
National	Learn about number systems, ratios, proportions, and percentages
Global	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Employability	Develop skills in participating and contributing to group discussions, meetings, or presentations.
Entrepreneurship	-
Skill Development	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Time Management
Local	Attentively listen to others, understand their perspectives, and respond appropriately with timelines
Regional	-
National	Contributes to develop skill and improved productivity
Global	Aligns with global trends in understanding the deadlines.
Employability	Enhance the employability of individuals by developing essential skills and competencies sought by employers
Entrepreneurship	-
Skill Development	Strengthening critical thinking, problem-solving, memory, and other cognitive functions to improve overall mental agility and performance.
Professional Ethics	-

Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts employability

Summer Internship / Project-I

Department:	**Department of Computer Science and Engineering**		
Course Name: Summer Internship / Project-I	**Course Code**	**L-T-P**	**Credits**
	ENSI251	0-0-0	2
Type of Course:	INT		
Pre-requisite(s), if any: NA			

The duration of the internship will be two weeks. It will be after completion of 2nd Semester and before the commencement of Semester III.

The following options can be opted by the students:

1. Offline internship in industry - Student is supposed to produce a joining letter and relieving letter once the internship is over in case of Offline internship in any industry.

2. Online internships – with organizations /institutions those are approved /supported / recommended by the All-India Council of Technical Education for Internship (like SWAYAM, NPTEL, Internshala etc.).

Report Submission and Evaluation Guidelines:

• Student must prepare a detailed report and submit the report. A copy of the report can be kept in the departments for record.

• Each student must be assigned a faculty as a mentor from the university and an Industry Expert as External Guide or Industry Mentor.

• The presentation by student for Internship/ project should in the presence of all students is desirable.

• Student should produce successful completion certificate in case of summer internship in industry.

Course Outcomes:

At the end of the course, students will be able to:

1. Get exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Get possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job(s).
3. Gain experience in writing technical reports / projects and presentation of it.
4. Learn and gain exposure to the engineer's responsibilities and ethics.
5. Understand the social, economic, and administrative considerations that influence the working environment of industrial organizations.

Semester: 4

PROBABILITY AND STATISTICS

Department:	**Department of Computer Science and Engineering**		
Course Name: **Probability And Statistics**	**Course Code** **ENMA202**	**L-T-P** 3-1-0	**Credits** 4
Type of Course:	Major		
Pre-requisite(s), if any: Basics of Probability and Statistics			

Brief Syllabus:

The Probability and Statistics course is designed to provide students with a strong foundation in the principles and applications of probability and statistics in the context of data science. The course will cover various topics, including probability functions, random variables, discrete and continuous distributions, correlation and regression analysis, central limit theorem, and modeling uncertainty. Students will also explore real-world examples and utilize programming languages for statistical analysis and data visualization.

UNIT WISE DETAILS

Unit Number: 1	**Title: Basic Probability**	**No. of hours: 8**

Content Summary:

Definition of probability, conditional probability, independent events, Bayes' theorem, Bernoulli trials, Random variables, discrete random variable, probability mass function, continuous random variable, probability density function, cumulative distribution function, properties of cumulative distribution function, Two dimensional random variables and their distribution functions, Marginal probability function, Independent random variables.

Unit Number: 2	**Title: Some special Probability Distributions**	**No. of hours: 8**

Content Summary:

Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Normal, Exponential and Gamma densities, Evaluation of statistical parameters for these distributions.

Unit Number: 3	**Title: Basic Statistics**	**No. of hours: 6**

Content Summary:

Measure of central tendency: Moments, Expectation, dispersion, skewness, kurtosis, expected value of two-dimensional random variable, Linear Correlation, correlation coefficient, rank correlation coefficient, Regression, Bounds on probability, Chebyshev's Inequality.

Unit Number: 4	**Title: Applied Statistics**	**No. of hours: 10**

Content Summary:

Formation of Hypothesis, Test of significance: Large sample test for single proportion, Difference of proportions, Single mean, Difference of means, and Difference of standard deviations. Test of significance for small samples: t- Test for single mean, difference of means, t-test for correlation coefficients, F- test for ratio of variances, Chi-square test for goodness of fit and independence of attributes.

Unit Number: 5	**Title: Curve fitting**	**No. of hours: 8**

Content Summary:

Curve fitting by the numerical method: Curve fitting by of method of least squares, fitting of straight lines, second degree parabola and more general curves. Correlation - Coefficient of correlation, Rank correlation, Regression- Regression coefficients, Lines of regression.

Multiple correlation and regression - Coefficient of multiple Correlation, multiple regression, multiple linear regression equations

***Self-Learning Components**:

- **Probability Simulation**: Students can explore and practice probability concepts through simulations using tools like Python's NumPy library or R programming language.

https://pll.harvard.edu/course/data-science-probability

https://www.mygreatlearning.com/academy/learn-for-free/courses/probability-for-data-science

https://www.udemy.com/course/statistics-probability-for-data-science/

- **Data Analysis using R**: Students can learn and apply statistical techniques using R, an open-source statistical programming language, to analyze real-world datasets.

  https://www.coursera.org/learn/data-analysis-r

  https://www.udemy.com/course/data-analysis-with-r/

- **Hypothesis Testing with Excel**: Students can learn how to perform hypothesis testing using Excel's built-in statistical functions and conduct statistical analyses on data sets.

  https://www.coursera.org/learn/hypothesis-testing-python-excel

- **Introduction to Data Visualization**: Students can explore data visualization techniques and tools such as Tableau or matplotlib to effectively present statistical findings and insights.

  udemy.com/course/introduction-to-data-visualization/

- **Introduction to Machine Learning**: Students can gain an understanding of basic machine learning algorithms and their applications in data analysis and prediction, using tools like scikit-learn or TensorFlow.

  https://www.coursera.org/learn/machine-learning-duke

  https://onlinecourses.nptel.ac.in/noc22_cs29/preview

Reference Books:

1. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall.
2. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India.
3. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, Wiley.

4. D. C. Montgomery and G. C. Runger, Applied Statistics and Probability for Engineers, Wiley. **5.** J. L. Devore, Probability and Statistics for Engineering and the Sciences, Cengage Learning.

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the terminologies of basic probability, two types of random variables and their probability functions.
CO2	**Apply** the various discrete and continuous probability distributions.
CO3	**Analyze** the central tendency, correlation and correlation coefficient and regression.
CO4	**Evaluate** the statistics for testing the significance of the given large and small sample data by using t- test, F- test and Chi-square test.
CO5	**Create** the fitting of various curves by method of least square.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 7. Knowledge 8. Understand 9. Apply 10.Analyze 11.Evaluate 12.Create	Affective levels(A) 6. Receiving 7. Responding 8. Valuing 9. Organizing 10.Characterizing	Psychomotor levels(P) 6. Imitation 7. Manipulation 8. Precision 9. Articulation 10.Improving
CO1	-	-	-
C02	-	-	-

CO3	-	A4	-
CO4	C4	A4	P4
CO5	C5	A5	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	2	-	-	-	-	-	-	2
CO2	2	2	3	-	2	-	-	-	-	-	-	2
CO3	1	3	2	-	2	-	-	2	2	2	-	3
CO4	-	2	3	1	-	3	-	3	3	2	3	3
CO5	1	2	3	2	2	-	-	-	-	2	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-
CO2	2	3	-	-
CO3	2	3	2	-
CO4	2	3	2	1
CO5	-	2	-	1

Relevance of the Syllabus to various indicators

Unit I	Basic Probability
Local	Addresses local understanding probability of events in online activities
Regional	-
National	Contributes to national digital literacy (probability concepts are fundamental to understanding data and making informed decisions in the digital realm).

Global	Aligned with global trends in probability concepts apply universally in analyzing and predicting outcomes.
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Some special Probability Distributions
Local	Addresses local understanding probability distributions can be applied to analyze and model various online phenomena.
Regional	
National	Contributes to national digital literacy probability distributions that play a role in understanding and analyzing data in the digital landscape.
Global	Aligns with global trends probability distributions which are applicable in analyzing data worldwide.
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-

Human Values	-
Environment & Sustainability	-
Unit III	Basic Statistics
Local	-
Regional	-
National	Contributes to national network security strategies and protocols (understanding statistical measures helps in analyzing and evaluating network security).
Global	Aligns with global trends in network security techniques and protocols (statistical analysis is essential in assessing and improving network security worldwide).
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Applied Statistics
Local	Addresses local understanding and implementation of statistics applied in analyzing and optimizing internet-based services.
Regional	-
National	Contributes to national statistics aids in analyzing and enhancing digital communication.

Global	Aligns with global trends in applied statistics which is relevant in analyzing and improving global digital services).
Employability	Develops skills in knowledge of applied statistics supports data analysis and optimization in these areas.
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4 (Quality Education)
NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO (the syllabus content covers relevant topics in these areas).

ANALYSIS AND DESIGN OF ALGORITHMS

Department:	**Department of Computer Science and Engineering**			
Course Name: **Analysis and Design of Algorithms**	**Course Code**	**L-T-P**	**Credits**	
	ENCS202	3-1-0	4	
Type of Course:	**Major**			
Pre-requisite(s), if any: - Data Structure				

Brief Syllabus:

The analysis and design of algorithm course introduce students to the design of computer algorithms, as well as analysis of sophisticated algorithms. Students will learn how to analyse the asymptotic performance of algorithms as well as provides familiarity with major algorithms and data structures. This course introduces basic methods for the design and analysis of efficient algorithms emphasizing methods useful in practice. Different algorithms for a given computational task are presented and their relative merits evaluated based on performance measures. The following important computational problems will be discussed: sorting, searching, elements of dynamic programming and greedy algorithms, advanced data structures, graph algorithms (shortest path, spanning trees, tree traversals), string matching, elements of computational geometry, NP completeness.

UNIT WISE DETAILS

Unit Number: 1	**Title:** Introduction to Algorithms	**No. of hours: 10**

Content Summary:

Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst-case behaviour, Performance measurements of Algorithm, Time and Time and space trade- offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Recursion tree method and Masters' theorem.

Unit	**Title:** Fundamental Algorithmic Strategies	**No. of hours: 10**

Number: 2		
Content Summary: Brute -Force, Greedy, Dynamic Programming, Branch-and-Bound and Backtracking methodologies for the design of algorithms; Illustrations of these techniques for Problem-Solving, Bin Packing, Knap Sack. Heuristics – characteristics and their application domains. Heaps and priority queues, Hash tables and hash functions. String matching		
Unit Number: 3	**Title:** Graph and Tree Algorithms	**No. of hours: 10**
Content Summary: Traversal algorithms: Depth First Search (DFS) and Breadth First Search (BFS); Shortest path algorithms, Transitive closure, Minimum Spanning Tree, Topological sorting, Network Flow Algorithm. Graph Colouring and matching algorithms.		
Unit Number: 4	**Title**: Tractable and Intractable Problems	**No. of hours: 10**
Content Summary: Computability of Algorithms, Computability classes – P, NP, NP complete and NP-hard. Cook's theorem, Standard NP-complete problems and Reduction techniques. Advanced Topics: Approximation algorithms, Randomized algorithms, Online algorithms, Quantum algorithms.		
Self-Learning Components Container loading problem, stable marriage problem, Coin Change problem		
Reference Books 1. Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill. 2. Fundamentals of Algorithms – E. Horowitz et al.		

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** fundamental algorithmic concepts and how to analyze Complexities.
CO2	**Analyze** and evaluate algorithm performance.
CO3	**Design** efficient algorithms in terms of space and time.
CO4	**Apply** algorithmic problem-solving strategies.
CO5	**Develop** algorithm implementation skills.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2		P1
C02	C4		P2
CO3	C3		P3
CO4	C4		-
CO5	C6		P3

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										2
CO2		3		3	2							1
CO3			3									3
CO4					2				2			
CO5				3						2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	3		
CO2		3		3
CO3	3	2		
CO4		3	3	
CO5		2	3	

Relevance of the Syllabus to various indicators

Unit I	Introduction to algorithm
Local	Addresses local understanding of the problems and how to find its solutions
Regional	Addresses regional understanding of the problems and how to find its solutions
National	Addresses national understanding of the problems and how to find its solutions
Global	Addresses global understanding of the problems and how to find its solutions
Employability	After having knowledge about how to solve real world problems, new problems can be addressed to develop their algorithms.
Entrepreneurship	-

Skill Development	Develops basic knowledge and skills to develop analytical skills
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	
Local	Understanding and applying algorithm design methodologies enhances programming and problem-solving skills at the local level.
Regional	Knowledge of algorithm design methodologies allows individuals to develop innovative solutions and potentially start their own businesses in the region
National	Adhering to ethical principles in algorithm design ensures professionalism and ethical practices at the national level.
Global	Employability: Proficiency in algorithm design techniques enhances employability opportunities globally.
Employability	Employability: Proficiency in algorithm design techniques enhances employability opportunities globally.
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills to develop analytical skills
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	

Local	Addresses local understanding of the problems and how to find its solutions
Regional	Addresses regional understanding of the problems and how to find its solutions
National	Addresses national understanding of the problems and how to find its solutions
Global	Addresses global understanding of the problems and how to find its solutions
Employability	After having knowledge about how to solve real world problems, new problems can be addressed to develop their algorithms.
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills to develop analytical skills
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	
Local	Addresses local understanding of the problems and how to find its solutions
Regional	Addresses regional understanding of the problems and how to find its solutions
National	Addresses national understanding of the problems and how to find its solutions
Global	Addresses global understanding of the problems and how to find its solutions
Employability	After having knowledge about how to solve real world problems, new problems can be addressed to develop

	their algorithms.
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills to develop analytical skills
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4, 8, 9
NEP 2020	-
POE/4th IR	-

ANALYSIS AND DESIGN OF ALGORITHMS LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **Analysis and Design of Algorithms**	**Course Code**	**L-T-P**	**Credits**
	ENCS256	0-0-2	1
Type of Course:	**Major**		
Pre-requisite(s), if any: - Data Structure			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Analyze** the time and space complexities of algorithms and evaluate their performance
CO 2	**Apply** algorithmic problem-solving strategies to solve complex computational problems
CO 3	**Design** and develop innovative algorithms for solving complex computational problems.
CO 4	**Generate** algorithmic solutions that consider trade-offs between time complexity, space complexity, and problem constraints.

Ex. No	Experiment Title	Mapped CO/COs
1	Sort a given set of elements using the Quicksort method and determine the time required to sort the elements. Repeat the experiment for different values of n, the number of elements in the list to be sorted and plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator	CO1
2	Design an algorithm to find the maximum and minimum elements in an unsorted array.	CO1
3	Implement Largest Common Subsequence.	CO1
4	Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm.	CO1
5	Find Minimum Cost Spanning Tree of a given undirected graph using Prim’s algorithm.	CO2
6	To Implement Optimal Binary Search Tree.	CO2
7	To Implement Strassen’s matrix multiplication Algorithm	CO2
8	Design an algorithm to find the maximum subarray sum in an array.	CO2
9	From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.	CO2
10	Implement 0/1 Knapsack Problem using Dynamic algorithm concepts.	CO2
11	To implement Bellman Ford’s Algorithm.	CO2
12	To implement Depth First Search and Breadth First Search Algorithm.	CO2
13	To implement Naïve String-matching Algorithm.	CO3
14	Implement N Queen's problem using Back Tracking.	CO3

15	Design an algorithm to check if a given graph is acyclic (a DAG).	CO3
16	Obtain the Topological ordering of vertices in a given digraph.	CO3
17	Compute the transitive closure of a given directed graph using Warshall's algorithm	CO3
18	Design an algorithm to find the nth Fibonacci number using dynamic programming.	CO3
19	Design an algorithm to solve the 3-SAT problem using a backtracking approach.	CO4
20	Implement the brute-force algorithm to solve the Subset Sum Problem.	CO4
21	Design an algorithm to solve the Independent Set Problem using the branch and bound approach.	CO4
22	Design an algorithm to solve the Vertex Cover Problem using the 2-approximation algorithm.	CO4

DATABASE MANAGEMENT SYSTEMS

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:
Database Management System</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENCS204</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Major</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: Nil</td></tr>
<tr><td colspan="4">Brief Syllabus:
Introduction to database, Database modelling languages, E-R modelling, Transaction Processing, Database security.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Introduction</td><td>No. of hours: 12</td></tr>
<tr><td colspan="4">Content Summary:
Introduction to DBMS: Database system architecture: Data Abstraction, Data Independence, Data models: network model, relational and object-oriented data models, Entity-relationship model: Relationship model, constraints, keys, Design issues, Extended E-R features- Generalization, Specialization, Aggregation, Translating E-R model into Relational model, integrity constraints in relational model.</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Relational Query Languages</td><td>No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:
Relational query languages: Relational algebra: Tuple and domain relational calculus, SQL, DDL, DML and DCL constructs. Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms. Open source and Commercial DBMS - MYSQL, ORACLE, DB2,</td></tr>
</table>

SQL server. Relational database design: Database anomalies, Domain and data dependency, Armstrong's axioms, Normal forms (1NF,2NF, 3NF, Boyce/Codd Normal, 4NF), Dependency preservation, Lossless design.

Unit Number: 3	**Title: Transaction Processing**	**No. of hours: 12**

Content Summary:

Storage strategies: File Organization, Indices, B-tree and B+ trees, hashing, Transaction processing: Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp-based schedulers, multi-version and optimistic Concurrency Control schemes, Database recovery.

Unit Number: 4	**Title: Database Security**	**No. of hours: 8**

Database Security: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection. Advanced topics: Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.

***SELF-LEARNING COMPONENTS:**

https://onlinecourses.nptel.ac.in/noc22_cs91/preview

Please Note:

1)Students are supposed to learn the components on self-basis

2) At least 5-10 % syllabus will be asked in end term exams from self-learning components.

Reference Books:

1."Database System Concepts", 6th Edition by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill.

2. "Principles of Database and Knowledge – Base Systems", Vol 1 by J.D. Ullman, Computer Science Press.

Define Course Outcomes (CO)

Course Outcomes (COs) Possible usefulness of this course after its completion i.e., how this course will be practically useful to him once it is completed.	
COs	**Statements**
CO 1	**Summarize** the concepts of database objects; enforce integrity constraints on a database using RDBMS.
CO 2	**Use** Structured Query Language (SQL) for database manipulation
CO 3	**Understand** basic database storage structures and access techniques
CO 4	**Analyze** and **implement** transaction processing, concurrency control and database recovery protocols in databases.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	2	-	1	-	-	-	3
CO2	-	1	1	-	-	-	1	-	1	1	1	2
CO3	2	2	-	2	2	3	2	-	-	-	-	3
CO4	-	-	-	2	2	-	-	2	1	2	2	3

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	-	-	1	-
CO2	-	2	2	-
CO3	1	-	2	-
CO4	1	-	3	-

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1	-	-
C02	C2	-	-
CO3	C3	A4	P4
CO4	C5	-	P5

Relevance of the Syllabus to various indicators

Unit I	**Introduction**
Local	Understanding the fundamentals of DBMS can aid in solving local data management challenges.
Regional	Understanding DBMS architecture can be applied to regional projects or research in data management fields.
National	DBMS plays a significant role in various national data management systems and applications.
Global	DBMS is fundamental to global data management practices and technologies.
Employability	Knowledge of DBMS enhances employability in various technical and IT professions.
Entrepreneurship	Knowledge of DBMS can inspire entrepreneurial opportunities in IT-based ventures.
Skill Development	Learning DBMS develops analytical and problem-solving

	skills for data management tasks.
Professional Ethics	Applying DBMS principles with integrity ensures ethical practices in data handling.
Gender	DBMS education is equally important for individuals of all genders pursuing IT careers.
Human Values	Applying DBMS with ethical considerations contributes to responsible data management.
Environment & Sustainability	-
Unit II	**Relational Query Languages**
Local	Understanding relational query languages can aid in solving local data retrieval challenges.
Regional	Understanding relational query languages can be applied to regional projects or research in data management.
National	Relational query languages are widely used in various national data management systems and applications.
Global	Relational query languages are fundamental to global data retrieval and processing practices.
Employability	Knowledge of relational query languages enhances employability in IT and database-related professions.
Entrepreneurship	Knowledge of relational query languages can inspire entrepreneurial opportunities in IT-based ventures.
Skill Development	Learning relational query languages develops analytical and query optimization skills.
Professional Ethics	Applying relational query languages with integrity ensures ethical data retrieval and manipulation.
Gender	Relational query languages education is equally important for individuals of all genders pursuing IT careers.
Human Values	Applying relational query languages with ethical considerations promotes user privacy and data security.

Environment & Sustainability	-
Unit III	**Transaction Processing**
Local	Understanding transaction processing aids in managing local data operations and concurrency control.
Regional	Understanding transaction processing can be applied to regional data management systems and applications.
National	Transaction processing is crucial for various national data-intensive applications and systems.
Global	Transaction processing is fundamental to global data management and processing practices.
Employability	Knowledge of transaction processing enhances employability in IT and database management professions.
Entrepreneurship	Knowledge of transaction processing can inspire entrepreneurial opportunities in data management ventures.
Skill Development	Learning transaction processing develops skills in data concurrency control and recovery mechanisms.
Professional Ethics	Applying transaction processing with integrity ensures data consistency and reliability.
Gender	Transaction processing education is equally important for individuals of all genders pursuing IT careers.
Human Values	Applying transaction processing with ethical considerations maintains data integrity and security.
Environment & Sustainability	-
Unit IV	**Database Security**
Local	Understanding database security aids in protecting local data from unauthorized access and attacks.
Regional	Understanding database security can be applied to regional data management systems and applications.
National	Database security is essential for safeguarding national data and information systems.
Global	Database security is fundamental to global data protection and privacy practices.

Employability	Knowledge of database security enhances employability in IT security and data protection professions.
Entrepreneurship	Knowledge of database security can inspire entrepreneurial opportunities in cybersecurity ventures.
Skill Development	Learning database security develops skills in access control and intrusion detection.
Professional Ethics	Applying database security with integrity ensures ethical data protection and privacy.
Gender	Database security education is equally important for individuals of all genders pursuing IT security careers.
Human Values	Applying database security with ethical considerations promotes data confidentiality and integrity.
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	-

DATABASE MANAGEMENT SYSTEMS LAB

Department:	Department of Computer Science and Engineering		
Course Name: **Database Management System Lab**	**Course Code**	L-T-P	Credits
	ENCS254	0-0-2	1
Type of Course:	Major		

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	Apply the basic concepts of Database Systems and create model using ER Diagrams
CO 2	Understand the basics of SQL and construct queries for database creation and interaction
CO 3	Understand PL/SQL statements: Exception Handling, Cursors, and Triggers
CO 4	Analyse and implement Join operations to extract information from more than one table.

Ex. No.	Experiment Title	Mapped CO/COs
1	Consider following databases and draw ER diagram and convert entities and relationships to relation table for a given scenario: COLLEGE DATABASE: STUDENT (USN, SName, Address, Phone, Gender) SEMSEC (SSID, Sem, Sec) CLASS (USN, SSID) SUBJECT (Subcode, Title, Sem, Credits) IAMARKS (USN, Subcode, SSID, Test1, Test2, Test3, FinalIA)	CO1
2	Consider following databases and draw ER diagram and convert entities and relationships to relation table for a given scenario: COMPANY DATABASE: EMPLOYEE (SSN, Name, Address, Sex, Salary, SuperSSN, DNo) DEPARTMENT (DNo, DName, MgrSSN, MgrStartDate) DLOCATION (DNo,DLoc) PROJECT (PNo, PName, PLocation, DNo) WORKS_ON (SSN, PNo, Hours)	CO1
3	Consider the below Database: Movies (title, director, making_year, rating), actors (actor, acting_year), acts(actor, title), directors (director, director_year) Write relation algebra queries for given relations: 1. Find movies made after 1997 2. Find movies made by Hanson after 1997 3. Find all movies and their ratings 4. Find all actors and directors Find Coen's movies with McDormand	CO2
4	**Database Schema for a customer-sale scenario** Customer(**Cust id : integer,** cust_name: string) Item(**item_id: integer,** item_name: string, price: integer) Sale(**bill_no: integer,** bill_data: date, **cust_id: integer, item_id: integer**, qty_sold: integer) For the above schema, perform the following— i. Create the tables with the appropriate integrity constraints. ii. Insert around 10 records in each of the tables. iii. List all the bills for the current date with the customer names and item numbers. iv. List the total Bill details with the quantity sold, price of the item and the final amount. v. List the details of the customer who have bought a product which has a price>200.	CO2

<table>
<tr>
<td></td>
<td>vi. Give a count of how many products have been bought by each customer
vii. Give a list of products bought by a customer having cust_id as 5.
viii. List the item details which are sold as of today.
ix. Create a view which lists out the bill_no, bill_date, cust_id, item_id, price, qty_sold, amount.
Create a view which lists the daily sales date wise for the last one week</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Consider the following table:
Table: CLASS
<table>
<tr><td>Id</td><td>Name</td></tr>
<tr><td>1</td><td>Bravo</td></tr>
<tr><td>2</td><td>Alex</td></tr>
<tr><td>4</td><td>Cheng</td></tr>
</table>
Give the output of the following SQL script:
> INSERT INTO class VALUES (5,'Rahul');
> COMMIT;
> UPDATE class SET name = 'Abhijeet' WHERE id= '5';
> SAVEPOINT A;
> INSERT INTO class VALUES (6, 'Chris');
> SAVEPOINT B;
> INSERT INTO class VALUES (7, 'Bravo');
> SAVEPOINT C
> SELECT * FROM class;
> ROLLBACK TO B;
> SELECT * FROM class;
> ROLLBACK TO A;</td>
<td>CO2</td>
</tr>
<tr>
<td>6</td>
<td>(Exercise on retrieving records from the table) EMPLOYEES (Employee_Id, First_Name, Last_Name, Email, Phone_Number, Hire_Date, Job_Id, Salary, Commission_Pct, Manager_Id, Department_Id)
(a) Find out the employee id, names, salaries of all the employees
(b) List out the employees who works under manager 100
(c) Find the names of the employees who have a salary greater than or equal to 4800
(d) List out the employees whose last name is 'AUSTIN'
(e) Find the names of the employees who works in departments 60,70 and 80
(f) Display the unique Manager_Id.</td>
<td>CO2</td>
</tr>
<tr>
<td>7</td>
<td>(Exercise on updating records in table) Create Client_master with the following fields(ClientNO, Name, Address, City,</td>
<td>CO2</td>
</tr>
</table>

	State, bal_due) (a) Insert five records (b) Find the names of clients whose bal_due> 5000 . (c) Change the bal_due of ClientNO " C123" to Rs. 5100 (d) Change the name of Client_master to Client12. (e) Display the bal_due heading as "BALANCE"	
8	Rollback and Commit commands Create Teacher table with the following fields(Name, DeptNo, Date of joining, DeptName, Location, Salary) (a) Insert five records (b) Give Increment of 25% salary for Mathematics Department . (c) Perform Rollback command (d) Give Increment of 15% salary for Commerce Department (e) Perform commit command	CO2
9	(Exercise on order by and group by clauses) Create Sales table with the following fields(Sales No, Salesname, Branch, Salesamount, DOB) (a) Insert five records (b) Calculate total salesamount in each branch (c) Calculate average salesamount in each branch (d) Display all the salesmen, DOB who are born in the month of December as day in character format i.e. 21-Dec-09 (e) Display the name and DOB of salesman in alphabetical order of the month.	CO2
10	Consider the following tables namely "DEPARTMENTS" and "EMPLOYEES" Their schemas are as follows, Departments (dept _no , dept_ name , dept_location); Employees (emp_id , emp_name , emp_salary,dept_no); a) Develop a query to grant all privileges of employees table into departments table b) Develop a query to grant some privileges of employees table into departments table c) Develop a query to revoke all privileges of employees table from departments table d) Develop a query to revoke some privileges of employees table from departments table e) Write a query to implement the save point.	CO2
11	Using the tables "DEPARTMENTS" and "EMPLOYEES" perform the following queries a) Display the employee details, departments that the departments are same in both the emp and dept.	CO4

	b) Display the employee name and Department name by implementing a left outer join. c) Display the employee name and Department name by implementing a right outer join. d) Display the details of those who draw the salary greater than the average salary	
12	Employee Database An Enterprise wishes to maintain a database to automate its operations. Enterprise is divided into certain departments and each department consists of employees. The following two tables describes the automation schemas Dept (deptno, dname, loc) Emp (empno, ename, job, mgr, hiredate, sal, comm, deptno) a) Update the employee salary by 15%, whose experience is greater than 10 years. b) Delete the employees, who completed 30 years of service. c) Display the manager who is having maximum number of employees working under him? d) Create a view, which contain employee names and their manager	CO2
13	Using Employee Database perform the following queries a) Determine the names of employee, who earn more than their managers. b) Determine the names of employees, who take highest salary in their departments. c) Determine the employees, who are located at the same place. d) Determine the employees, whose total salary is like the minimum Salary of any department. e) Determine the department which does not contain any employees.	CO2
14	Write a PL/SQL program to demonstrate Exceptions.	CO3
15	Write a PL/SQL program to demonstrate Cursors.	CO3
16	Write a PL/SQL program to demonstrate Functions.	CO3
17	Write a PL/SQL program to demonstrate Packages.	CO3
18	Write PL/SQL queries to create Procedures.	CO3
19	Write PL/SQL queries to create Triggers.	CO3

INTRODUCTION TO DATA SCIENCE

Department:	**Department of Computer Science and Engineering**			
Course Name: Introduction to Data Science	**Course Code**	**L-T-P**	**Credits**	
	ENSP204	4-0-0	4	
Type of Course:	Minor			
Pre-requisite(s), if any: Core Python				
Frequency of offering (check one): Even				

Brief Syllabus:

Data science is the domain of study that deals with vast volumes of data using modern tools and techniques to find unseen patterns, derive meaningful information, and make business decisions. Data science uses complex machine learning algorithms to build predictive models.

Total lecture, Tutorial and Practical Hours for this course:

Lectures: 40	**Practice**	
	Tutorials:	**Lab Work:**

Course Outcomes (COs)

Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.

COs	By the end of this course, learners will be able to
CO 1	Explore end-to-end data science industry use cases using the data analytics lifecycle.
CO 2	Understand the scientific method for science projects, and the data science team key roles

CO 3	Acquire technical expertise using popular open source data science frameworks including Jupyter notebooks and Python.
CO 4	Gain a competitive edge using low-code cloud- based platform for data science - IBM Watson Studio
CO5	Data engineering and data modeling practices using machine learning

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to Data Science**	**No. of hours: 8**

Content Summary:

Introduction to Data Science
What is Data Science, what does a data scientist do? Various examples of Data Science in the industries. How Python is deployed for Data Science applications. Various steps in the Data Science process like data wrangling, data exploration and selecting the model.
Basic Python: History of Python, Features of python, Installation of jupyter notebook, Python operators, Python Data types and its inbuilt functions, Conditional statement, Loops

Unit Number: 2	**Title: Python Libraries for data science**	**No. of hours: 8**

Content Summary:

Data Wrangling and Cleaning using pandas
Understanding the importance of data wrangling and cleaning in data science. Identifying common challenges in data wrangling and cleaning. Handling missing data. Dealing with outliers. Handling duplicates. Addressing inconsistent data. Normalization and scaling. Data discretization. Data aggregation. Tools for data wrangling and cleaning: Data cleaning in Python using Pandas

Unit Number: 3	**Title: Data Visualization and Machine Learning**	**No. of hours: 8**

Content Summary:

Data visualization principles and best practices
Data visualization with Matplotlib
and Seaborn, Introduction to Matplotlib. Using Matplotlib for plotting graphs and charts like Scatter, Bar, Pie, Line, Histogram and more.

Supervised Learning Understanding linear regression, Simple linear regression, Multiple linear regression, Model building and evaluation, Feature selection and regularization, Understanding logistic regression, Model building and evaluation, Feature selection and regularization, Confusion matrix and classification report, Understanding decision trees, Building decision trees, Pruning, Random forests, Ensemble methods, Understanding SVM, Kernel functions, Soft margin SVM, Model building and evaluation, Hyperparameter tuning, Understanding Naive Bayes, Bayesian probability, Building a Naive Bayes model, Multinomial Naive Bayes, Bernoulli Naive Bayes Unsupervised Learning Use cases of unsupervised learning, What is clustering and Types of clustering. What is K-means clustering and Hierarchical Clustering? Step by step calculation of k-means algorithm.		
Unit Number: 4	**Title: Introduction to Watson Studio**	**No. of hours: 8**
Content Summary: Exploring IBM cloud and its catalog, Exploring Watson Services, understanding of Watson Studio, Watson Machine Learning, Exploring Collaborators and Asset, Understanding Data Mining, Exploring CRISP-DM, Represent and Transform Data, Data Visualization using Watson, Working with Data Refinery Flow.		
Unit Number: 5	**Title: Working with Watson Studio**	**No. of hours: 8**
Content Summary: Overview of modelling techniques, Machine learning techniques, Accuracy, precision and recall, Model building, Model Training, and Testing, Creating Jobs, Spaces, and Deployment, Working with Jupyter Notebooks, and other Environments.		
Self-Learning Components: mention 4-5 topics for students in bullet points Please Note: 1)Students are supposed to learn the components on self-basis 2)Mention open-source tools/ new concepts/technologies that students will be required to learn and present through presentations in class 3) At least 5-10 % syllabus will be asked in end-term exams from self-learning components		

Reference Books: IBM Course Material

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	1	2	2	2	1	2	3	2	2
CO2	1	2	2	2	1	3	1	2	1	2	1	1
CO3	2	2	3	2	2	2	2	2	2	1	1	3
CO4	3	2	2	1	3	1	3	1	3	2	2	2
CO5	3	1	1	3	1	2	1	2	1	2	1	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PO1	PO2	PO3	PSO4
CO1	2	1	3	1
CO2	1	2	2	2
CO3	2	2	3	2
CO4	3	2	2	1
CO5	3	1	1	3

Relevance of the syllabus to various indicators

Unit I	**Introduction to Data Science**
Local	Addresses understanding of Data Science and its impact on society
Regional	

National	
Global	Aligns with global trends in Data scienceMethodologies and Statistical analysis.
Employability	Develops skills in Machine Learning Concepts, Visualization, and UnderstandingStatistics.
Entrepreneurship	-
Skill Development	Learning basics of Data Science and its uses in real time.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**nPython Libraries for data science**
Local	Addresses local understanding of Advance python and working with Data
Regional	-
National	
Global	Aligns with global trends in Data Usage, Management, and Understanding
Employability	Develops skills in using Python and building Machine Learning Models.
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in internet technologies and network protocols

Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Client-Server programming, Threats, Network security techniques, Firewall
Local	To teach the fundamental techniques and principles in achieving data science with scalability and streaming capability.
Regional	-
National	
Global	Aligns with global trends in Data Science Open-source tools and techniques.
Employability	Develops skills in Machine Learning Algorithms and implementation.
Entrepreneurship	-
Skill Development	Develops knowledge and skills in Classification, clustering, and Regression Models.
Professional Ethics	-
Gender	-
Human Values	-
Environment &Sustainability	-
Unit IV	**Introduction to Watson Studio**

Local	-To have skills that will help them to solve complex real-world problems in business decisions using IBM Tool.
Regional	-
National	
Global	Aligns with global trends in IBM Watson Studio Pak for Data.
Employability	Develops skills in IBM Watson and its applications.
Entrepreneurship	-
Skill Development	Develops knowledge and skills IBM Watson and its applications.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	IBM Watson and its applications.

DATA SCIENCE LAB

Department:	Department of Computer Science and Engineering			
Course Name:	**Course Code**	**L-T-P**	**Credits**	
Data Science Lab	ENSP254	0-0-2	1	
Type of Course:	Major			

Proposed Lab Experiments

Defined Course Outcomes

COs	By the end of this course, learners will be able to
CO 1	Learning numbers of Data Science related Phases on cloud.
CO 2	Implementing Data Exploration and Understanding on any data.
CO 3	Implementing Data Preparation and Conversion on any data.
CO 4	Understand various visualization chart and their characteristics.

Ex. No	**Experiment Title**	**Mapped CO/COs**
1	Implement data cleaning and wrangling using pandas.	CO2
2	Implement all data pre-processing steps in python.	CO2
3	Implementation of linear and logistic regression.	CO2
4	Implementation of Random forest algorithm	CO2
5	Implementation of K-means clustering algorithm	CO4
6	To Study About Data Refinery Tool in IBM Watson	CO2

	Studio.	
7	Explore and Understand Data using IBM Watson Studio.	CO5
8	Data Preparation and Conversion using IBM Watson Studio.	CO2
9	To Study about different type of Visualization graph using DataRefinery Visualization features.	CO2
10	To Study About Different ML Algorithm/Estimator using scikit-learn.	CO2
11	Introduction to AutoAI .	CO2
12	Build Models using AutoAI and study about their different Hyperparameters.	CO6
13	Deploying AutoAI Model.	CO3
14	Do Fraud Analysis on Auto Insurance Datasets.	CO4

Projects to be covered: (atleast 4-5 projects). Please provide objectives of the project

- Recognition of Speech Emotion
- Gender and Age Detection with Data Science
- Driver Drowsiness Detection in Python
- Handwritten Digit & Character Recognition Project

Please Note: at least 25-30 experiments per lab. Experiment Title must be descriptive & complete

LIFE SKILLS FOR PROFESSIONALS-II

Department:	**Department of Computer Science and Engineering**		
Course Name: **Life Skills for Professionals - II**	**Course Code**	**L-T-P**	**Credits**
	AEC012	3-0-0	3
Type of Course:	AEC		
Pre-requisite(s), if any:			

Brief Syllabus:

This course is a multifaceted initiative designed to enhance and optimize learner's communication practices across various platforms. This program integrates a range of strategies, tools, and techniques to foster effective communication, facilitate collaboration, and promote a cohesive information flow within the learner's area. This course is structured and comprehensive initiative designed to develop and improve individuals' aptitude across various cognitive and behavioral domains. This course incorporates a range of assessments, training modules, and activities to enhance critical thinking, problem-solving, decision-making, and other essential aptitudes required for personal and professional success.

UNIT WISE DETAILS

Unit Number: 1	**Title: Personality Improvement**	**No. of hours: 4**

Content Summary: Asking for and giving information, Offering and responding to offers, Requesting and responding to requests, Congratulating people on their success, Asking questions and responding politely, Apologizing and forgiving

Unit Number: 2	**Title: Ratio & its application**	**No. of hours: 8**

Content Summary: Time & Work, Time & Distance, Train, Boat & Stream, Permutation & combination, Probability		
Unit Number: 3	**Title: Arithmetic**	**No. of hours: 8**
Content Summary: Inequalities, Log, progression, Mensuration, BODMAS		
Unit Number: 4	**Title: Presentation Skills**	**No. of hours: 8**
Content Summary: Presentation Skills, Telephone etiquettes, LinkedIn Profile and professional networking, Video resumes & Mock interview sessions.		
Unit Number: 5	**Title: Leadership skills**	**No. of hours: 4**
Content Summary: Nurturing future leaders, Increasing productivity of the workforce, Imparting Self-leadership, Executive leadership		

***Self-Learning Components**:

Please Note:

1) Students are supposed to learn the Interactive Learning Modules on the internet.

2) Webinars and Podcasts/ Self-Assessment Tools/Case Studies and Projects

3) At least 5-10 % syllabus will be asked in end term exams from self-learning components

Reference Books:

Aggarwal, R. S. (2014). Quantitative aptitude (Revised edition).
Gladwell, M. (2021). Talking to strangers.
Scott, S. (2004). Fierce conversations.

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** and apply the fundamental theories, models, and principles of communication.
CO2	**Apply** ability to communicate effectively through spoken and written forms. It includes developing skills in public speaking, interpersonal communication, professional writing, and persuasive communication.
CO3	**Evaluate** the development of teamwork and collaboration skills. It includes activities such as group projects, team-building exercises, and simulations that allow students to practice effective communication and collaboration within diverse teams
CO4	**Improve** their communication skills in different professional and personal contexts, such as interviews, networking events, customer interactions, and interpersonal relationships
CO5	**Analyze** ideas and information clearly and concisely through spoken language. They will develop the ability to articulate their thoughts, use appropriate vocabulary, and convey their message with clarity.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2		-
C02	C3		-
CO3	C5		
CO4			P5

CO5	C5		P5

***Please Note:**
Map only 1 or 2 Levels in each category. If a higher level is given, no need to mention lower level

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PEO1	PEO2	PEO3	PEO4	PSO1	PSO2	PSO3	PSO4
CO1											3									
CO2												3		3						
CO3						2														3
CO4								2							3					
CO5																			3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Relevance of the Syllabus to various indicators

Unit I	**Personality Improvement**
Local	Improve personality, enhance basic communication skills.
Regional	Recognize the importance of continuous learning and practice to maintain and further develop interpersonal ability.
National	Practice leadership strategies for solving problems within time constraints, as in competitive exams.
Global	Aligns with global trends in employment
Employability	Develop skills in real-life situations, such as academic exams, job interviews, and problem-solving scenarios.
Entrepreneurship	Learn to share ideas, listen to others, build consensus, and manage conflicts to achieve common goals in collaborative settings.
Skill Development	Develops Skills in public speaking, interpersonal communication, professional writing, and persuasive communication.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Ratio & its application**
Local	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Regional	Practice attentive listening techniques, such as paraphrasing and asking clarifying questions.
National	Attentively listen to others, understand their perspectives, and respond appropriately.
Global	Aligns with global trends in employment
Employability	Develop skills in participating and contributing to group discussions, meetings, or presentations.

Entrepreneurship	Learn to share ideas, listen to others, build consensus, and manage conflicts to achieve common goals in collaborative settings.
Skill Development	Apply skills in real-life situations, such as academic exams, job interviews, and problem-solving scenarios.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Arithmetic**
Local	Improve number sense, enhance basic arithmetic skills and strengthen mental math abilities and speed.
Regional	-
National	Learn about Inequalities, Log, progression, Mensuration, BODMAS
Global	Recognize the importance of continuous learning.
Employability	Develop skills in participating and contributing to group discussions, meetings, or presentations.
Entrepreneurship	-
Skill Development	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Presentation Skills**

Local	Attentively listen to others, understand their perspectives, and respond appropriately with timelines
Regional	-
National	Contributes to develop skill and improved productivity
Global	Aligns with global trends in understanding the deadlines.
Employability	Enhance the employability of individuals by developing essential skills and competencies sought by employers
Entrepreneurship	-
Skill Development	Strengthening critical thinking, problem-solving, memory, and other cognitive functions to improve overall mental agility and performance.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts employability

MINOR PROJECT-I

Department:	**Department of Computer Science and Engineering**		
Course Name: Minor Project-I	**Course Code**	**L-T-P**	**Credits**
	ENSI252	---	2
Type of Course:	Project		
Pre-requisite(s), if any: NA			

- Students expected to develop a basic project that demonstrates the application of learnings from studied subjects.
- Students are required to submit a hard copy of project file as per the template (Provided at the end of Handbook). File needs to be submitted in spiral bind.
- Project will be evaluated on the scale of 100 with following evaluation criteria.
  - Project idea & features (10)
  - Literature review (10)
  - Tools & Techniques employed (10)
  - Methodology (10)
  - Presentation of Results and its usefulness (20)
  - Implementation and its understandability (10)
  - Meetings & comments by guide (20)
  - Research paper (10)

File format for Minor project

1.	Abstract	Page No.
2.	Introduction (description of broad topic)	
3.	Motivation	
4.	Literature Review	
5.	Gap Analysis	
6.	Problem Statement	
7.	Objectives	

8.	Tools/platform used	
9.	Methodology	
10.	Experimental Setup	
11.	Evaluation Metrics	
12.	Results And Discussion	
13.	Conclusion & Future Work	
14.	References	
15.	Annexure I: Responsibility Chart	
16.	Annexure II: Screenshots of all the MS-Team Meetings with links (online)/ handwritten comments(offline) from guide	
17.	Annexure III Complete implementation code	
18.	Annexure IV Research Paper (Published/Submitted)	

Semester: 5

THEORY OF COMPUTATION

<table>
<tr><td>Department:</td><td colspan="4">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:
Theory of
Computation</td><td colspan="2">Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td colspan="2">ENCS301</td><td>3-1-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="4">Major</td></tr>
<tr><td colspan="5">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="5">Brief Syllabus:

This course provides a formal connection between algorithmic problem solving and the theory of languages and automata and develops them into a mathematical view towards algorithmic design and in general computation itself. The course should in addition clarify the practical view towards the applications of these ideas in the engineering part of computer science.</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Introduction to Finite automata</td><td colspan="2">No. of hours: 12</td></tr>
<tr><td colspan="5">Content Summary:

Finite automata: Review of Automata, its types and regular expressions, Equivalence of NFA, DFA and €-NFA, Conversion of automata and regular expression, Applications of Finite Automata to lexical analysis</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: PDA and Parser</td><td colspan="2">No. of hours: 10</td></tr>
<tr><td colspan="5">Content Summary:

PDA and Parser: Parse Trees, Ambiguity in grammars and languages, Push down automata, Context Free grammars, Top down and Bottom up parsing. Closure Properties of CFL.</td></tr>
<tr><td>Unit Number: 3</td><td colspan="2">Title: Chomsky hierarchy and Turing Machine</td><td colspan="2">No. of hours: 08</td></tr>
</table>

Content Summary: **Chomsky hierarchy and Turing Machine:** Chomsky hierarchy of languages and recognizers, Context Sensitive features like type checking, Turing Machine as language acceptors and its design.		
Unit Number: 4	**Title: Code generation and optimization**	**No. of hours: 10**
Content Summary: **Code generation and optimization:** Syntax directed translation, S-attributed and L-attributed grammars, Intermediate code generation, type conversions, and equivalence of type expression, Code generation and optimization.		
Text Books 1. J.E. Hopcroft, R. Motwani and J.D. Ullman, "Introduction to Automata Theory, Languages and Computations", second Edition, Pearson Education. **Reference Books/Materials** 1. H.R. Lewis and C.H. Papadimitriou, "Elements of the theory of Computation", Second Edition, Pearson Education. 2. Thomas A. Sudkamp," An Introduction to the Theory of Computer Science, Languages and Machines", Third Edition, Pearson Education. 3. Raymond Greenlaw an H.James Hoover, "Fundamentals of Theory of Computation, Principles and Practice", Morgan Kaufmann Publishers. 4. MichealSipser, "Introduction of the Theory and Computation", Thomson Brokecole. 5. J. Martin, "Introduction to Languages and the Theory of computation" Third Edition, Tata Mc Graw Hill.		

Define Course Outcomes (CO)

COs	**Statements**
CO1	To solve the problems related to regular expression, regular grammar, and Finite Automata
CO2	To write a formal notation for strings, languages and machines
CO3	To identify the phases of compilers for a programming language and construct the parsing table for a given syntax
CO4	To discover syntax directed translation rules for a given context free grammar by examining S-attributed and L-attributed grammars
CO5	To construct grammars and machines for a context free and context sensitive languages
CO6	To build the intermediate code by applying various code optimization strategies.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C3	A2	P3
CO2	C2	A1	P4
CO3	C4	A2	P3

CO4	C4	A4	P4
CO5	C5	A3	P2
CO6	C6	A5	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										1
CO2	2	2										1
CO3	2	3	3	3			3					1
CO4	3	3	3	3			3	3	3			1
CO5	1			2	3		1					1
CO6						3						1

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1
CO2	3	2	2	2
CO3	3	3	2	2
CO4	2	3	2	3
CO5	3	3	2	3

K.R. MANGALAM UNIVERSITY

Relevance of the Syllabus to various indicators

Unit I	**Introduction to formal proof**
Local	-
Regional	-
National	-
Global	In the global context, formal proof and finite automata have significant relevance as they are fundamental concepts in computer science and mathematics. The global technology industry heavily relies on formal proof techniques for developing secure software systems, cryptography, and algorithmic design.
Employability	-
Entrepreneurship	-
Skill Development	Studying formal proof and finite automata develops critical thinking, logical reasoning, and problem-solving skills. These skills are transferable and applicable to various domains beyond computer science, including mathematics, engineering, and natural sciences. They enhance overall skill development and promote a deeper understanding of computational processes and structures.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Regular Expression**
Local	-
Regional	-

National	-
Global	In the global context, regular expressions and automata have significant relevance as they are fundamental concepts in computer science and information processing.
Employability	-
Entrepreneurship	-
Skill Development	Studying regular expressions and automata develops critical thinking, problem-solving, and logical reasoning skills. These skills are transferable and applicable to various domains beyond computer science, including linguistics, mathematics, and data analysis.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Context-Free Grammar (CFG)**
Local	-
Regional	-
National	-
Global	In the global context, context-free grammars and automata play a significant role in programming language design, parsing algorithms, and language translation tools.
Employability	-
Entrepreneurship	-
Skill Development	Studying context-free grammars and automata develops critical thinking, problem-solving, and algorithmic design skills. These skills are transferable and applicable to various domains beyond computer science, such as

	linguistics, mathematics, and formal reasoning.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**A language that is not Recursively Enumerable (RE)**
Local	-
Regional	-
National	-
Global	The study of languages that are not recursively enumerable (RE) has global significance as it forms the basis of theoretical computer science. Researchers and academics worldwide collaborate to explore undecidable problems, develop new mathematical models, and advance the understanding of computability.
Employability	-
Entrepreneurship	-
Skill Development	Studying languages that are not recursively enumerable (RE) enhances critical thinking, problem-solving, and analytical skills. The exploration of undecidable problems requires creativity, logical reasoning, and the ability to work with complex mathematical concepts.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4, 9

NEP 2020	Context-free grammars and automata align with NEP 2020 in the following ways: Integration of Emerging Technologies, Multidisciplinary Approach and Skill Development.
POE/4th IR	Context-free grammars and automata contribute to the Fourth Industrial Revolution (IR 4.0) in the following ways: Advancements in Computing, Data Processing and Analysis, Technological Disruption and Interdisciplinary Collaboration.

OPERATING SYSTEMS

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:
OPERATING SYSTEM</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENCS303</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">MAJOR</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: Basics of programming</td></tr>
</table>

Brief Syllabus:

The Operating systems course is intended as a general introduction to the techniques used to implement operating systems and related kinds of systems software. The topics covered will be functions and structure of operating systems, process management (creation, synchronization, and communication); processor scheduling; deadlock prevention, avoidance, and recovery; main-memory management; virtual memory management (swapping, paging, segmentation and page-replacement algorithms); control of disks and other input/output devices; file-system structure and implementation; and protection and security.

UNIT WISE DETAILS

Unit Number: 1	Title: Introduction to Operating System and Process Scheduling	No. of hours: 8

Content Summary:

Introduction to Operating System: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Functions of an Operating System Structure of an OS-Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine.

The Abstraction: The Processes definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching.

Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads.

Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time.

Scheduling Algorithms: Pre-emptive and Non-preemptive, FCFS, SJF, RR.

Unit Number: 2	Title: Memory & File Management	No. of hours: 12

Content Summary:

Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging.

Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit– Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).

Unit Number: 3	Title: Process-Synchronization, Deadlocks & I/O Systems	No. of hours: 10

Content Summary:

Process-Synchronization & Deadlocks: Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Peterson's Solution, The Producer\ Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.

Deadlocks: Definition of Deadlocks, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery. Memory and I/O Management: Introduction Memory Allocation Techniques: Fragmentation, Segmentation.

I/O Systems: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers.

Unit Number: 4	Title: Distributed Operating Systems & Concurrent System	No. of hours: 10

Content Summary:

Distributed Operating Systems: Introduction, Issues, Communication Primitives, Distributed Deadlock Detection, Issues, Centralized Deadlock-Detection Algorithms Distributed Deadlock-Detection Algorithms. Agreement Protocols, Classification-Solutions, Applications. Distributed Resource Management: Distributed File systems, Architecture, Mechanisms, Design Issues, Distributed Shared Memory, Architecture, Algorithm, Protocols-Design Issues. Distributed Scheduling, Issues, Components, Algorithms.

Concurrent System: Failure Recovery and Fault Tolerance: Basic Concepts-Classification of Failures, Basic Approaches to Recovery; Recovery in Concurrent System; Synchronous and Asynchronous Check-pointing and Recovery; Check pointing in Distributed Database Systems; Fault Tolerance.

***Self-Learning Components**:

1. Case study on UNIX and WINDOWS Operating System.

2. Practice of System calls

3. Students can refer the following book as well:

Operating Systems: Three Easy Pieces by Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau

https://pages.cs.wisc.edu/~remzi/OSTEP/

4. Students can refer the following courses as per the Open-Source University Curriculum

- "Operating system courses" on Udemy.
- " Introduction to Operating Systems Specialization" Coursera.
- “Introduction to Operating Systems” by Udacity.

Reference Books:

1. MukeshSinghal and N. G. Shivaratri, “Advanced Concepts in Operating Systems”, McGrawHill, 2000
2. Abraham Silberschatz, Peter B. Galvin, G. Gagne, “Operating System Concepts”, Sixth Addison Wesley Publishing Co., 2003.
3. Andrew S. Tanenbaum, “Modern Operating Systems”, Second Edition, Addison Wesley, 2001.
4. Tannenbaum, “Operating Systems”, PHI, 4th Edition.
5. William Stallings, “Operating Systems Internals and Design Principles”, PHI

Define Course Outcomes (CO)

COs	**Statements**
CO1	Recall and explain the fundamental concepts and principles of operating systems.
CO2	Compare and contrast different types of operating systems, their architectures, and their services.
CO3	Apply knowledge of process management and scheduling algorithms to solve problems.
CO4	Evaluate the performance of scheduling algorithms and memory management techniques by analyzing system metrics, such as CPU utilization, throughput, turnaround time, waiting time, and response time.
CO5	Design and create programs to simulate file management, virtual memory, and distributed operating systems concepts.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A1	P4
CO2	C4	A3	P4
CO3	C3	A4	P2
CO4	C5	A4	P3

CO5	C6	A5	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	1	-	-	1
CO2	3	2	-	-	-	1	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	-	3	-	3	-	-	-	-	-	2	-	-
CO5	3	-	3	-	2	-	-	-	1	-	-	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	1
CO2	3	2	2	2
CO3	3	3	2	2
CO4	2	3	2	3
CO5	3	3	2	3

Relevance of the Syllabus to various indicators

Unit I	**Introduction to Operating System and Process Scheduling**
Local	Can help students to build a strong foundation in computer science.
Regional	

National	Widely used across industries and organizations
Global	Applicable in various global industries and organizations.
Employability	Covers essential concepts and skills related to operating systems.
Entrepreneurship	Understanding of operating systems can be beneficial for entrepreneurs in the technology industry.
Skill Development	Students will develop skills in understanding operating system concepts, system calls, and kernel functionalities
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Memory & File Management**
Local	-
Regional	To meet the demand for skilled professionals in the region.
National	It provides fundamental knowledge about processes, threads, and process scheduling, which are essential for the functioning of computer systems in various national industries and organizations.
Global	Relevant globally as processes, threads, and process scheduling are fundamental concepts in operating systems used worldwide.
Employability	It covers essential concepts and skills related to processes, threads, and process scheduling in operating systems.
Entrepreneurship	-

Skill Development	Provides foundational knowledge and skills related to processes, threads, and process scheduling.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Process-Synchronization, Deadlocks & I/O Systems**
Local	-
Regional	-
National	It is important for national educational institutions to offer this course to produce skilled graduates who can contribute to the national workforce.
Global	Fundamental concepts are applicable in various global industries and organizations.
Employability	Concepts are crucial for various roles in software development
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Distributed Operating Systems & Concurrent System**
Local	-

Regional	-
National	Can contribute to the national workforce and address the challenges of concurrent programming.
Global	It can be applied globally in various industries and organizations that deal with concurrent programming and need professionals who understand these concepts.
Employability	Graduates with knowledge of these concepts are highly sought after by companies that develop concurrent software applications.
Entrepreneurship	Can be beneficial for entrepreneurs in the technology industry, especially those involved in developing software systems that require efficient concurrent processing.
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4, 8, 9, 11
NEP 2020	OS supports collaborative learning environments, which are encouraged under NEP 2020 to promote interactive and engaging teaching practices.
POE/4th IR	OS contributes to the development of smart systems, autonomous devices, and intelligent algorithms that are central to the 4IR and POE.

OPERATING SYSTEM LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: OPERATING SYSTEM LAB	**Course Code**	**L-T-P**	**Credits**
	ENCS351	0-0-2	1
Type of Course:	MAJOR		
Pre-requisite(s), if any: Basics of programming			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Recall** the concepts and principles of CPU scheduling algorithms used in operating systems.
CO 2	**Compare** and contrast different CPU scheduling algorithms and their advantages and disadvantages.
CO 3	**Implement** CPU scheduling algorithms, such as Round Robin and Priority, using Python programming.
CO 4	**Evaluate** the performance of CPU scheduling algorithms by analyzing and interpreting the generated Gantt charts and calculating average waiting time and turnaround time.
CO 5	**Design** Python programs to simulate various file allocation strategies and memory management techniques, such as sequential, indexed, linked, and paging.

Ex No	Experiment Title	Mapped CO/COs
1	Write Python programs to simulate the following CPU Scheduling algorithm: First-Come, First-Served (FCFS)	CO1
2	Write Python programs to simulate the following	CO1

	CPU Scheduling algorithm: Shortest Job First (SJF)	
3	Write Python programs to simulate the following CPU Scheduling algorithms: Round Robin	CO1
4	Write Python programs to simulate the following CPU Scheduling algorithms: Priority	CO1
5	Given the list of processes, their CPU burst times, and arrival times, write a Python program to display/print the Gantt chart for Priority and Round Robin scheduling algorithms. Compute and print the average waiting time and average turnaround time for each scheduling policy.	CO4
6	Write a Python program to simulate the following file allocation strategies like Sequential	CO5
7	Write a Python program to simulate the following file allocation strategies like Indexed	CO5
8	Write a Python program to simulate the following file allocation strategies like linked.	CO5
9	Write Python programs to simulate the following contiguous memory allocation techniques: a) Worst-fit b) Best-fit c) First-fit	CO5
10	Write programs using the I/O system calls of UNIX/Linux operating system (open, read, write, close, fcntl, seek, stat, opendir, readdir).	CO1
11	Write program to simulate the MVT (Multiple Variable Tasks) memory management technique.	CO5
12	Write program to simulate the MFT (Multiple Fixed Tasks) memory management technique.	CO5
13	Write program to simulate the Banker's Algorithm for Deadlock Avoidance and Prevention.	CO5
14	Write program to implement the Producer-Consumer problem using semaphores using UNIX/Linux system calls.	CO3
15	Write programs to illustrate the following IPC (Inter-Process Communication) mechanisms: a) Pipes	CO3

16	Write programs to illustrate the following IPC (Inter-Process Communication) mechanisms: a) FIFOs (Named Pipes)	CO3
17	Program to implement process synchronization using semaphores in Python.	CO4
18	Program to implement a basic File allocation strategy like sequential file allocation in Python.	CO5
19	Program to demonstrate the use of signals in Python for process management.	CO1
20	Program to create and manipulate threads in Python.	CO3
21	Program to implement memory management techniques (e.g., paging, segmentation) in Python.	CO5
22	Program to simulate file system operations (e.g., open, read, write, close) in Python.	CO1
23	Program to implement process synchronization using mutex locks in Python.	CO4
24	Program to simulate the working of virtual memory in Python.	CO5
25	Program to simulate disk file management operations (e.g., allocation, deallocation) in Python.	CO5
26	Program to implement file locking mechanisms (e.g., advisory, mandatory) in Python.	CO5
27	Write a Python program to simulate the following file organization techniques Two level directories	CO5
28	Write Python programs to simulate the paging in memory management techniques	CO5
29	Write Python programs to simulate the segmentation in memory management techniques	CO5
30	Write a Python program to simulate the following file organization technique: Single level directory	CO5

MACHINE LEARNING WITH PYTHON

<table>
<tr><td>Department:</td><td colspan="4">Department of Computer Science and Engineering</td></tr>
<tr><td colspan="2" rowspan="2">Course Name:
Machine Learning with Python</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP311</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="4">Minor</td></tr>
<tr><td colspan="5">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="5">Frequency of offering (check one): Odd</td></tr>
<tr><td colspan="5">Brief Syllabus:
Machine learning with python – Machine learning concepts – Supervised and Unsupervised Learning, Different Algorithms like KNN, K-Mean, Random Forests, Decision Trees, Logistic and Linear Regression, etc, Basics of Neural Networks, Working with Images and Audios in ML, Libraries like sklearn, matplotlib, pandas, etc. Techniques like Standardization, Encoding, Normalization, etc.</td></tr>
<tr><td colspan="5">Total lecture, Tutorial and Practical Hours for this course:</td></tr>
<tr><td colspan="2" rowspan="2">Lectures: 40</td><td colspan="3">Practice</td></tr>
<tr><td>Tutorials:</td><td colspan="2">Lab Work:</td></tr>
<tr><td colspan="5">11. Course Outcomes (COs)
Possible usefulness of this course after its completion i.e. how this course will be practically useful to him once it is completed.</td></tr>
<tr><td>COs</td><td colspan="4"></td></tr>
<tr><td>CO 1</td><td colspan="4">To introduce students to the basic concepts and techniques of Machine Learning.</td></tr>
<tr><td>CO 2</td><td colspan="4">To develop skills of using recent machine learning software for solving practical problems.</td></tr>
<tr><td>CO 3</td><td colspan="4">To gain experience of doing independent study and research.</td></tr>
<tr><td>CO 4</td><td colspan="4">Ability to identify the characteristics of datasets and compare the trivial data and big data for</td></tr>
</table>

	various applications.

12. UNIT WISE DETAILS

Unit Number: 1	**Title: INTRODUCTION TO AI - ML**	**No. of hours: 8**

Content Summary:
Defining Artificial Intelligence and Machine learning, Artificial Intelligence Use cases, Tools used in AI : Python , Jupyter Notebook, Anaconda, SKLearn, R language, Computer Vision, Natural Language Processing, Data Visualization and its importance in understanding data.

Unit Number: 2	**Title: INTRODUCTION TO MACHINE LEARNING**	**No. of hours: 8**

Content Summary:

Application of Machine Learning, Supervised vs Unsupervised Learning, Python libraries suitable for Machine Learning : sklearn, pytorch, tensorflow

Unit Number: 3	**Title: DATA PRE-PROCESSING AND DATA**	**No. of hours: 8**

Content Summary:

Identifying and handling the missing values, dealing with duplicates, Encoding the categorical data, Normalization, Standardization, PCA

Unit Number: 4	**Title: SUPERVISED LEARNING : REGRESSION AND CLASSIFICATION**	**No. of hours: 8**

Content Summary:

Linear Regression,Non-Linear Regression, Model evaluation methods, K-Nearest Neighbour, Decision Tree, Logistic Regression, Support Vector Machines, Model Evaluation

Unit Number: 5	**Title: UNSUPERVISED LEARNING**	**No. of hours: 8**

Content Summary: K-means Clustering, Hierarchical Clustering, Density-Based Clustering
Self-Learning Components **Numpy, Seaborn**
Reference Books: **1. Machine Learning - Tom M. Mitchell** **2. Python Machine Learning – Sebastian, Raschka and Vahid Mirjalili** **3. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Technique to Build Intelligent Systems - AurélienGéron** **4. Understanding Machine Learning - Shai Shalev-Shwartz and Shai Ben-David La**

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2	2	3	3	2	2	3	2	1	1
CO2	2	1	1	2	3	2	2	3	2	2	2	3
CO3	2	1	2	1	1	2	1	3	1	1	2	1
CO4	2	2	3	3	2	2	2	2	3	3	3	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PO1	PO2	PO3	PSO4
CO1	2	2	3	2
CO2	1	2	1	2
CO3	2	2	3	3
CO4	2	1	3	2

K.R. MANGALAM UNIVERSITY

Relevance of the Syllabus to various indicators

Unit I	**INTRODUCTION TO AI - ML**
Local	
Regional	
National	Government and Policy Development: AI/ML supports evidence-based policymaking by providing tools for analyzing government data, conducting surveys, and evaluating policy interventions. It assists in monitoring and evaluating public programs, assessing their impact, and identifying areas for improvement. R's open-source nature allows governments to leverage existing resources, reducing costs associated with proprietary software.
Global	-
Employability	Lead to positions such as data visualization specialist, data scientist, business intelligence analyst, or data engineer
Entrepreneurship	-
Skill Development	Helps data scientists perform complex data analysis, recognizing patterns, and understanding datasets
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**INTRODUCTION TO MACHINE LEARNING**

Local	
Regional	-
National	Research and Development: ML is widely used in academic research, contributing to advancements in various fields such as social sciences, economics, healthcare, and environmental studies. Its flexibility and extensive statistical capabilities make it an invaluable tool for researchers and scientists to analyze complex data and generate reliable research outcomes
Global	
Employability	Lead to positions such as data visualization specialist, data scientist, business intelligence analyst, or data engineer
Entrepreneurship	-
Skill Development	
Professional Ethics	Collaboration and Knowledge Sharing:-The R community is vibrant and globally connected. By embracing R, nations can tap into this collaborative ecosystem, enabling researchers, analysts, and policymakers to share knowledge, exchange best practices, and collaborate on solving complex problems.
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**DATA PRE-PROCESSING AND DATA**
Local	

Regional	-
National	Research and Development: ML is widely used in academic research, contributing to advancements in various fields such as social sciences, economics, healthcare, and environmental studies. Its flexibility and extensive statistical capabilities make it an invaluable tool for researchers and scientists to analyze complex data and generate reliable research outcomes
Global	Cost Savings: AI is an open-source programming language, which means it is freely available to use. This can result in cost savings for government entities, educational institutions, and businesses that rely on data analysis. The availability of numerous R packages and libraries further enhances the cost-effectiveness of data analysis tasks
Employability	ML programming skills are in high demand in the job market, particularly in fields such as data science, analytics, and research. By promoting the use of R, nations can foster the development of a skilled workforce capable of performing data analysis tasks, thereby driving economic growth and attracting investment in data-driven industries.
Entrepreneurship	-
Skill Development	Develops knowledge and skills in client-server programming and network security
Professional Ethics	-
Gender	-
Human Values	-
Environment &	-Helps students to work on social issues

Sustainability	
Unit IV	**SUPERVISED LEARNING : REGRESSION AND CLASSIFICATION**
Local	
Regional	Infrastructure Planning and Optimization: R can be utilized in infrastructure planning and optimization tasks. It can help analyze large datasets related to transportation, energy, and urban planning to identify patterns, make predictions, and optimize resource allocation, leading to more efficient and sustainable infrastructure development
National	
Global	
Employability	RE is extensively used in economic research and business analytics. Its statistical modeling and machine learning capabilities enable economists and analysts to study economic indicators, forecast market trends, and optimize business strategies. R's visualization capabilities also aid in presenting complex economic data in a clear and meaningful manner, facilitating evidence-based decision-making.
Entrepreneurship	-
Skill Development	RE programming skills are in high demand in the job market, particularly in fields such as data science, analytics, and research. By promoting the use of R, nations can foster the development of a skilled workforce capable of performing data analysis tasks, thereby driving economic growth and attracting investment in data-driven industries.
Professional Ethics	-

Gender	-
Human Values	-
Environment & Sustainability	-Public Health and Epidemiology: R plays a vital role in public health and epidemiological studies. It is extensively used for analyzing health-related data, tracking disease outbreaks, modeling infectious diseases, and conducting statistical studies to inform public health policies and interventions.
Unit V	**UNSUPERVISED LEARNING**
Local	Addresses local understanding and implementation of internet-based services
Regional	-
National	Contributes to national digital communication strategies and multimedia applications
Global	Aligns with global trends in internet telephony, multimedia applications, and SEO
Employability	Develops skills in internet telephony, multimedia applications, and SEO
Entrepreneurship	-
Skill Development	Develops knowledge and skills in internet telephony, multimedia applications, and SEO
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-

SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO

MACHINE LEARNING WITH PYTHON LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Machine Learning with Python Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP361	0-0-2	1
Type of Course:	Minor		
Pre-requisite(s), if any: Basics of programming			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	Popular algorithms: Regression, Classification, and Clustering
CO 2	Learn Latest ML Techniques and algorithms to encourage self-learning
CO 3	Implement ML on music, images, etc.
CO 4	Paradigms of supervised and unsupervised learning

Ex. No	Experiment Title	Mapped CO/COs
1	Data pre-processing using pandas	CO1
2	Data Visualization using matplotlib and sklearn	CO2
3	Data pre-processing using sklearn	CO1
4	Implement Decision tree classifier on churn data	CO4

5	Saving and loading a model	CO3
6	Implementing Linear regression	CO4
7	Implement Logistic regression algorithm	CO3
8	Build a simple ANN using tensorflow	CO1
9	Build a simple CNN using tensorflow	CO1
10	MNIST Digit Classification	CO4
11	Implement KNN algorithm on a real dataset	CO2
12	Implement SVM algorithm for classification	CO2
13	Take all previously built models and evaluate them.	CO1
14	Implementing Random Forest algorithm for classification of churn customer data	CO1
15	K-Means: clustering of Real dataset	CO1
16	Basics of Image Processing using CV2 python library	CO3
17	Fruit images classification using CNN	CO2
18	Implement SVM algorithm for regression	CO3
19	Creating a simple chat bot	CO2
20	Machine Learning Model deployment	CO3
21	Sentiment Analysis on Twitter Data	CO2
22	Stock Market Prediction	CO1
23	Bitcoin value Prediction	CO1
24	Weather Prediction	CO4
25	Cats vs Dogs image classifier	CO3

Projects to be covered: (atleast 4-5 projects). Please provide objectives of the project

- Music Genre classification
- Build a virtual assistant
- YOLO Object Detection
- Face recognition Model
- Stock market value Prediction
- Food classification

LIFE SKILLS FOR PROFESSIONALS-III

<table>
<tr><td rowspan="1">Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Life Skills for Professionals -III</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>AEC013</td><td>3-0-0</td><td>3</td></tr>
<tr><td>Type of Course:</td><td colspan="3">AEC</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="4">Brief Syllabus:

This Course designed to enhance the employability of individuals by developing essential skills and competencies sought by employers. This program equips participants with a wide range of skills necessary for success in the modern job market. To engage in interactive workshops, practical exercises, role-playing, and real-world simulations to reinforce their learning. The course is designed to be inclusive and caters to individuals from diverse backgrounds and career aspirations. The course is designed to enhance and develop various cognitive skills and mental abilities. This course focuses on strengthening critical thinking, problem-solving, memory, and other cognitive functions to improve overall mental agility and performance.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
</table>

Unit Number: 1	**Title: Data interpretation**	**No. of hours: 4**
Content Summary: Table chart, Line graph, Bar graph, Pie chart		
Unit Number: 2	**Title: Logical Reasoning**	**No. of hours: 8**
Content Summary: Coding & Decoding, Sitting arrangement, Calendar, Clock, Direction Sense, Blood relation, Syllogism.		
Unit Number: 3	**Title: Logical & Non-verbal reasoning**	**No. of hours: 8**

Content Summary: Series, Puzzle Text, Statement & Arguments, Cube & Dice, Non-verbal Reasoning		
Unit Number: 4	**Title: Understanding Stress**	**No. of hours: 8**
Content Summary: Introduction to Stress (i) Introduction to stress: Meaning, Definition, Eustress, Distress, (ii) Types of stress: Acute stress, Episodic Acute stress and chronic stress, signs and Symptoms Sources of stress (i) Psychological, Social, Environmental (ii) Academic, Family and Work stress Impact of stress		
Unit Number: 5	**Title: Employability skills**	**No. of hours: 4**
Content Summary: Identifying job openings, Enhancing interpersonal skills, including teamwork, Applying for a job, Preparing Cover letters, preparing a CV/Resume and Effective Profiling, Group Discussions, Preparing for and Facing a Job Interview, Mock Interview, Feed Back – Improvement		
***Self-Learning Components**:		
Reference Books: Aggarwal, R. S. (2014). Quantitative aptitude (Revised edition). Gladwell, M. (2021). Talking to strangers. Scott, S. (2004). Fierce conversations.		

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** their critical thinking skills and become adept at analyzing and evaluating information, identifying problems, generating innovative solutions, and making informed decisions.
CO2	**Apply** digital literacy skills necessary for the modern workplace and become proficient in using online platforms relevant to their field.

CO3	**Evaluate** Contribute positively, respect different perspectives, resolve conflicts, and achieve shared goals.
CO4	**Improve** and develop skills related to career planning, job search strategies, and personal branding
CO5	**Create** leadership skills and to motivate and inspire others, manage projects effectively, and demonstrate a proactive and responsible approach to their spoken language.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2		
C02	C3		
CO3	C5		
CO4			P5
CO5	C6		

CO-PO & PSO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO 1	3	3										3	3	1		
CO 2	3	2		1	1							3	3			
CO 3	2	3					1					3	2	2		
CO 4	2	2	1	1						3		3	3			2
CO 5			1	3	3							3	3	2	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Relevance of the Syllabus to various indicators

Unit I	Data interpretation
Local	Improve personality, enhance basic mental ability skills.
Regional	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
National	Practice leadership strategies for solving problems within time constraints, as in competitive exams.
Global	Aligns with global trends in employment
Employability	Develop skills in real-life situations, such as academic exams, job interviews, and problem-solving scenarios.
Entrepreneurship	Learn to share ideas, listen to others, build consensus, and manage conflicts to achieve common goals in collaborative settings.
Skill Development	Develops Skills in public speaking, interpersonal communication, professional writing, and persuasive communication.
Professional Ethics	-

Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Logical Reasoning
Local	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Regional	Practice attentive listening techniques, such as paraphrasing and asking clarifying questions.
National	Attentively listen to others, understand their perspectives, and respond appropriately.
Global	Aligns with global trends in employment
Employability	Develop skills in participating and contributing to group discussions, meetings, or presentations.
Entrepreneurship	Learn to share ideas, listen to others, build consensus, and manage conflicts to achieve common goals in collaborative settings.
Skill Development	Apply skills in real-life situations, such as academic exams, job interviews, and problem-solving scenarios.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Logical & Non-verbal reasoning
Local	Improve number sense, enhance basic arithmetic skills and strengthen mental math abilities and speed.
Regional	-
National	Learn about Series, Puzzle Text, Statement & Arguments, Cube & Dice, Non-verbal Reasoning
Global	Recognize the importance of continuous learning.

Employability	Develop skills in participating and contributing to group discussions, meetings, or presentations.
Entrepreneurship	-
Skill Development	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Understanding Stress
Local	Attentively listen to others, understand their perspectives, and respond appropriately
Regional	-
National	Contributes to develop skill and improved productivity
Global	Aligns with global trends in encouraged to establish professional connections and learn effective techniques for engaging in informational interviews or networking events
Employability	Enhance the employability of individuals by developing essential skills and competencies sought by employers
Entrepreneurship	-
Skill Development	Strengthening critical thinking, problem-solving, memory, and other cognitive functions to improve overall mental agility and performance.
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit V	Employability skills
Local	Attentively listen to others, understand their perspectives, and respond appropriately with timelines
Regional	-
National	Contributes to develop skill and improved productivity
Global	Aligns with global trends in understanding importance of networking during the job search process
Employability	Enhance the employability of individuals by developing essential skills and competencies sought by employers
Entrepreneurship	-
Skill Development	Strengthening critical thinking, problem-solving, memory, and other cognitive functions to improve overall mental agility and performance.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts employability

Summer Internship / Project-II

Department:	**Department of Computer Science and Engineering**		
Course Name: Summer Internship / Project-II	**Course Code**	**L-T-P**	**Credits**
	ENSI351	0-0-0	2
Type of Course:	INT		
Pre-requisite(s), if any: NA			

The duration of the internship will be two weeks. It will be after completion of 2nd Semester and before the commencement of Semester III.

The following options can be opted by the students:

1. Offline internship in industry - Student is supposed to produce a joining letter and relieving letter once the internship is over in case of Offline internship in any industry.

2. Online internships – with organizations /institutions those are approved /supported / recommended by the All-India Council of Technical Education for Internship (like SWAYAM, NPTEL, Internshala etc.).

Report Submission and Evaluation Guidelines:

• Student must prepare a detailed report and submit the report. A copy of the report can be kept in the departments for record.

• Each student must be assigned a faculty as a mentor from the university and an Industry Expert as External Guide or Industry Mentor.

• The presentation by student for Internship/ project should in the presence of all students is desirable.

• Student should produce successful completion certificate in case of summer internship in industry.

Course Outcomes:

At the end of the course, students will be able to:

1. Get exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Get possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job(s).
3. Gain experience in writing technical reports / projects and presentation of it.
4. Learn and gain exposure to the engineer's responsibilities and ethics.
5. Understand the social, economic, and administrative considerations that influence the working environment of industrial organizations.

SOFTWARE ENGINEERING

Department:	**Department of Computer Science and Engineering**		
Course Name: **Software Engineering**	**Course Code**	**L-T-P**	**Credits**
	ENCS305	4-0-0	4
Type of Course:	Major		
Pre-requisite(s), if any:			

Brief Syllabus:

Importance of Software Engineering, Software Development Lifecycle and its models, Agile vs. Plan Based development, Development of Software Documents, Version Control system using GitHub and Eclipse IDE, Requirements Engineering technique, Development of UML Diagrams, Software Architecture and Design patterns, Software Testing- Black Box and White Box, Developing Test cases using Equivalence and Boundary value partitioning techniques, Test Driven Development with Junit in Eclipse, Software Refactoring.

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to Software Engineering**	**No. of hours: 6**

Content Summary:

Importance of Software Engineering, Discipline of Software Engineering; Eclipse Introduction, Overview, and Demo; Lifecycle models: Requirements Engineering, Design and Implementation, Maintenance, Software Process Model Introduction, Waterfall Process, Spiral Process, Evolutionary Prototyping Process, Agile Process, Choosing a Model, Lifecycle Documents.

Unit Number: 2	**Title: Engineering Requirements**	**No. of hours: 8**

Content Summary:

Requirements Engineering: General RE Definition, Functional and Non-functional Requirements, User and System Requirements, Modelling Requirements, Analyzing Requirements, Requirements Prioritization, Requirements Engineering Process and steps; Creating SRS and performing requirements inspections. Engineering standards in building, testing, operation and maintenance of the computer and software systems. Requirements analysis using DFD, ER Diagrams, Requirement documentation, Nature of SRS, Characteristics & organization of SRS.

Unit Number: 3	Title: Software Metrics and UML	No. of hours: 14

Content Summary:

Software Metrics: Size Metrics like LOC, Token Count, Function Count, Design Metrics, Data Structure Metrics, Information Flow Metrics. Cost Estimation Models: COCOMO, COCOMO-II.

Object Orientation Introduction, UML Structural Diagrams: Class Diagrams, Component Diagram, UML Structural Diagram: Deployment Diagram. UML creation tips; UML Behavioural Diagram: Use Case, Use Case Diagram: Creation Tips, UML Behavioural Diagrams: Sequence, UML Behavioural Diagrams: State Transition Diagram. UML creation tips; Software Architecture: What is Software Architecture? Advantages and use of architectural models. Architectural patterns. Designing architectural patterns. Design Patterns: Patterns Catalogue, Pattern Format, Factory Method Pattern, Strategy Pattern, Choosing a Pattern, Negative Design Patterns.

Unit Number: 4	Title: Software Testing and Maintenance	No. of hours: 12

Content Summary:

Testing: Black Box Testing Failure, Fault and Error, Verification Approaches, Pros and Cons of Approaches, Testing Introduction, Testing Granularity Levels, Alpha and Beta Testing, Black-Box Testing, Systematic Functional Testing Approach; Test Data Selection, Equivalence Partitioning and Boundary Value Analysis, Create and Evaluate Test Case Specifications, Generate Test Cases from Test Case Specifications. White-Box Testing: Coverage Criteria Intro, Statement Coverage, Control Flow Graphs, Test Criteria, MC/DC Coverage.

Software Maintenance: Management of Maintenance, Maintenance Process,

Maintenance Models, Regression Testing, Reverse Engineering, Software Re-engineering.
Reference Books: a) R. Pressman, Software Engineering A Practitioner's Approach (8 ed.), McGraw Hill International, 2019. ISBN 978-1259253157. b) Sommerville, Software Engineering (10 ed.), Person Publications Publishing Company, 2017. ISBN 978-9332582699. c) K. K. Aggarwal & Yogesh Singh, "Software Engineering", New Age International. d) W.S. Jawadekar, "Software Engineering – Principles and Practices", McGraw Hill.

Define Course Outcomes (CO)

COs	Statements
CO1	Demonstrate understanding of Software Engineering as an iterative and systematic process.
CO2	Recall the lifecycle models of software engineering.
CO3	Design the software development process to complement technical understanding of software products.
CO4	Analyze requirements using modeling techniques such as DFD and ER diagrams.
CO5	Generate test case specifications and test cases from given requirements.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A3	P4
CO2	C1	A1	P1
CO3	C6	A4	P5
CO4	C4	A4	P2
CO5	C3	A2	P3

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	2	-	-	2	-	2	-	-	-	2
CO2	3	2	3	-	2	-	-	-	-	-	-	2
CO3	3	-	3	-	2	-	-	-	2	-	2	-
CO4	3	3	2	2	2	-	-	-	-	-	-	-
CO5	2	2	2	-	3	-	-	-	-	2	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2
CO2	2	2	2	2
CO3	3	3	2	2
CO4	2	3	2	2
CO5	2	3	2	2

Relevance of the Syllabus to various indicators

Unit I	Introduction to Software Engineering
Local	Can help students understand the local software industry and its specific challenges.
Regional	Can provide insights into the regional software development practices and challenges.
National	Address the broader context of software engineering within a country, including its impact on the economy and society
Global	Explore the global nature of software development and its impact on various industries and sectors worldwide.
Employability	Provide students with a foundational understanding of software engineering concepts and practices, which are valuable skills in the job market.
Entrepreneurship	Provide insights into the software industry, its challenges, and potential opportunities for innovation and business ventures.
Skill Development	Introduce fundamental concepts and techniques used in software engineering.
Professional Ethics	Consideration of ethical issues in software development, such as privacy, security, and responsible use of technology.
Gender	-
Human Values	Impact of software on individuals, societies, and ethical considerations related to human well-being.
Environment & Sustainability	-

Unit II	**Engineering Requirements**
Local	Help in assessing the complexity and quality of software developed within the local context.
Regional	Provide insights into the software development practices and trends within a specific region.
National	contribute to evaluating software quality and productivity within a country's software industry.
Global	Provide standardized measures for assessing software complexity and quality, regardless of the geographical location.
Employability	Commonly used in software development organizations to measure productivity, quality, and project estimation.
Entrepreneurship	Evaluating the feasibility, cost estimation, and risks associated with software development projects.
Skill Development	By enhancing the ability to measure, analyze, and improve software quality and productivity.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Software Metrics and UML**
Local	Standardized techniques can be employed by local software development teams.
Regional	Provide a common language and methodology for software development, facilitating collaboration and communication among regional software development teams.
National	Provide a standardized framework for software

	development, promoting consistency and interoperability among national software projects.
Global	Widely adopted internationally, allowing for effective communication and collaboration among software development teams across different countries.
Employability	Commonly used in industry, and proficiency in these techniques is valued by employers.
Entrepreneurship	Aiding entrepreneurs in planning, designing, and communicating their software ideas.
Skill Development	Enhancing students' proficiency in software modeling and design.
Professional Ethics	Address the importance of developing reliable software and adhering to quality standards in the software engineering profession.
Gender	-
Human Values	-
Environment & Sustainability	Development of reliable software that reduces wastage, energy consumption, and potential negative environmental impacts.
Unit IV	**Software Testing and Maintenance**
Local	Provide practical knowledge and techniques for testing software developed within the local context.
Regional	Address common testing challenges and practices in software development within the region.
National	Provide essential knowledge and skills required for testing software developed within the country.
Global	Testing is an integral part of software development across different countries and industries worldwide.
Employability	As software testing skills are in high demand by employers seeking quality assurance in software development projects.

Entrepreneurship	Provide knowledge and techniques for ensuring the quality and reliability of software products developed by entrepreneurs.
Skill Development	Introduce essential concepts, methodologies, and tools used in software testing.
Professional Ethics	Addressing ethical considerations in software testing, such as ensuring impartiality, confidentiality, and integrity in the testing process.
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4,8,9
NEP 2020	-
POE/4th IR	Emphasizes the responsible and ethical development and deployment of the systems.

Semester: 6

COMPUTER ORGANIZATION & ARCHITECTURE

Department:	**Department of Computer Science and Engineering**			
Course Name: **Computer Organization & Architecture**	**Course Code**	**L-T-P**	**Credits**	
	ENCS302	3-1-0	4	
Type of Course:	Major			
Pre-requisite(s), if any: Concepts of Digital Electronics				

Brief Syllabus: Computer Organization & Architecture (COA) covers topics in computer architecture and organization focusing on multicore, graphics-processor unit (GPU), and heterogeneous SOC multiprocessor architectures and their implementation issues (architect's perspective). The objective of the course is to provide in-depth coverage of current and emerging trends in computer organization and architecture focusing on performance and the hardware/software interface. The course emphasis is on analysing fundamental issues in architecture design and their impact on application performance.		
UNIT WISE DETAILS		
Unit Number: 1	**Title: Introduction**	**No. of hours: 10**
Content Summary: Role of abstraction, basic functional units of a computer, Von-Neumann model of computation, A note on Moore's law, Notion of IPC, and performance. Data representation and basic operations.		
Unit	**Title: Instruction Set**	**No. of hours: 10**

Number: 2	Architecture (RISC-V)	

Content Summary:

CPU registers, instruction format and encoding, addressing modes, instruction set, instruction types, instruction decoding and execution, basic instruction cycle, Reduced Instruction Set Computer (RISC), Complex Instruction Set Computer (CISC), RISC-V instructions; X86 Instruction set.

Unit Number: 3	Title: The Processor	No. of hours: 10

Content Summary:

Revisiting clocking methodology, Amdahl's law, Building a data path and control, single cycle processor, multi-cycle processor, instruction pipelining, Notion of ILP, data and control hazards and their mitigations.

Unit Number: 4	Title: Memory hierarchy, Storage and I/O	No. of hours: 10

Content Summary:

SRAM/DRAM, locality of reference, Caching: different indexing mechanisms, Trade-offs related to block size, associativity, and cache size, Processor-cache interactions for a read/write request, basic optimizations like writethrough/write-back caches, Average memory access time, Cache replacement policies (LRU), Memory interleaving.

Introduction to magnetic disks (notion of tracks, sectors), flash memory. I/O mapped, and memory mapped I/O. I/O data transfer techniques: programmed I/O, Interrupt-driven I/O, and DMA.

***Self-Learning Components**:

1. BSim Documentation

References:

1. https://www.nand2tetris.org/
2. https://www.coursera.org/learn/computer-organization-design
3. https://www.geeksforgeeks.org/computer-organization-and-architecture-tutorials/
4. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-823-computer-system-architecture-fall-2005/

Please Note:

At least 5-10 % syllabus will be asked in end term exams from self-learning components

Textbook:

1. "Computer Organization and Design: The Hardware/Software Interface", David A. Patterson and John L. Hennessy, 5th Edition, Elsevier.

Reference Books:

1. "Computer Organization & Architecture", Smruti Ranjan Sarangi, McGraw Hill
2. "Computer System Architecture", Mano M. Morris, Pearson.
3. "Computer Organization and Embedded Systems", 6th Edition by Carl Hamacher, McGraHill Higher Education
4. "Computer Architecture and Organization", 3rd Edition by John P. Hayes, WCB/McGraw-Hill
5. "Computer Organization and Architecture: Designing for Performance", 10th Edition by William Stallings, Pearson Education.

Online References:

1. https://learning.edx.org/course/course-v1:MITx+6.004.2x+3T2015/block-v1:MITx+6.004.2x+3T2015+type@sequential+block@c3s1/block-v1:MITx+6.004.2x+3T2015+type@vertical+block@c3s1v1
2. RIPES: https://freesoft.dev/program/108505982
3. GEM5: https://www.gem5.org/documentation/learning_gem5/introduction/
4. CACTI: https://github.com/HewlettPackard/cacti
5. PIN: https://www.intel.com/content/www/us/en/developer/articles/tool/pin-a-binary-instrumentation-tooldownloads.html
6. TEJAS: https://www.cse.iitd.ac.in/~srsarangi/archbooksoft.html
7. XILINX(VHDL/Verilog tools): https://www.xilinx.com/support/university/students.html

Course Outcomes (CO)

COs	Statements
CO1	Understand the basics of instructions sets and their impact on processor design
CO2	Demonstrate an understanding of the design of the functional units of a digital computer system

CO3	Evaluate cost performance and design trade-offs in designing and constructing a computer processor including memory.
CO4	Design a pipeline for consistent execution of instructions with minimum hazards
CO5	Manipulate representations of numbers stored in digital computers using I/O devices and store them into memory

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels(C) 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A1	P1
C02	C3	A4	P1
CO3	C5	A2	P2
CO4	C6	A1	P4
CO5	C4	A2	P3

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	-	-	-	-	-	-	-	-	-
CO3	-	-	-	3		-	-	-	-	-	-	3
CO4	-	-	3	-	-		-	-	-	-	-	-
CO5	2	-	-	-	-	-	-	-	-	-	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	2			3
CO2	2	2		2
CO3		2		
CO4				3
CO5		2		2

Relevance of the Syllabus to various indicators

Unit I	**Introduction**
Local	Data representation and basic operations: Local, as it focuses on specific techniques and algorithms used within a computer system. Notion of IPC: Local, as it refers to the communication and interaction between processes or components within a computer system.
Regional	-
National	-
Global	-
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Instruction Set Architecture (RISC-V)**
Local	-

Regional	-
National	
Global	Addressing modes: Global, as they are a fundamental concept in computer architecture and are used in various CPU architectures worldwide. Instruction set: Global, as it refers to the collection of instructions supported by a CPU architecture, which is applicable across different computer systems.
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**The Processor**
Local	-
Regional	-
National	-
Global	Global, as they are techniques used to improve performance and increase instruction-level parallelism, relevant across different computer architectures.
Employability	
Entrepreneurship	-
Skill	-

Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Memory hierarchy, Storage and I/O**
Local	-
Regional	-
National	-
Global	Introduction to magnetic disks, notion of tracks, sectors, flash memory: Global, as they are fundamental concepts and technologies applicable to computer storage systems worldwide.
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4, SDG 8, SDG 9
NEP 2020	Promoting universal access to education, holistic development, multidisciplinary approach, skill development, critical thinking, creativity, ICT integration, research and development, global

	competencies, and professional ethics.
POE/4th IR	Aligns with the concepts of parallel computing, advanced processors, and memory architectures.

COMPUTER NETWORKS

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Computer Network</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENCS304</td><td>3-1-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Major</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="4">Brief Syllabus:

This course provides a comprehensive study of computer networks, covering fundamental concepts, protocols, and technologies. It emphasizes hands-on learning and explores open-source tools commonly used in the field of computer networking. Through practical assignments and projects, students will gain a solid understanding of network design, implementation, security, and management.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Evolution of Computer Networking</td><td>No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:

Data communication Components: Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Access networks, physical media, Forwarding, routing; packet switching; circuit switching; a network of network, packet delay and loss, end-end throughput.</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Data Link Layer Design Issues</td><td>No. of hours: 12</td></tr>
<tr><td colspan="4">Content Summary:

Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -</td></tr>
</table>

Pure ALOHA, Slotted ALOHA, CSMA/CD,CDMA/CA.		
Unit Number: 3	**Title: Introduction to Network Layer and Transport Services**	**No. of hours: 12**
Content Summary: Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routing protocols. Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality of Service, QoS improving techniques: Leaky Bucket and Token Bucket algorithm.		
Unit Number: 4	**Title: Principles of Network Applications**	**No. of hours: 8**
Content Summary: Application Layer: Domain Name Space (DNS), DDNS, TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP, Bluetooth, Firewalls, Basic concepts of Cryptography.		
***Self-Learning Components**: **https://gaia.cs.umass.edu/kurose_ross/videos/1/** Cisco Networking Academy: network fundamentals, routing and switching, and network security. They provide free learning materials and hands-on practice: https://www.netacad.com/ Open-Source Networking Tools and Technologies • Open-source network monitoring tools (e.g., Nagios, Zabbix) • Open-source network management tools (e.g., OpenNMS) • Open-source network security tools (e.g., Snort, Suricata)		
Text Book: 1. Computer Networks (Fifth Edition) – Andrew S. Tanenbaum (Prentice Hall of India) 2. Data communication and Networking(Fourth Edition)- Behrouz A		

Forouzan(Tata Mcgraw Hill) **Reference Books:** 3. Computer Networking A Top-Down Approach(Fifth Edition)-James F. Kurose-Keith W. Ross (Pearson) 4. Computer Networks – Protocols, Standards and Interfaces (Second Edition) – UylessBlack(Prentice Hall of India Pvt. Ltd.)

Define Course Outcomes (CO)

COs	Statements
CO1	Understand the fundamental concepts and principles of computer networks.
CO2	Demonstrate knowledge of network hardware and software components.
CO3	Develop skills in network administration and management.
CO4	Choose appropriate protocol for desired communication service.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1		
C02	C2		
CO3	C3	A4	

CO4	C6		P5
CO5			

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2		2	2									
CO3				3								
CO4				3								

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	2			
CO2				
CO3			2	
CO4				
CO5				

Relevance of the Syllabus to various indicators

Unit I	**Evolution of Computer Networking**
Local	Computer networking enables local communication and connectivity within communities, businesses, and educational institutions. It facilitates information sharing, collaboration, and resource sharing at the local level.
Regional	Networking infrastructure connects regions and nations, promoting economic growth, social development, and knowledge sharing. It enables efficient communication, e-commerce, and government services across regions and countries.
National	-

Global	The global network infrastructure, such as the internet, connects people worldwide. It fosters global communication, cultural exchange, international trade, and enables the global dissemination of knowledge and information.
Employability	Computer networking skills are in high demand across industries. Proficiency in networking technologies and protocols enhances employability prospects in fields such as network administration, cybersecurity, cloud computing, and telecommunications.
Entrepreneurship	Networking knowledge is crucial for entrepreneurs to establish and manage their businesses effectively. It enables the creation of scalable, secure, and interconnected systems that support business operations, communication, and data exchange.
Skill Development	Computer networking cultivates essential technical skills, such as network design, configuration, troubleshooting, and optimization. It also fosters critical thinking, problem-solving, and analytical skills required to address complex network challenges.
Professional Ethics	Computer networking professionals must adhere to ethical standards and guidelines. They need to respect user privacy, ensure data security, and practice responsible use of network resources. Professional ethics in networking include principles like confidentiality, integrity, accountability, and respect for intellectual property rights.
Gender	Promoting gender diversity and inclusivity in computer networking is crucial. Encouraging women's participation in networking fields helps bridge the gender gap and fosters diverse perspectives and innovative solutions.
Human Values	Computer networking should prioritize human values, such as accessibility, equity, and social responsibility. Access to network resources and services should be inclusive, regardless of geographical location or socioeconomic background. Networking technologies should be leveraged to bridge digital divides and empower underserved communities.
Environment &	Networking can contribute to environmental sustainability by

Sustainability	enabling remote work, reducing the need for commuting, and minimizing carbon emissions. It also facilitates energy-efficient network infrastructure design and management, leading to reduced power consumption and environmental impact.
Unit II	**Data Link Layer Design Issues**
Local	Data Link Layer design issues are relevant at the local level as they affect the efficiency and reliability of local area networks (LANs). Local network connectivity is vital for businesses, educational institutions, and communities to facilitate communication and data exchange.
Regional	Efficient Data Link Layer design ensures seamless connectivity within regions and nations, enabling smooth data transmission across a wide range of industries and sectors.
National	-
Global	In the global context, the design of the Data Link Layer plays a crucial role in ensuring interoperability and standardization across networks worldwide. Global communication and data exchange rely on well-designed protocols and technologies at this layer.
Employability	Proficiency in Data Link Layer design is valuable for networking professionals seeking employment in roles such as network engineers, system administrators, and network architects. Employers look for individuals with a strong understanding of data link protocols and the ability to design reliable and efficient data link connections.
Entrepreneurship	Data Link Layer design knowledge is also essential for entrepreneurs who need to establish and manage their network infrastructure effectively. It enables the creation of secure and efficient data links to support business operations and communication.
Skill Development	Understanding Data Link Layer design issues contributes to the development of technical skills in network engineering and administration. It involves knowledge of protocols, error detection and correction techniques, flow control, and media access control.

Professional Ethics	Data Link Layer design should adhere to professional ethics, including principles of integrity, privacy, and security. Designers must ensure the confidentiality and integrity of transmitted data, implement appropriate access control mechanisms, and protect against unauthorized access or data breaches.
Gender	Promoting gender diversity and inclusivity in Data Link Layer design is important to ensure a diverse range of perspectives and innovative solutions. Efforts should be made to encourage and support the participation of underrepresented groups in networking fields.
Human Values	Data Link Layer design should consider human values such as accessibility, reliability, and user-friendliness. Networks should be designed to provide reliable and efficient data transmission, ensuring that users have access to network resources without discrimination or unnecessary barriers.
Environment & Sustainability	Sustainable Data Link Layer design involves optimizing network performance and reducing power consumption. Energy-efficient network technologies, such as link aggregation and power-saving modes, can contribute to environmental sustainability by minimizing energy consumption and reducing carbon emissions.
Unit III	**Introduction to Network Layer and Transport Services**
Local	Local: The Network Layer and Transport Services enable local connectivity and communication within communities, organizations, and institutions. They facilitate local data transmission and routing within a network.
Regional	Regional and National: These networking components play a vital role in regional and national connectivity, enabling data transmission across networks and facilitating communication between different regions and countries.
National	-
Global	Global: The Network Layer and Transport Services are essential for global connectivity, enabling data transmission across the internet and connecting individuals and

	organizations worldwide.
Employability	Proficiency in the Network Layer and Transport Services is highly relevant for networking professionals seeking employment. It enhances employability in roles such as network engineers, network administrators, and system architects. Employers value individuals with expertise in network design, routing, and transport protocol selection.
Entrepreneurship	Understanding the Network Layer and Transport Services is crucial for entrepreneurs who need to design and manage their network infrastructure effectively. It allows for scalable and efficient data transmission, supporting business operations and facilitating communication.
Skill Development	Skill development in these areas also enhances critical thinking, problem-solving, and troubleshooting skills, as network professionals need to analyze and resolve issues related to routing, congestion control, and reliability.
Professional Ethics	Ethical considerations are important when working with the Network Layer and Transport Services. Networking professionals must ensure the confidentiality, integrity, and availability of data during transmission. They must also respect user privacy and adhere to ethical standards in handling network traffic and data.
Gender	Encouraging gender diversity and inclusivity in the Network Layer and Transport Services is crucial to foster diverse perspectives and innovative solutions. Efforts should be made to promote the participation and representation of underrepresented groups in networking fields.
Human Values	The Network Layer and Transport Services should prioritize human values such as accessibility, reliability, and user-friendliness. Networks should be designed to provide reliable and efficient data transmission, ensuring equitable access and usability for all users.
Environment & Sustainability	Sustainable network design involves optimizing the Network Layer and Transport Services to minimize resource consumption and reduce environmental impact. This includes implementing efficient routing algorithms, congestion control

	mechanisms, and energy-saving techniques to reduce power consumption and promote environmental sustainability.
Unit IV	**Principles of Network Applications**
Local	Principles of computer network applications enable local communication and connectivity within communities, organizations, and institutions. Local network applications facilitate information sharing, collaboration, and resource utilization at the local level.
Regional	These principles play a crucial role in regional and national connectivity, allowing for efficient communication and data exchange across networks within a region or country.
National	-
Global	The principles of computer network applications are essential for global connectivity, enabling the exchange of data and information across the internet on a global scale.
Employability	Proficiency in the principles of computer network applications enhances employability in various roles such as application developers, network engineers, and system administrators. Employers seek individuals with a strong understanding of network protocols, application design, and development.
Entrepreneurship	Understanding these principles is crucial for entrepreneurs who need to develop and manage networked applications effectively. It enables the creation of innovative and scalable applications to support business operations and provide value to users.
Skill Development	The principles of computer network applications contribute to the development of technical skills in application development, network programming, and protocol implementation. It involves knowledge of network protocols, application layer protocols (e.g., HTTP, FTP), and client-server communication.
Professional Ethics	Ethical considerations are important when working with computer network applications. Professionals should prioritize user privacy, data security, and responsible use of network resources. Adhering to ethical guidelines ensures the confidentiality, integrity, and availability of data during

	application communication.
Gender	Promoting gender diversity and inclusivity in computer network applications is important to ensure diverse perspectives and inclusive designs. Efforts should be made to encourage and support the participation of underrepresented groups in application development and networking fields
Human Values	Principles of computer network applications should prioritize human values such as accessibility, usability, and user-friendliness. Applications should be designed to provide seamless and intuitive user experiences, ensuring equitable access and usability for all users.
Environment & Sustainability	Sustainable application design involves optimizing network communication to minimize resource consumption and reduce environmental impact. This includes implementing efficient data transfer mechanisms, minimizing unnecessary data transmission, and promoting energy-efficient application architectures.
SDG	SDG 4
NEP 2020	-
POE/4th IR	

COMPUTER NETWORKS LAB

Department:	Department of Computer Science and Engineering		
Course Name: Computer Network Lab	**Course Code**	**L-T-P**	**Credits**
	ENCS352	0-0-2	1
Type of Course:	Major		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	To gain hands-on experience working with network hardware, software, and tools.
CO 2	Network Configuration and Troubleshooting.
CO 3	Network Design and Implementation.
CO 4	To measure and evaluate network performance using tools and techniques.

Ex. No	Experiment Title	Mapped CO/COs
1	Create a simple network with multiple PCs, switches, and routers.	CO 1

2	Assign IP addresses to devices and configure basic connectivity.	CO 1, CO 2
3	Test connectivity between PCs using ping and trace routes.	CO 2
4	Configure VLANs on switches and assign ports to specific VLANs.	CO 2, CO 3
5	Enable inter-VLAN routing using a router or Layer 3 switch.	CO 3
6	Test connectivity between PCs in different VLANs.	CO 3
7	Set up a network with multiple routers.	CO 1, CO 3
8	Configure static routes on routers to enable communication between networks.	CO 3, CO 4
9	Verify routing tables and test connectivity between networks.	CO 4
10	Set up a network with a private IP address space.	CO 4
11	Configure NAT on a router to enable translation between private and public IP addresses.	CO 4
12	Test connectivity between devices on the private network and the Internet.	CO 4
13	Create a wireless network using access points and wireless clients.	CO 1, CO 2
14	Simulate network issues such as connectivity problems, routing errors, or misconfigurations.	CO 2, CO 3
15	Design and implement a network traffic monitoring.	CO 3
16	Setting up small computer networks and Hands on networking commands: Set up a small wired and wireless network of 2 to 4 computers using Hub/Switch/Access point.	CO 1
17	Write a program for error detection and correction for 7/8 bits ASCII codes using Hamming Codes.	CO 4
18	Write a program for error detection and correction for 7/8 bits ASCII codes using CRC.	CO 4

19	Write a program to simulate Go back N and Selective Repeat Modes of Sliding Window Protocol in peer to peer mode. Further extend it to real implementation of Flow Control over TCP protocol.	CO 4
20	Design and deploy TCP based Multithreaded HTTP client server for accessing student activity data in the institute.	CO 3, CO 4
21	Design and deploy TCP based Multithreaded FTP client server to share institute level notices.	CO 3, CO 4
22	Design and deploy TCP based Multithreaded Chat client server for your class.	CO 3, CO 4
23	Design and deploy UDP based Multithreaded Chat client server for your class.	CO 3, CO 4
24	Examining real-world network deployments.	CO 3, CO 4
25	Case studies of network failures and their resolutions.	CO 2, CO 3, CO 4

INTRODUCTION OF NEURAL NETWORK AND DEEP LEARNING

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name: Introduction to Neural Network and Deep learning</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENCS306</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Major</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="4">Brief Syllabus:

The course begins with key concepts of neural networks, feed-forward neural network, and back propagation. The student gets an opportunity to learn the programming languages (Tensor Flow) to train the deep learning models. The student learns the concepts behind deep learning algorithms and its use cases.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Basics of Neural Network</td><td>No. of hours: 10</td></tr>
<tr><td colspan="4">Content Summary: Basic ideas behind the Neural Network, Social Engineering about the data, Importance, and applications of Neural network Neural network concepts, Information flow in a neural network, understanding the basic structure of biological Neural Networks and ANN. Activation functions and their uses.(Sigmoid, Relu, Tanh etc.)</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Feedforward neural network</td><td>No. of hours: 10</td></tr>
<tr><td colspan="4">Content Summary: Linear Models, Training a Neural network, how to determine hidden layers, recurrent neural, multi-layer neural network, Risk minimization, regularization, model selection, and practical optimization.</td></tr>
</table>

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Unit Number: 3	Title: Deep Learning	No. of hours: 10
Content Summary: Deep Feed Forward network, bias-variance dilemma, Overfitting, dropouts, Gradient decent algorithm, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network. Challenges in designing the best Neural Network ---**Self-learning**		
Unit Number: 4	**Title: Probabilistic Neural Network and Deep Learning Research**	**No. of hours: 10**
Content Summary: Hopfield Net, Boltzmann machine, RBMs, Need of Encoders and Auto encoders, Object recognition, computer vision, natural language processing. Research areas in Probabilistic Neural Networks		

Reference Books:

1. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
2. Golub, G., H. and Van Loan, C, F, Matrix Computations, JHU Press,2013.
3. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

Text Books

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** neural network and Biological Neural Network
CO2	**Express** proficiency in the handling of feedforward Neural Network
CO3	**Determine** methods to create and manipulate Deep Neural Network
CO4	**Identify** commonly used operations involving in designing Deep Neural Network

CO5	**Articulate** Neural Network, such as Backpropagation, Drop out, overfitting and their use in programs.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2		P1
C02	C3		P2
CO3	C3		P2
CO4	C1		-
CO5	C1		P4

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	–	–	–	–	1	1	1	–	–	–	1
CO2	3	3	3	–	3	–	–	–	–	2	–	–
CO3	3	3	3	2	3	–	–	–	–	–	–	2
CO4	2	2	2	–	2	–	–	–	–	–	–	–
CO5	2	2	–	2	2	–	–	–	–	2	–	–

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	2	–	–	–
CO2	3	3	3	–
CO3	3	3	–	–
CO4	2	2	–	2
CO5	2	2	2	2

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Relevance of the Syllabus to various indicators

Unit I	**The Neural Network**
Local	Information flow in a neural network
Regional	understanding the basic structure of biological Neural Networks and ANN.
National	Training a network
Global	loss functions, activation functions
Employability	Develops skills in using internet-based services and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in Neural networks.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Feedforward neural network**
Local	Understanding of how to train the neural networks
Regional	-
National	-
Global	Aligns with global trends in Neural networks technologies
Employability	Develops skills in using Neural network
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in Deep learning.

Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Deep Learning**
Local	Understanding different algorithms used in deep learning
Regional	-
National	Contributes to deep learning technology strategies
Global	Aligns with global trends in Deep neural network
Employability	Develops skills in programming and other techniques
Entrepreneurship	-
Skill Development	Develops knowledge and skills in Deep learning
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Probabilistic Neural Network and Deep Learning research**
Local	
Regional	-
National	Contributes to national business strategies.
Global	Aligns with global trends in deep learning research and

	applications
Employability	Develops skills in predictive modeling
Entrepreneurship	-
Skill Development	Develops knowledge and skills in data analytics as well as in predictions
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of Neural network and Deep Learning applications

INTRODUCTION TO NEURAL NETWORKS & DEEP LEARNING LAB

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name: Introduction to Neural Network and Deep learning Lab</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENCS354</td><td>0-0-2</td><td>1</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Major</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
</table>

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	Acquire a practical understanding of neural networks and deep learning algorithms through hands-on lab experiments.
CO 2	Develop proficiency in implementing feedforward neural networks and understanding their underlying principles.
CO 3	Demonstrate the ability to create and manipulate deep neural networks for solving complex real-world problems.
CO 4	Analyze and evaluate the performance of neural network models using appropriate evaluation metrics and techniques.

Ex. No	Experiment Title	Mapped CO/COs
1	Familiarize students with the lab environment, software, and tools.	CO1
2	Compare the information flow in a simple biological neural network (such as a single neuron) with a corresponding ANN architecture. Analyze how information is processed and propagated through each system and identify similarities and differences.	CO1
3	Implement a basic feedforward neural network using a library/framework of choice.	CO2
4	Train and test the neural network using a simple dataset to classify inputs.	CO2
5	Review the architecture and working principles of feedforward neural networks.	CO2
6	Explore different activation functions and their effects on network performance.	CO1
7	Implementation of different Learning Rules.	CO2
8	Implementation of Perceptron Networks.	CO2
9	Introduce the concepts of neural networks, artificial neurons, and activation functions.	CO1
10	Analyze and implement a pre-trained Neural Network	CO3
11	Common issues and errors encountered during deep learning experiments,	CO3
12	Experiment with different regularization techniques (e.g., regularization, dropout) to mitigate overfitting and evaluate their impact on model performance.	CO3
13	Troubleshooting strategies and debugging techniques for deep learning experiments.	CO3
14	Compare different optimization algorithms (e.g., stochastic gradient descent, Adam, RMS prop) and analyse their effects on model convergence and	CO3

	performance.	
15	Investigate the impact of batch normalization on model convergence and performance.	CO3
16	Compare the performance of different loss functions (e.g., cross-entropy, mean squared error) for a specific task.	CO3
17	Implement a sequence-to-sequence model for machine translation using an encoder-decoder architecture.	CO3
18	Study the concept of information bottleneck in neural networks by systematically varying the network's capacity	CO4
19	Investigate the impact of network architecture on information flow and learning capabilities.	CO4
20	Project related to the application of machine learning in healthcare.	CO4
21	Project related to the application of machine learning in business analysis.	CO4
22	Analyze the overall network and check how different layers or units contribute to the network's decision-making process.	CO3

COMPETITIVE CODING LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **Competitive Programming Lab**	**Course Code**	**L-T-P**	**Credits**
	SEC036	0-0-4	2
Type of Course:	Skill Enhancement Course (SEC)		
Pre-requisite(s), if any: None			
Brief Syllabus: Introduction to Competitive Coding, Data Structures and Algorithms, Time and Space Complexity Analysis, Problem Solving Techniques, Advanced Data Structures, Coding Paradigms, Online Judges and Contest Platforms, Tips and Tricks for Competitive Coding, Mock Contests and Practice Sessions, Self-Learning Components			

Table of Contents

S.N	Experiment Index	COs
1	Introduction to Competitive Coding • Overview of competitive coding and its importance in the field of computer science. • Understanding the significance of problem-solving skills and algorithmic thinking in competitive coding.	CO1
2	Data Structures and Algorithms • Review of fundamental data structures: arrays, linked lists, stacks, queues, trees, graphs, and hash tables. • Study of essential algorithms: searching, sorting, recursion, dynamic programming, greedy algorithms, and graph algorithms.	CO1
	Time and Space Complexity Analysis • Understanding time and space complexity of algorithms. • Analysis of algorithm efficiency and choosing the most optimal	

3	solutions.	CO2
4	Problem Solving Techniques • Introduction to problem-solving techniques like brute force, divide and conquer, backtracking, and more. • Practice in applying different techniques to solve a variety of programming problems.	CO3
5	Advanced Data Structures • Study of advanced data structures: heaps, priority queues, segment trees, trie, and advanced graph structures. • Understanding the use of these data structures in solving complex programming problems.	CO4
6	Coding Paradigms • Introduction to different coding paradigms: procedural programming, object-oriented programming, and functional programming. • Understanding the benefits and drawbacks of each paradigm in competitive coding.	CO5
7	Online Judges and Contest Platforms • Familiarization with popular online judge platforms like Codeforces, Topcoder, and LeetCode. • Practice solving problems from online contests and participating in coding competitions. List of suggested links to coding platforms ▪ Codeforces: https://codeforces.com/ ▪ Topcoder: https://www.topcoder.com/ ▪ AtCoder: https://atcoder.jp/ ▪ LeetCode: https://leetcode.com/ ▪ HackerRank: https://www.hackerrank.com/ ▪ CodeChef: https://www.codechef.com/ ▪ HackerEarth: https://www.hackerearth.com/ ▪ Project Euler: https://projecteuler.net/ ▪ UVa Online Judge: https://onlinejudge.org/ ▪ SPOJ (Sphere Online Judge): https://www.spoj.com/ ▪ Google Code Jam:	CO5

	https://codingcompetitions.withgoogle.com/codejam ▪ Kick Start by Google: https://codingcompetitions.withgoogle.com/kickstart ▪ ACM ICPC Live Archive: https://icpcarchive.ecs.baylor.edu/ ▪ A2 Online Judge: https://a2oj.com/ ▪ CodeSignal: https://codesignal.com/	
8	Tips and Tricks for Competitive Coding • Learning effective coding techniques, shortcut methods, and best practices for competitive coding. • Developing strategies to optimize code, manage time, and improve problem-solving speed.	CO5
9	Mock Contests and Practice Sessions • Conducting mock contests and practice sessions to simulate real coding competitions. • Solving a wide range of problems to enhance coding skills and adaptability to different problem types.	CO5
10	**Self-Learning Component:** List of Suggested Competitive programming Courses: ▪ Competitive Programmer's Core Skills" by Coursera: This course covers fundamental algorithms and data structures used in competitive programming. Link: https://www.coursera.org/learn/competitive-programming-core-skills ▪ "Algorithms and Data Structures" by MIT OpenCourseWare: This course teaches essential algorithms and data structures for competitive programming. Link: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-006-introduction-to-algorithms-fall-2011/ ▪ "Data Structures and Algorithms" by GeeksforGeeks: This course covers various data structures and algorithms commonly used in competitive programming. Link: https://practice.geeksforgeeks.org/courses/dsa-self-paced ▪ "Introduction to Competitive Programming" by NPTEL: This course introduces the basics of competitive programming and covers algorithms and problem-solving techniques. Link: https://onlinecourses.nptel.ac.in/noc21_cs07/ ▪ "Competitive Programming" by HackerRank: This course provides in-depth coverage of algorithms and data structures	CO5

with hands-on coding exercises. Link: https://www.hackerrank.com/domains/tutorials/10-days-of-statistics

- "Advanced Data Structures and Algorithms" by Udemy: This course dives deeper into advanced data structures and algorithms for competitive programming. Link: https://www.udemy.com/course/advanced-data-structures-and-algorithms-in-java/
- "Mastering Data Structures and Algorithms using C and C++" by Udemy: This course covers data structures and algorithms with a focus on problem-solving for coding interviews and competitive programming. Link: https://www.udemy.com/course/datastructurescncpp/
- "Competitive Programming" by Coding Ninjas: This course provides comprehensive training in competitive programming, covering algorithms, data structures, and problem-solving techniques. Link: https://www.codingninjas.com/courses/online-competitive-programming-course
- "Algorithmic Toolbox" by Coursera: This course from the University of California San Diego covers algorithmic techniques and data structures for competitive programming. Link: https://www.coursera.org/learn/algorithmic-toolbox
- "Competitive Programming - From Beginner to Expert" by Udemy: This course offers a complete guide to competitive programming, starting from the basics and progressing to advanced topics. Link: https://www.udemy.com/course/competitive-programming-from-beginner-to-expert/
- Competitive Programming Essentials, Master Algorithms 2022 (Udemy) https://www.udemy.com/course/competitive-programming-algorithms-coding-minutes/
- The Bible of Competitive Programming & Coding Interviews

**All students must complete one online course from the suggested programs*

List of popular Competitive Programming Competitions:

1. ACM International Collegiate Programming Contest (ICPC): This is one of the most prestigious programming competitions for college students. Teams compete in solving a set of challenging algorithmic problems within a time limit. Website
2. Google Code Jam: Organized by Google, this annual coding competition challenges participants to solve algorithmic problems. It consists of multiple online rounds leading to a final onsite competition. Website
3. Facebook Hacker Cup: This annual coding competition by Facebook features multiple online rounds and an onsite final round. Participants solve algorithmic problems for a chance to win prizes. Website
4. Topcoder Open: Topcoder hosts this annual programming competition featuring algorithmic and design challenges. Participants compete for cash prizes and a chance to be recognized by industry experts. Website
5. International Olympiad in Informatics (IOI): IOI is an annual international programming competition for high school students. Participants solve algorithmic problems in a contest format. Website
6. AtCoder Grand Contest: AtCoder hosts this regular contest series featuring algorithmic programming challenges. Participants can compete individually or as a team. Website
7. Codeforces: Codeforces is a popular competitive programming platform that hosts regular contests. Participants compete in solving algorithmic problems and earn ratings based on their performance. Website
8. LeetCode Weekly Contests: LeetCode organizes weekly contests where participants can solve algorithmic problems and compete for rankings. Website
9. HackerRank Contests: HackerRank hosts various contests and challenges covering a wide range of programming topics. Participants can compete individually or as part of a team. Website
10. Kaggle Competitions: Kaggle is a platform for data science competitions, where participants solve real-world problems using machine learning and data analysis techniques. Website

All students must participate in some competitions

Suggested Books

1. "Competitive Programming 3" by Steven Halim and Felix Halim: This book is a comprehensive guide to competitive programming, covering algorithms, data structures, problem-solving techniques, and contest strategies. It includes numerous examples, explanations, and practice problems. Book Link
2. "Algorithms" by Robert Sedgewick and Kevin Wayne: This book provides a thorough introduction to algorithms, including sorting, searching, graph algorithms, and dynamic programming. It includes detailed explanations, visualizations, and implementation examples. Book Link
3. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein: Known as "CLRS," this book is a classic reference for algorithms. It covers a wide range of algorithms, data structures, and algorithm design techniques. Book Link
4. "Programming Challenges" by Steven S. Skiena and Miguel A. Revilla: This book presents a collection of programming problems from various competitions and online judges. It provides problem-solving techniques, algorithmic approaches, and example solutions. Book Link
5. "The Art of Computer Programming" by Donald E. Knuth: This multi-volume series is considered a classic in computer science. It covers various algorithms, data structures, and mathematical techniques in great detail. Book Link
6. "Cracking the Coding Interview" by Gayle Laakmann McDowell: Although not specifically focused on competitive programming, this book is a popular resource for coding interview preparation. It covers essential data structures, algorithms, and problem-solving techniques. Book Link
7. "Programming Pearls" by Jon Bentley: This book presents a collection of programming challenges and discusses techniques for solving them efficiently. It emphasizes problem-solving skills and algorithmic thinking. Book Link

Web References

- https://www.geeksforgeeks.org/competitive-programming-a-complete-guide/
- https://www.geeksforgeeks.org/must-do-coding-questions-for-companies-like-amazon-microsoft-adobe/
- https://www.udemy.com/course/competitive-programming
- https://github.com/smv1999/CompetitiveProgrammingQuestionBank
- https://github.com/parikshit223933/Coding-Ninjas-Competitive-Programming
- https://www.hackerearth.com/getstarted-competitive-programming/
- https://www.csestack.org/competitive-coding-questions/

Course Outcomes

CO1	Proficiency in Algorithms and Data Structures: Demonstrate proficiency in implementing and analyzing various algorithms and data structures commonly used in competitive programming.
CO2	Efficient Problem Solving: Develop the ability to analyze problem statements, design efficient algorithms, and write optimized code to solve competitive programming problems within time and memory constraints.
CO3	Algorithmic Thinking: Cultivate algorithmic thinking and problem-solving skills by identifying patterns, applying appropriate algorithms, and selecting optimal data structures for a given problem.
CO4	Code Optimization and Complexity Analysis: Apply strategies to optimize code and improve time and space complexity of solutions, considering factors such as algorithm selection, data structure usage, and efficient coding techniques.
CO5	Competitive Programming Skills: Gain familiarity with different online competitive programming platforms, participate in coding competitions, and develop strong problem-solving and critical thinking skills in a competitive programming environment.

List of Suggested Experiments in Lab Sessions

Questions on Arrays
1. Maximum Subarray Sum: Given an array of integers, find the contiguous subarray with the largest sum.
2. Two Sum: Given an array of integers and a target value, find two numbers in the array that add up to the target.
3. Rotate Array: Rotate an array of n elements to the right by k steps.
4. Merge Intervals: Given a collection of intervals, merge overlapping intervals.
5. Majority Element: Find the majority element in an array. The majority element appears more than n/2 times, where n is the size of the array.

6. Trapping Rain Water: Given an array representing the heights of bars, calculate the amount of water that can be trapped between the bars.
7. Next Permutation: Implement the next permutation algorithm to find the lexicographically next greater permutation of an array of integers.
8. Subarray with Given Sum: Given an unsorted array of non-negative integers and a target sum, find a subarray that adds up to the target sum.
9. Product of Array Except Self: Given an array of n integers, return an array output such that each element at index i of the output array is the product of all the elements in the original array except the one at i.
10. Minimum Size Subarray Sum: Given an array of positive integers and a target sum, find the minimum length of a contiguous subarray whose sum is greater than or equal to the target sum.
Questions on Recursion
1. Factorial: Write a recursive function to calculate the factorial of a given number.
2. Fibonacci Series: Write a recursive function to generate the nth term of the Fibonacci series.
3. Power of a Number: Write a recursive function to calculate the power of a given number.
4. Sum of Digits: Write a recursive function to find the sum of digits of a given number.
5. Palindrome Check: Write a recursive function to check whether a given string is a palindrome or not.
6. Tower of Hanoi: Solve the Tower of Hanoi problem using recursion.
7. Binary Search: Implement a recursive binary search algorithm to find an element in a sorted array.
8. Permutations: Write a recursive function to generate all permutations of a given string.
9. Subset Sum: Given an array of integers and a target sum, write a recursive function to check if there exists a subset that sums up to the target.
10. Combination Sum: Given an array of integers and a target sum, write a recursive function to find all possible combinations that sum up to the

target.

Questions on Stacks & Queues:

1. Balanced Parentheses: Given a string of parentheses, write a function to determine if the parentheses are balanced using a stack.
2. Reverse a String: Write a function to reverse a string using a stack.
3. Evaluate Postfix Expression: Given a postfix expression, write a function to evaluate it using a stack.
4. Next Greater Element: Given an array, find the next greater element for each element in the array using a stack.
5. Largest Rectangle in Histogram: Given a histogram represented by an array of bar heights, find the largest rectangle that can be formed in the histogram using a stack.
6. Implement Stack using Queues: Implement a stack data structure using queues.
7. Implement Queue using Stacks: Implement a queue data structure using stacks.
8. Sliding Window Maximum: Given an array and an integer k, find the maximum element in each sliding window of size k using a queue.
9. Print Binary Tree in Level Order: Given a binary tree, print its elements in level order using a queue.
10. Implement Recent Counter: Design a data structure that counts the number of recent requests within a certain time range using a queue.

Questions on Linked Lists

1. Reverse a Linked List: Write a function to reverse a singly linked list.
2. Detect Cycle in a Linked List: Write a function to detect if a linked list contains a cycle.
3. Find the Middle of a Linked List: Write a function to find the middle node of a linked list.
4. Merge Two Sorted Lists: Given two sorted linked lists, write a function to merge them into a single sorted linked list.

5. Remove Nth Node from End of List: Given a linked list, remove the nth node from the end of the list and return its head.
6. Intersection of Two Linked Lists: Given two linked lists, write a function to find the intersection point if it exists.
7. Palindrome Linked List: Given a singly linked list, determine if it is a palindrome.
8. Remove Duplicates from Sorted List: Given a sorted linked list, remove duplicates from it.
9. Add Two Numbers as Linked Lists: Given two linked lists representing two numbers, write a function to add them and return the resulting linked list.
10. Flatten a Multilevel Linked List: Given a linked list with a special structure, flatten it into a single-level linked list.
Questions on Trees
1. Binary Tree Traversals: Implement different tree traversal algorithms such as in-order, pre-order, and post-order traversal.
2. Maximum Depth of Binary Tree: Find the maximum depth or height of a binary tree.
3. Validate Binary Search Tree: Given a binary tree, check if it is a valid binary search tree.
4. Lowest Common Ancestor of Two Nodes: Find the lowest common ancestor of two nodes in a binary tree.
5. Diameter of Binary Tree: Find the diameter of a binary tree, which is the longest path between any two nodes.
6. Binary Tree Level Order Traversal: Traverse a binary tree in level order and return the nodes in each level.
7. Symmetric Tree: Check if a binary tree is symmetric, meaning it is a mirror image of itself.
8. Serialize and Deserialize Binary Tree: Design algorithms to serialize and deserialize a binary tree.
9. Count Complete Tree Nodes: Count the number of nodes in a complete binary tree.
10. Construct Binary Tree from Preorder and Inorder Traversal: Given the

preorder and inorder traversal of a binary tree, construct the tree.

Questions on Graphs

- Shortest path: Find the shortest path between two vertices in a graph. This can be solved using Dijkstra's algorithm or Bellman-Ford's algorithm.
- Maximum flow: Find the maximum flow from one vertex to another in a graph. This can be solved using the Ford-Fulkerson algorithm or the Dinic algorithm.
- Minimum spanning tree: Find the minimum spanning tree of a graph. This can be solved using Prim's algorithm or Kruskal's algorithm.
- Topological sorting: Find a topological ordering of a graph. This can be solved using Kahn's algorithm.
- Strongly connected components: Find the strongly connected components of a graph. This can be solved using Tarjan's algorithm.
- Bipartite matching: Find a maximum bipartite matching in a graph. This can be solved using the Hungarian algorithm.
- Traveling salesman problem: Find the shortest tour that visits all the vertices in a graph. This is an NP-hard problem, but there are approximation algorithms that can be used to find a good solution.

Time & Space Complexity

1. Time Complexity Analysis: Analyze the time complexity of a given algorithm or piece of code.
2. Space Complexity Analysis: Analyze the space complexity of a given algorithm or piece of code.
3. Big O Notation: Given a function or algorithm, determine its big O notation in terms of time or space complexity.
4. Best/Worst/Average Case Complexity: Analyze the best, worst, and average-case time or space complexity of an algorithm.
5. Sorting Algorithms: Implement and analyze the time complexity of various sorting algorithms such as Bubble Sort, Insertion Sort, Merge Sort, Quick Sort, and Heap Sort.
6. Searching Algorithms: Implement and analyze the time complexity of various searching algorithms such as Linear Search, Binary Search, and

Hashing.
7. Dynamic Programming: Solve dynamic programming problems and analyze their time and space complexity.
8. Recursion vs. Iteration: Compare and analyze the time and space complexity of recursive and iterative solutions for a given problem.
9. Complexity Trade-offs: Analyze and compare the time and space complexity trade-offs of different algorithms for the same problem.
10. Space-Optimized Data Structures: Implement and analyze space-optimized data structures such as Bit Arrays, Bloom Filters, or Space-Efficient Hash Tables.
Questions on Divide & Conquer Strategy
1. Binary Search: Implement a recursive binary search algorithm to find an element in a sorted array.
2. Merge Sort: Implement the Merge Sort algorithm to sort an array of integers.
3. Quick Sort: Implement the Quick Sort algorithm to sort an array of integers.
4. Count Inversions: Given an array of integers, find the number of inversions present using the Divide and Conquer approach.
5. Closest Pair of Points: Given a set of points in a 2D plane, find the pair of points with the smallest distance between them using the Divide and Conquer technique.
6. Maximum Subarray Sum: Given an array of integers, find the maximum sum of a subarray using the Divide and Conquer approach.
7. Matrix Multiplication: Implement a Divide and Conquer algorithm to multiply two matrices efficiently.
8. Finding Majority Element: Given an array of integers, find the majority element (appearing more than n/2 times) using the Divide and Conquer technique.
9. Finding Kth Smallest Element: Given an array of integers, find the kth smallest element using the Divide and Conquer approach.
10. Closest Pair Sum: Given two sorted arrays and a target value, find the pair of elements (one from each array) with the closest sum to the target using

the Divide and Conquer technique.
Questions on Dynamic Programming
1. Fibonacci Series: Implement the Fibonacci series using dynamic programming to efficiently calculate the nth term.
2. Longest Common Subsequence: Given two strings, find the length of the longest common subsequence using dynamic programming.
3. Knapsack Problem: Given a set of items with weights and values, determine the maximum value that can be obtained by selecting a subset of items within a weight limit using dynamic programming.
4. Coin Change Problem: Given a set of coin denominations and a target value, find the minimum number of coins needed to make the target value using dynamic programming.
5. Rod Cutting Problem: Given a rod of a certain length and a price list for different rod lengths, find the maximum value that can be obtained by cutting and selling the rod using dynamic programming.
6. Edit Distance: Given two strings, find the minimum number of operations (insertion, deletion, and substitution) required to convert one string into another using dynamic programming.
7. Maximum Subarray Sum: Given an array of integers, find the maximum sum of a subarray using dynamic programming.
8. Longest Increasing Subsequence: Given an array of integers, find the length of the longest increasing subsequence using dynamic programming.
9. Matrix Chain Multiplication: Given a sequence of matrices, find the minimum number of scalar multiplications needed to multiply them using dynamic programming.
10. Subset Sum Problem: Given a set of integers and a target sum, determine if there exists a subset that sums up to the target using dynamic programming.
Questions on Greedy Programming
1. Fractional Knapsack Problem: Given a set of items with weights and values, determine the maximum value that can be obtained by selecting fractions of items within a weight limit using a greedy algorithm.

2. Activity Selection Problem: Given a set of activities with start and finish times, select the maximum number of activities that can be performed without overlapping using a greedy algorithm.
3. Minimum Spanning Tree: Given a weighted graph, find the minimum spanning tree using Kruskal's or Prim's algorithm, which are both based on greedy approaches.
4. Huffman Coding: Given a set of characters and their frequencies, construct a binary code that minimizes the total encoded length using a greedy algorithm.
5. Coin Change Problem: Given a set of coin denominations and a target value, find the minimum number of coins needed to make the target value using a greedy algorithm.
6. Job Scheduling Problem: Given a set of jobs with their deadlines and profits, schedule the jobs to maximize the total profit using a greedy algorithm.
7. Interval Scheduling Problem: Given a set of intervals, select the maximum number of non-overlapping intervals using a greedy algorithm.
8. Dijkstra's Algorithm: Given a weighted graph, find the shortest path from a source vertex to all other vertices using Dijkstra's algorithm, which is based on a greedy approach.
9. Egyptian Fraction: Given a fraction, represent it as a sum of unique unit fractions using a greedy algorithm.
10. Car Fueling Problem: Given the total distance to be covered, the capacity of the fuel tank, and a list of distances between fuel stations, determine the minimum number of refuelings needed to reach the destination using a greedy algorithm.
Questions on String Matching
1. Naive String Matching: Implement the naive string matching algorithm to find all occurrences of a pattern in a text.
2. Knuth-Morris-Pratt (KMP) Algorithm: Implement the KMP algorithm to efficiently find all occurrences of a pattern in a text.
3. Rabin-Karp Algorithm: Implement the Rabin-Karp algorithm to efficiently find all occurrences of a pattern in a text using hashing.
4. Longest Common Substring: Given two strings, find the longest common

substring using dynamic programming or other efficient algorithms.
5. Longest Common Prefix: Given an array of strings, find the longest common prefix using a suitable algorithm.
6. Regular Expression Matching: Implement a regular expression matching algorithm to determine if a string matches a given pattern.
7. Anagrams: Given a list of strings, find all pairs of strings that are anagrams of each other.
8. Palindromic Substrings: Given a string, find all palindromic substrings using a suitable algorithm.
9. Boyer-Moore Algorithm: Implement the Boyer-Moore algorithm to efficiently find all occurrences of a pattern in a text.
10.Subsequence Matching: Given two strings, determine if one string is a subsequence of the other.
Questions on Advanced Data Structures
1. Trie: Implement a Trie data structure and solve problems such as word search, autocomplete, or finding the longest common prefix.
2. Segment Tree: Implement a Segment Tree data structure and solve problems such as range sum queries, range minimum/maximum queries, or range updates.
3. Fenwick Tree (Binary Indexed Tree): Implement a Fenwick Tree data structure and solve problems such as prefix sum queries or range updates.
4. Disjoint Set Union (DSU) / Union-Find: Implement a DSU data structure and solve problems such as connected components, cycle detection, or Kruskal's algorithm for finding the minimum spanning tree.
5. Treap: Implement a Treap (a balanced binary search tree with randomized priorities) and solve problems such as maintaining the median of a dynamic set of numbers or solving range queries on a set of intervals.
6. Suffix Array: Implement a Suffix Array data structure and solve problems such as finding the longest common substring, finding the lexicographically smallest substring, or pattern matching.
7. LCA (Lowest Common Ancestor): Implement an LCA data structure and solve problems such as finding the lowest common ancestor of two nodes in a tree or solving distance-related queries on a tree.

8. K-D Tree: Implement a K-D Tree data structure and solve problems such as nearest neighbor search or range search in a multi-dimensional space.
9. AVL Tree or Red-Black Tree: Implement a balanced binary search tree (either AVL Tree or Red-Black Tree) and solve problems such as maintaining a sorted dynamic set or solving range queries.
10. B+ Tree: Implement a B+ Tree data structure and solve problems such as indexing or range queries on a large dataset.

References to Interview Questions

- https://www.simplilearn.com/coding-interview-questions-article
- https://www.csestack.org/competitive-coding-questions/
- https://www.geeksforgeeks.org/a-competitive-programmers-interview/
- https://www.geeksforgeeks.org/must-do-coding-questions-for-companies-like-amazon-microsoft-adobe/
- https://unstop.com/blog/competitive-coding-questions-with-solutions
- https://unstop.com/blog/competitive-coding-questions-with-solutions

MINOR PROJECT-II

Department:	**Department of Computer Science and Engineering**		
Course Name: Minor Project-II	**Course Code**	**L-T-P**	**Credits**
	ENSI352	---	2
Type of Course:	Project		
Pre-requisite(s), if any: NA			

- Students expected to develop a basic project that demonstrates the application of learnings from studied subjects.
- Students are required to submit a hard copy of project file as per the template (Provided at the end of Handbook). File needs to be submitted in spiral bind.
- Project will be evaluated on the scale of 100 with following evaluation criteria.
    - Project idea & features (10)
    - Literature review (10)
    - Tools & Techniques employed (10)
    - Methodology (10)
    - Presentation of Results and its usefulness (20)
    - Implementation and its understandability (10)
    - Meetings & comments by guide (20)
    - Research paper (10)

File format for Minor project

19.	Abstract	Page No.
20.	Introduction (description of broad topic)	
21.	Motivation	
22.	Literature Review	
23.	Gap Analysis	
24.	Problem Statement	
25.	Objectives	

26.	Tools/platform used	
27.	Methodology	
28.	Experimental Setup	
29.	Evaluation Metrics	
30.	Results And Discussion	
31.	Conclusion & Future Work	
32.	References	
33.	Annexure I: Responsibility Chart	
34.	Annexure II: Screenshots of all the MS-Team Meetings with links (online)/ handwritten comments(offline) from guide	
35.	Annexure III Complete implementation code	
36.	Annexure IV Research Paper (Published/Submitted)	

(DEPARTMENT ELECTIVE -I)

NATURAL LANGUAGE PROCESSING

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name: NATURAL LANGUAGE PROCESSING</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP302</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Department Elective I (Minor)</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: Strong programming skills, particularly in Python.</td></tr>
<tr><td colspan="4">Brief Syllabus:
The ultimate objective of NLP is to read, decipher, understand, and make sense of the human languages in a manner that is valuable

It helps resolve ambiguity in language and adds useful numeric structure to the data for many downstream applications, such as speech recognition or text analytics.</td></tr>
<tr><td colspan="4">Total lecture, Tutorial and Practical Hours for this course:</td></tr>
<tr><td rowspan="2">Lectures: 40</td><td colspan="3">Practice</td></tr>
<tr><td>Tutorials:</td><td colspan="2">Lab Work:</td></tr>
<tr><td colspan="4">Course Outcomes (COs)

The ultimate objective of NLP is to read, decipher, understand, and make sense of the human languages in a manner that is valuable
It helps resolve ambiguity in language and adds useful numeric structure to the data for many downstream applications, such as speech recognition or text analytics.</td></tr>
<tr><td>COs</td><td colspan="3"></td></tr>
<tr><td>CO 1</td><td colspan="3">NLP helps resolve ambiguity in language and adds useful numeric structure to the data for many downstream applications, such as speech</td></tr>
</table>

	recognition or text analytics.
CO 2	Its goal is to build systems that can make sense of text and automatically.
CO 3	Perform tasks like translation, spell check, or topic classification

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to NLP**	**No. of hours: 8**

Content Summary: Natural Language Processing in real world, What is language, Approached to NLP,

Build NLP model: Eights Steps for building NLP Model, Web Scrapping

Unit Number: 2	**Title: Text Representation**	**No. of hours: 12**

Content Summary: Basic Vectorization, One-Hot Encoding, Bag of Words, Bag of N Grams, TF-IDF, Pre-trained Word Embedding, Custom Word Embeddings, Vector Representations via averaging, Doc2Vec Model, Visualizing Embeddings using TSNW and Tensorbaord

Text Classification: Application of Text Classification, Steps for building text classification system, Text classification using Naïve Bayes Classifier, Logistic Regression, and Support Vector Machine, Neural embedding for Text Classification, text classification using deep learning, interpret text classification model

Unit Number: 3	**Title: Information Extraction**	**No. of hours: 12**

Content Summary: Applications of Information Extraction, Processes for Information Extraction. Key phrase Extraction, Named Entity Recognition, Disambiguation and linking of named entity, Relationship extraction

Chatbot: Real life applications of chatbot, Chatbot Taxonomy, Dialog Systems, Process of building a dialog, Components of Dialog System, End to End Approach, Rasa NLU

Unit Number:	**Title: NLP for social media**	**No. of hours: 8**

4		

Content Summary: Application of NLP in social media, challenges with social media, Natural Language Processing for Social Data, Understanding Twitter Sentiments, Identifying memes and Fake News

NLP for E-Commerce: E-commerce catalog, Search in E-Commerce, How to build an e-commerce catalog, Review and Sentiment Analysis, Recommendations for E-Commerce

Self-Learning Components:

https://onlinecourses.nptel.ac.in/noc23_cs45/preview

Please Note:

1)Students are supposed to learn the components on self-basis

2) At least 5-10 % syllabus will be asked in end term exams from self-learning components

Reference Books: Natural Language Processing with Python by Steven Bird, Ewan Klein and Edward Loper

Foundations of Statistical Natural Language Processing by Christopher Manning and Hinrich Schütze

NATURAL LANGUAGE PROCESSING LAB

Department:	Department of Computer Science and Engineering		
Course Name:	**Course Code**	**L-T-P**	**Credits**
NATURAL LANGUAGE PROCESSING LAB	**ENSP352**	0-0-2	1
Type of Course:	Department Elective I (Minor)		
Pre-requisite(s), if any: Strong programming skills, particularly in Python.			

List of Experiments

1. Write a program to scrap website
2. Write a program to inspect website using developer tool
3. Write a program to request permission to scrap website
4. Write a program to inspect H1 element
5. Write a program to inspect table element
6. Write a program to create column list
7. Write a program to clean column list
8. Write a program to word tokenization
9. Write a program to implement RegEx for word tokenization
10. Write a program to implement stopwords
11. Write a program to implement LSTM

K.R. MANGALAM UNIVERSITY

IMAGE PROCESSING & COMPUTER VISION

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Image Processing & Computer Vision</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP304</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Minor</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: (1) Linear Algebra and (2) programming in python</td></tr>
<tr><td colspan="4">Brief Syllabus:

The syllabus for the subject "Image Processing and Computer Vision using Python" covers the following topics: introduction to image processing and computer vision, Python programming basics for image processing, image acquisition and manipulation using Python libraries, image enhancement techniques, image filtering and convolution, feature extraction and object detection, image segmentation and boundary detection, image registration and alignment, camera calibration and 3D reconstruction, deep learning for image classification and object recognition, and applications of computer vision in fields like robotics, healthcare, and autonomous systems. The syllabus emphasizes hands-on programming exercises and projects to develop practical skills in implementing image processing and computer vision algorithms using Python.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td>Title: Introduction to Basic Concepts of Image Formation</td><td colspan="2">No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:

Fundamentals and Applications of image processing, Image processing system components, Image sensing and acquisition, Sampling and quantization, Neighbors of pixel adjacency connectivity, regions and boundaries ,Distance measures.

Image Enhancement: Frequency and Spatial Domain, Contrast Stretching, Histogram Equalization, Low pass and High pass filtering.</td></tr>
</table>

Unit Number: 2	Title: Image Restoration and coloring	No. of hours: 12

Content Summary:

Model of The Image Degradation Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations.

Colour Image Processing, Image Segmentation, Texture Descriptors, Colour Features, Edges/Boundaries, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Speeded up Robust Features, Saliency.

Unit Number: 3	Title: Image Compression and Segmentation	No. of hours: 8

Content Summary:

Data Redundancies, Image Compression models, Elements of Information Theory, Lossless and Lossy compression, Huffman Coding, Shanon-Fano Coding, Arithmetic Coding, Golomb Coding, LZW Coding, Run Length Coding, Loss less predictive Coding, Bit Plane Coding, Image compression standards.

Image Segmentation and Morphological Image Processing: Discontinuity based segmentation, similarity-based segmentation, Edge linking and boundary detection, Threshold, Region based Segmentation Introduction to Morphology, Dilation, Erosion, Some basic Morphological Algorithms Object

Unit Number: 4	Title: Object Representation and Computer Vision Techniques	No. of hours: 12

Content Summary:

Representation and description and Computer Vision Techniques: Introduction to Morphology, Some basic Morphological Algorithms, Representation, Boundary Descriptors, Regional Descriptors, Chain Code, and Structural Methods. Review of Computer Vision applications; Artificial Neural Network for Pattern Classification, Convolutional Neural Networks, Machine Learning Algorithms and their Applications in Image Segmentation, Motion Estimation and Object Tracking, Gesture Recognition, Face and Facial Expression Recognition, Image Fusion

***Self-Learning Components**:

Please Note:

1. **Concepts of Huffman coding, arithmetic coding, and other compression algorithms.**
2. **Presenting an overview of image compression standards (e.g., JPEG, JPEG2000) and their performance characteristics.**
3. **Presentation on a specific computer vision application (e.g., gesture recognition, facial expression recognition) and the underlying algorithms used**

Reference Books:

1. **Gonzalez Rafael C. and Woods Richard E., Digital Image Processing, New Delhi: Prentice– Hall of India.**

2. **M.K. Bhuyan , " Computer Vision and Image Processing: Fundamentals and Applications", CRC Press, USA, ISBN 9780815370840 - CAT# K338147**

3. **MOOCs course by Prof. M. K. Bhuyan, "Computer Vision and Image Processing - FundamentalsandApplications"https://onlinecourses.nptel.ac.in/noc21_ee23/course**

4. **Richard Szeliski, Computer Vision: Algorithms and Applications (1 ed.), Springer, 2011. ISBN 978-1848829350.**

5. **D. Forsyth and J. Ponce, Computer Vision: A Modern Approach (2 ed.), Prentice Hall, 2015. ISBN 978-9332550117.**

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the fundamental concepts and techniques of image processing.
CO2	**Apply** image enhancement techniques for improving image quality.
CO3	**Analyze** the impact of different image enhancement techniques on image quality and visual perception.
CO4	**Evaluate** the strengths and limitations of computer vision techniques in various applications
CO5	**Develop** innovative image fusion techniques for combining multiple images to enhance visual perception

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	-	-
C02	C3	-	P2
CO3	C4	-	P3
CO4	C5	A3	-
CO5	C6	A4	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	1	-	-	-	1	1	-	2
CO2	1	1	3	-	2	-	-	-	1	-	-	2
CO3	1	2	1	3	2	-	-	-	1	-	-	2
CO4	-	2	3	-	3	-	-	-	1	-	-	2
CO5	-	-	3	1	1	1	-	-	2	1	1	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PO3	PSO4
CO1	3	1	-	-
CO2	2	3	-	-
CO3	2	2	1	1
CO4	2	3	2	2
CO5	2	3	2	2

Relevance of the Syllabus to various indicators

Unit I	Introduction
Local	The fundamental concepts and applications of image processing can be relevant locally for various industries and research institutions that utilize image processing techniques.
Regional	-
National	-
Global	Image processing has global significance as it is used worldwide in multiple domains
Employability	Knowledge of image processing is in demand in the job market, and this syllabus can contribute to enhancing

	employability in related fields.
Entrepreneurship	-
Skill Development	Developing proficiency in image processing techniques
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Image Restoration and coloring
Local	Local industries such as photography studios, design agencies, and media production houses can benefit from students' knowledge of image restoration techniques to improve image quality and enhance visual content.
Regional	-
National	Contributes to national digital literacy and internet connectivity strategies
Global	Aligns with globally relevant as image restoration and computer vision techniques are used worldwide in various domains such as healthcare, surveillance, augmented reality, and autonomous systems.
Employability	Proficiency in image restoration, coloring, and computer vision techniques enhances the employability in industries such as image processing, computer vision, multimedia, animation, and gaming.
Entrepreneurship	-
Skill Development	-
Professional	-

Ethics	
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Image Compression and Segmentation
Local	-
Regional	-
National	-
Global	Image compression is a globally relevant field as the efficient transfer and storage of visual data is essential for various applications, including video streaming, social media, cloud services, and remote sensing.
Employability	Proficiency in image compression and segmentation techniques enhances the employability in industries such as multimedia, telecommunications, data analysis, and software development, where efficient handling of visual data is required.
Entrepreneurship	Students equipped with knowledge of image compression and segmentation techniques can explore entrepreneurial opportunities in areas such as image compression software development, image processing services, and innovative applications that rely on efficient image storage and transmission.
Skill Development	Develops critical skills in image compression algorithms, information theory, coding techniques, and image segmentation methodologies, empowering students to analyze, process, and optimize visual data effectively.
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit IV	Object Representation and Computer Vision Techniques
Local	The knowledge of object representation and computer vision techniques can contribute to the development of local industries and sectors that utilize computer vision technologies, such as surveillance systems, robotics, autonomous vehicles, and augmented reality applications.
Regional	-
National	-
Global	Object representation and computer vision techniques have global relevance due to their widespread applications in fields like image and video processing, computer graphics, virtual reality, and human-computer interaction, impacting global technological advancements.
Employability	The knowledge of object representation and computer vision techniques enhances the employability in industries related to computer vision, machine learning, and artificial intelligence, where the ability to develop and deploy computer vision algorithms and systems is highly valued.
Entrepreneurship	Students equipped with object representation and computer vision skills can explore entrepreneurial opportunities by developing innovative computer vision-based products, services, or solutions for industries such as retail, entertainment, healthcare, and security
Skill Development	Develops knowledge and skills in object representation, feature extraction, pattern recognition, and machine learning algorithms
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
SDG	SDG 4,9
NEP 2020	Emphasizes skill development in areas such as image enhancement, restoration, compression, segmentation, and computer vision techniques, which are highly relevant in the digital era and align with the policy's focus on skill-based education.
POE/4th IR	Aligns with the concepts of Technological Advancement, Innovation and Entrepreneurship ETCR

IMAGE PROCESSING & COMPUTER VISION LAB

Department:	**Department of Computer Science and Engineering**			
Course Name: **Image Processing & Computer Vision Lab**	**Course Code**	**L-T-P**	**Credits**	
	ENSP354	0-0-2	1	
Type of Course:	Minor			
Pre-requisite(s), if any: (1) Linear Algebra and (2) programming in python				

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Apply** image processing techniques using Python libraries.
CO 2	**Analyze** and evaluate the effectiveness of different image enhancement algorithms
CO 3	**Implement** image restoration algorithms and evaluate their performance in the presence of noise.
CO 4	**Develop** image compression algorithms and analyze their impact on image quality.
CO 5	**Formulate** computer vision techniques such as object detection and tracking, gesture recognition, and facial expression recognition using Python.

Ex. No	Experiment Title	Mapped CO/COs
1	Image acquisition and display using OpenCV library	CO 1
2	Image enhancement techniques: contrast stretching, histogram equalization	CO 2
3	Low-pass and high-pass filtering for image smoothing and sharpening	CO 2
4	Image degradation and restoration: modeling degradation process, noise reduction	CO 3
5	Inverse filtering and Wiener filtering for image restoration	CO 3
6	Geometric mean filter for image denoising	CO 3
7	Geometric transformations: translation, rotation, scaling	CO 1
8	Color image processing: color space conversion, histogram-based operations	CO 2
9	Image segmentation using thresholding techniques	CO 1
10	Texture analysis and feature extraction	CO 2
11	Edge detection and boundary extraction	CO 2
12	Interest point detection using Harris corner detector	CO 2
13	Speeded up robust features (SURF) for feature extraction	CO 2
14	Saliency detection in images	CO 2
15	Lossless and lossy image compression using Huffman coding	CO 4
16	Shanon-Fano coding and arithmetic coding for image compression	CO 4
17	Golomb coding and LZW coding for data compression	CO 4
18	Run-length coding for image compression	CO 4
19	Lossless predictive coding for image compression	CO 4
20	Bit plane coding for image compression	CO 4
21	Image segmentation based on discontinuity and similarity	CO 1

22	Edge linking and boundary detection in images	CO 1
23	Morphological operations: dilation and erosion	CO 1
24	Object representation and description using morphological algorithms	CO 1
25	Introduction to computer vision applications	CO 1
26	Pattern classification using artificial neural networks	CO 5
27	Convolutional neural networks for image classification	CO 5
28	Machine learning algorithms for image segmentation	CO 5
29	Motion estimation and object tracking	CO 5
30	Gesture recognition and face/facial expression recognition	CO 5

Detailed syllabus

Session 1: Image acquisition and display using OpenCV library
• Session: Introduction to image acquisition and display using OpenCV library
• Exercise: Write a Python code to capture and display images using OpenCV
• Project: Build a simple application to capture images from a webcam and display them in real-time
Session 2: Image enhancement techniques: contrast stretching, histogram equalization
• Session: Introduction to image enhancement techniques
• Exercise: Implement contrast stretching and histogram equalization algorithms in Python
• Project: Apply image enhancement techniques on a set of images and compare the results
Session 3: Low-pass and high-pass filtering for image smoothing and sharpening
• Session: Understanding low-pass and high-pass filters for image processing
• Exercise: Implement low-pass and high-pass filters in Python for image smoothing and sharpening
• Project: Apply filters on a set of images and analyze the effects of smoothing and sharpening
Session 4: Image degradation and restoration: modeling degradation

process, noise reduction
• Session: Introduction to image degradation and restoration
• Exercise: Model image degradation process and implement noise reduction techniques
• Project: Restore a set of degraded images using various restoration methods
Session 5: Inverse filtering and Wiener filtering for image restoration
• Session: Understanding inverse filtering and Wiener filtering for image restoration
• Exercise: Implement inverse filtering and Wiener filtering algorithms in Python
• Project: Apply restoration techniques on a set of images and evaluate the performance
Session 6: Geometric mean filter for image denoising
• Session: Introduction to geometric mean filter for image denoising
• Exercise: Implement geometric mean filter in Python for denoising images
• Project: Apply the filter on noisy images and compare the results with other denoising techniques
Session 7: Geometric transformations: translation, rotation, scaling
• Session: Introduction to geometric transformations in image processing
• Exercise: Implement translation, rotation, and scaling operations on images using OpenCV
• Project: Apply geometric transformations on a set of images and analyze the transformations' effects
Session 8: Color image processing: color space conversion, histogram-based operations
• Session: Understanding color image processing techniques
• Exercise: Perform color space conversion and histogram-based operations on images
• Project: Apply color image processing techniques on a set of images and analyze the results
Session 9: Image segmentation using thresholding techniques
• Session: Introduction to image segmentation using thresholding techniques
• Exercise: Implement thresholding algorithms for image segmentation in Python
• Project: Segment images using various thresholding methods and evaluate the segmentation results
Session 10: Texture analysis and feature extraction
• Session: Understanding texture analysis and feature extraction methods
• Exercise: Extract texture features from images using texture analysis

algorithms
• Project: Apply texture analysis and feature extraction techniques on images and analyze the extracted features
Session 11: Edge detection and boundary extraction
• Session: Introduction to edge detection and boundary extraction
• Exercise: Implement edge detection algorithms in Python
• Project: Detect edges and extract boundaries from a set of images using different edge detection methods
Session 12: Interest point detection using Harris corner detector
• Session: Understanding interest point detection using Harris corner detector
• Exercise: Implement Harris corner detection algorithm in Python
• Project: Detect interest points in images and analyze their properties using the Harris corner detector
Session 13: Speeded up robust features (SURF) for feature extraction
• Session: Introduction to SURF (Speeded Up Robust Features) algorithm
• Exercise: Implement SURF algorithm for feature extraction in Python
• Project: Extract features from images using SURF and evaluate their robustness and speed
Session 14: Saliency detection in images
• Session: Understanding saliency detection in images
• Exercise: Implement saliency detection algorithm in Python
• Project: Detect salient regions in images and analyze their significance using the implemented algorithm
Session 15: Lossless and lossy image compression using Huffman coding
• Session: Introduction to image compression using Huffman coding
• Exercise: Implement Huffman coding for lossless image compression in Python
• Project: Compress a set of images using Huffman coding and evaluate the compression ratio and quality
Session 16: Shanon-Fano coding and arithmetic coding for image compression
• Session: Understanding Shanon-Fano coding and arithmetic coding for image compression
• Exercise: Implement Shanon-Fano coding and arithmetic coding algorithms in Python
• Project: Compare the performance of Shanon-Fano coding and arithmetic coding for image compression
Session 17: Golomb coding and LZW coding for data compression
• Session: Introduction to Golomb coding and LZW (Lempel-Ziv-Welch)

coding for data compression
• Exercise: Implement Golomb coding and LZW coding algorithms in Python
• Project: Apply Golomb coding and LZW coding on data and analyze the compression efficiency
Session 18: Run-length coding for image compression
• Session: Understanding run-length coding for image compression
• Exercise: Implement run-length coding algorithm in Python
• Project: Compress images using run-length coding and analyze the compression performance
Session 19: Lossless predictive coding for image compression
• Session: Introduction to lossless predictive coding for image compression
• Exercise: Implement lossless predictive coding algorithm in Python
• Project: Apply predictive coding on images and evaluate the compression results
Session 20: Bit plane coding for image compression
• Session: Understanding bit plane coding for image compression
• Exercise: Implement bit plane coding algorithm in Python
• Project: Apply bit plane coding on images and analyze the compression efficiency
Session 21: Image segmentation based on discontinuity and similarity
• Session: Introduction to image segmentation based on discontinuity and similarity
• Exercise: Implement image segmentation algorithms using discontinuity and similarity measures
• Project: Segment images based on different segmentation criteria and evaluate the results
Session 22: Edge linking and boundary detection in images
• Session: Understanding edge linking and boundary detection in images
• Exercise: Implement edge linking algorithms for boundary detection in Python
• Project: Detect and link edges to extract boundaries from images using various edge linking methods
Session 23: Morphological operations: dilation and erosion
• Session: Introduction to morphological operations in image processing
• Exercise: Implement dilation and erosion operations using morphological algorithms
• Project: Apply morphological operations on images to analyze their effects on different objects
Session 24: Object representation and description using morphological algorithms

• Session: Understanding object representation and description using morphological algorithms
• Exercise: Implement object representation and description techniques using morphological operations
• Project: Represent and describe objects in images using morphological algorithms and analyze the results
Session 25: Introduction to computer vision applications
• Session: Overview of computer vision applications and use cases
• Exercise: Explore different computer vision applications and their functionalities
• Project: Choose a specific computer vision application, implement it, and demonstrate its capabilities
Session 26: Pattern classification using artificial neural networks
• Session: Introduction to pattern classification using artificial neural networks
• Exercise: Implement an artificial neural network for pattern classification in Python
• Project: Train a neural network model to classify patterns and evaluate its performance
Session 27: Convolutional neural networks for image classification
• Session: Understanding convolutional neural networks (CNNs) for image classification
• Exercise: Implement a CNN architecture in Python for image classification
• Project: Train a CNN model on a dataset for image classification and evaluate its accuracy
Session 28: Machine learning algorithms for image segmentation
• Session: Introduction to machine learning algorithms for image segmentation
• Exercise: Implement machine learning algorithms for image segmentation in Python
• Project: Apply machine learning techniques for image segmentation and analyze the segmentation results
Session 29: Motion estimation and object tracking
• Session: Understanding motion estimation and object tracking techniques
• Exercise: Implement motion estimation and object tracking algorithms in Python
• Project: Track objects in video sequences using motion estimation and analyze the tracking performance
Session 30: Gesture recognition and face/facial expression recognition
• Session: Introduction to gesture recognition and face/facial expression recognition

• Exercise: Implement gesture recognition and face/facial expression recognition algorithms in Python
• Project: Develop a system that can recognize gestures and facial expressions from video input

INTRODUCTION TO GENERATIVE AI

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Introduction to Generative AI</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP306</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Minor</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="4">Brief Syllabus:

This course introduces students to the fundamental concepts and techniques of Generative Artificial Intelligence (AI). Generative AI is an emerging field that focuses on developing algorithms and models capable of generating new content, such as images, music, and text. The course will cover the theoretical foundations of generative models and provide hands-on experience with open-source tools for creating and exploring generative AI applications.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Foundations of Generative AI</td><td>No. of hours: 12</td></tr>
<tr><td colspan="4">Content Summary:

Introduction to Generative AI: Definition, working and applications of generative AI, Historical overview and recent advancements, Ethical considerations and societal impact.
Probability and Statistics for Generative AI: Probability distributions and random variables, Maximum likelihood estimation, Bayesian inference and generative models.
Fundamentals of Deep Learning: Neural networks and their architectures, Backpropagation and optimization algorithms, Transfer learning and pre-trained models.</td></tr>
<tr><td>Unit</td><td colspan="2">Title: Generative Models</td><td>No. of hours: 8</td></tr>
</table>

Number: 2		
Content Summary: Overview of generative models: Gaussian Mixture Models, Hidden Markov Models; Representation learning and latent variables; Autoencoders: Basics of autoencoders and their applications, Encoder and decoder architectures, Reconstruction loss and latent space representation; Variational autoencoders (VAEs): Introduction to VAEs, reparameterization;		
Unit Number: 3	**Title: Generative Adversarial Networks and Flow-based Models**	**No. of hours: 8**
Content Summary: Generative Adversarial Networks (GANs)**:** Introduction, Architecture of GANs, Training GANs and understanding the loss functions; Autoregressive Models (including information-theoretic foundations) Flow-based generative models and their advantages, Normalizing flows and invertible transformations, Training and sampling from flow-based models, Evaluation of Generative Models: Metrics for evaluating generative models (log-likelihood, Inception Score)		
Unit Number: 4	**Title: Applications and Future Directions**	**No. of hours: 12**
Content Summary: **Real-World Applications of Generative AI:** Image synthesis and editing, Data augmentation and data generation, Generative AI in healthcare, gaming, and art; **Ethical Considerations and Challenges:** Bias and fairness in generative models, Deepfakes and misinformation, Responsible AI practices; Emerging **Trends and Future Directions:** Reinforcement learning and generative models, Meta-learning and few-shot generation, OpenAI's DALL-E.		
***Self-Learning Components:** • **Students are encouraged to explore and familiarize themselves with the tools of Python programming language for machine learning (NumPy, Pandas, PyTorch)** • **Experiment with popular open-source tools: TensorFlow and Keras** • **Presentation on current research areas like: style transfer, multimodal generation, and unsupervised learning.** • **Open source tools for image: CycleGAN for image translation, StyleGAN and StyleGAN2 for high-quality image synthesis, OpenAI's**		

CLIP for cross-model understanding • **Course on "Introduction to Generative AI" with Google Cloud**
Reference Books: 1. **Generative Deep Learning, by David Foster, 2nd Edition, O'Reilly Media, Inc.** 2. **Deep Learning by Ian Goodfellow, Yoshua Bengio and Aaron Courville , The MIT Press** 3. **PATTERN RECOGNITION AND MACHINE LEARNING by Christopher M. Bishop** 4. **Natural Language Processing with Python" by Steven Bird, Ewan Klein, and Edward Loper** **Reference Links:** • **Deep Learning Specialization on Coursera (includes a course on generative models):https://www.coursera.org/specializations/deep-learning** • **TensorFlow Tutorials on Generative Models: https://www.tensorflow.org/tutorials/generative** • **OpenAI's Generative Models page: https://openai.com/research/generative-models/**

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the foundational concepts of Generative AI
CO2	**Apply** probability distributions and random variables in generative models
CO3	**Employ** various generative models, such as VAEs, GANs, and flow-based models, to generate new data samples in different domains.
CO4	**Implement** and **Analyze** generative models

CO5	**Evaluate** emerging trends and future directions in the field of Generative AI
CO6	**Develop** sequence generation models using recurrent neural networks (RNNs) and LSTM

COs Mapping with Levels of Bloom’s taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A1	P1
CO2	C3	A2	P2
CO3	C3	A3	P3
CO4	C4	A4	P4
CO5	C5	A4	P5
CO6	C6	A5	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	2	-	2	-	2	-	3
CO2	3	3	-	2	2	-	-	-	-	-	-	3
CO3	-	-	3	-	-	-	2	2	2	3	-	2
CO4	-	3	2	3	3	-	2	-	-	-	-	2
CO5	-	-	-	2	3	-	2	-	2	-	1	2
CO6	-	-	1	2	-	3	-	-	3	3	2	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PO1	PO2	PO3	PSO4
CO1	3	-	-	-
CO2	3	3	-	-
CO3	3	3	3	-
CO4	-	3	-	-
CO5	3	3	-	-
CO6	-	3	3	-

Relevance of the Syllabus to various indicators

Unit I	**Foundations of Generative AI**
Local	-
Regional	-
National	-
Global	Understanding generative AI enables participation in global technological development and collaboration.
Employability	Proficiency in generative AI enhances employability in AI-related fields and industries.
Entrepreneurship	-
Skill Development	Develops technical skills in deep learning, probabilistic modeling
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Generative Models**

Local	-
Regional	-
National	-
Global	Technological development and innovation.
Employability	-
Entrepreneurship	-
Skill Development	Develops technical skills in autoencoders, VAEs, GANs, and autoregressive models.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Generative Adversarial Networks and Flow-based Models**
Local	-
Regional	-
National	-
Global	Developing algorithms and models
Employability	-
Entrepreneurship	-
Skill Development	Develops technical skills in Generative Adversarial Networks and Flow-based Models
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit IV	**Applications and Future Directions**
Local	-
Regional	-
National	-
Global	Knowledge of emerging trends and future directions in the field of Generative AI
Employability	-
Entrepreneurship	-
Skill Development	Develops skills in applying generative models, analyzing their performance, and exploring future directions.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4,8,9
NEP 2020	Development of a knowledge-based society and promotes interdisciplinary learning.
POE/4th IR	Advancement of AI technologies.

INTRODUCTION TO GENERATIVE AI LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Generative AI Lab	**ENSP356**	0-0-2	1
Type of Course:	Minor		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Utilize** Python programming to generate random samples from various probability distributions
CO 2	**Apply** knowledge of generative AI models and frameworks
CO 3	**Develop** proficiency in building and training feedforward neural networks and deep learning frameworks
CO 4	**Implement** basic autoencoder models and train them on datasets
CO5	**Evaluate** the performance metrics of trained models, such as accuracy and loss

Ex. No	Experiment Title	Mapped CO/COs
1	Generate random samples from various probability distributions (e.g., normal distribution, uniform distribution) using Python	CO1
2	Implement maximum likelihood estimation (MLE) for a given dataset and estimate the parameters of a selected probability distribution.	CO1
3	Explore and experiment with existing generative AI models and frameworks (e.g., TensorFlow, PyTorch).	CO2
4	Implement a basic generative AI model (e.g., a simple image generator) using a chosen framework.	CO2
5	Implement a feedforward neural network using a deep learning framework (e.g., TensorFlow, PyTorch).	CO3
6	Train the neural network on a benchmark dataset (e.g., MNIST, CIFAR-10) using backpropagation and a chosen optimization algorithm (e.g., stochastic gradient descent).	CO3
7	Evaluate the trained model's performance metrics (e.g., accuracy, loss) on a separate validation set.	CO5
8	Compare and analyze the performance of the trained model with and without transfer learning.	CO5
9	Train an autoencoder on a dataset of images.	CO4
10	Encode a set of images using the trained encoder and visualize their corresponding latent space representations	CO4
11	Build an encoder and a decoder architecture for a VAE using a deep learning framework.	CO4
12	Train the VAE on a dataset of images (e.g., MNIST, CIFAR-10) using a chosen loss function	CO4
13	Implement a basic autoencoder model and train it on a dataset.	CO4

14	Implement an autoregressive model, such as PixelCNN or PixelRNN, using a deep learning framework.	CO3
15	Implement a GAN architecture using a deep learning framework.	CO3
16	Train the GAN on a dataset of images (e.g., MNIST, CIFAR-10) and monitor the generator and discriminator losses.	CO5
17	Analyze the loss functions used in GAN training (e.g., adversarial loss, feature matching loss)	CO5
18	Train an RNN-based model to generate sequences (e.g., text or music)	CO3
19	Train the RNN on a dataset of sequences (e.g., text corpus, MIDI data) using backpropagation through time (BPTT)	CO3
20	Implement a flow-based generative model using a deep learning framework	CO3
21	Fine-tune a pre-trained deep learning model on a new task or dataset.	CO3
22	Implement the Tacotron model using a deep learning framework.	CO3
23	Implement the CycleGAN model using a deep learning framework.	CO3
24	Implement the evaluation metrics using appropriate libraries or frameworks.	CO5
25	Evaluate the performance of different generative models using the implemented metrics.	CO5

Projects:

Project 1: Random Data Analysis
Description: In this project, you will generate random samples from various probability distributions using Python and analyze the generated data.
Tasks:
1. Choose three different probability distributions (e.g., normal distribution, uniform distribution, exponential distribution).
2. Write Python code to generate random samples from each distribution using appropriate libraries or functions.
3. Plot histograms or density plots to visualize the generated samples for each distribution.
4. Compute and display summary statistics (e.g., mean, standard deviation) for each generated sample.
5. Compare the characteristics of the generated samples from different distributions and analyze their differences.
Project 2: Parameter Estimation for a Probability Distribution
Description: In this project, you will implement the maximum likelihood estimation (MLE) algorithm to estimate the parameters of a selected probability distribution based on a given dataset.
Task:
1. Choose a probability distribution (e.g., normal distribution, exponential distribution) and specify its probability density function (PDF) or probability mass function (PMF).
2. Generate a synthetic dataset based on the chosen distribution with known parameters.
3. Implement the MLE algorithm using Python to estimate the parameters of the distribution from the synthetic dataset.
4. Compare the estimated parameters with the known true parameters and calculate the estimation error.
5. Repeat the process for multiple iterations with different dataset sizes to analyze the performance of the MLE algorithm with varying sample sizes.
Project 3: Exploring Pre-trained Generative AI Models
Description: In this mini project, you will explore and experiment with existing pre-trained generative AI models using popular frameworks such as TensorFlow

or PyTorch.
Task:
1. Choose a specific generative AI model, such as a pre-trained image generation model (e.g., GAN, VAE) or a text generation model (e.g., language model).
2. Set up the chosen deep learning framework (e.g., TensorFlow or PyTorch) and load the pre-trained model.
3. Understand the input and output requirements of the model and experiment with generating new samples.
4. Analyze and interpret the generated samples in terms of their quality, diversity, or other relevant metrics.
5. Explore different input variations or techniques to generate customized or specific samples.
Project 4: Image Classification using Feedforward Neural Network
Description: In this mini project, you will implement a feedforward neural network using a deep learning framework and train it for image classification on a benchmark dataset.
Task:
1. Choose a benchmark dataset for image classification, such as MNIST or CIFAR-10.
2. Set up the chosen deep learning framework (e.g., TensorFlow or PyTorch) and define the architecture of the feedforward neural network for image classification.
3. Preprocess the dataset, including normalization and splitting into training and validation sets.
4. Implement the training loop for the feedforward neural network using backpropagation and a chosen optimization algorithm (e.g., stochastic gradient descent).
5. Evaluate the trained model's performance metrics (e.g., accuracy, loss) on the separate validation set and analyze the results.

TRANSFER LEARNING

Department:	**Department of Computer Science and Engineering**		
Course Name: **Transfer Learning**	**Course Code**	**L-T-P**	**Credits**
	ENSP308	4-0-0	4
Type of Course:	Minor		
Pre-requisite(s), if any:			

Brief Syllabus:

The "Transfer Learning" syllabus covers an Introduction to transfer learning, pretrained models, fine-tuning, and feature extraction. Deep transfer learning techniques, including domain adaptation and multi-task learning. Practical implementation with data preprocessing, model adaptation, and experimentation. Applications in computer vision, NLP, and challenges like negative transfer and ethical considerations.

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to Transfer Learning**	**No. of hours: 8**

Content Summary:

Fundamentals of transfer learning, motivation, and applications. Pretrained models and their usage. Fine-tuning and feature extraction. Transfer learning frameworks and libraries. Transfer learning strategies and techniques. Evaluation and performance metrics for transfer learning models. Case studies and real-world applications.

Unit Number: 2	**Title: Transfer Learning Techniques and Algorithms**	**No. of hours: 8**

Deep transfer learning methods, including domain adaptation, instance transfer, and multi-task learning. Transfer learning in convolutional neural networks (CNNs), recurrent neural networks (RNNs), and generative models. Ensemble-based transfer learning approaches. Handling domain shift and dataset bias. Advanced transfer learning algorithms and architectures.

Unit Number: 3	Title: Practical Implementation of Transfer Learning	No. of hours: 12

Data preprocessing and feature extraction for transfer learning. Fine-tuning and model adaptation techniques. Transferring knowledge across different domains and tasks. Implementing transfer learning in popular deep learning frameworks. Experimentation, analysis, and fine-tuning of transfer learning models.

Unit Number: 4	Title: Transfer Learning Applications and Challenges	No. of hours: 12

Content Summary:

Transfer learning in computer vision, natural language processing (NLP), and speech recognition. Transfer learning for specific domains like healthcare, finance, and social media analysis. Challenges in transfer learning, such as negative transfer and overfitting. Ethical considerations and fairness in transfer learning. Latest research trends and future directions in transfer learning.

***Self-Learning Components**:

- Students can leverage online platforms like Coursera, edX, and Udemy to access transfer learning courses. These resources provide in-depth knowledge, practical examples, and hands-on exercises to enhance their understanding
- Students can explore and experiment with open-source libraries and frameworks like TensorFlow, PyTorch, and Scikit-learn. These tools provide pre-trained models, sample code, and documentation that facilitate self-learning and experimentation.
- https://www.coursera.org/lecture/convolutional-neural-networks/transfer-learning

**students will demonstrate the self-learning components through classroom presentations*

Reference Books:

- "Transfer Learning" by Sinno Jialin Pan and Qiang Yang (Morgan & Claypool Publishers)
- "Transfer Learning for Natural Language Processing" by Shervin Minaee and Amirali Abdolrashidi (Springer)

- "Domain Adaptation in Computer Vision Applications" by Gabriela Csurka (Morgan & Claypool Publishers)
- "Transfer Learning in Reinforcement Learning" by Panpan Cai, Yang Yu, and Xuewen Yao (Springer)

Text Books

- "Transfer Learning: Algorithms and Applications" by B. K. Tripathy and Sandipan Roy (Springer)
- "Transfer Learning and Domain Adaptation in NLP" by Yoshua Bengio, Jian-Yun Nie, and Geoffrey J. Gordon (Morgan & Claypool Publishers)
- Transfer Learning: Methods, Applications, and Challenges" by R. Sathya and K. S. Devi (CRC Press)

Define Course Outcomes (CO)

COs	Statements
CO1	Understand transfer learning concepts and principles.
CO 2	Apply transfer learning techniques to real-world problems.
CO 3	Analyze and evaluate the performance of transfer learning algorithms
CO 4	Synthesize and adapt pre-trained models for specific tasks.
CO 5	Critically think, propose innovative approaches, and effectively communicate transfer learning concepts

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1,C2	A1	P1
CO2	C3	A2	P2
CO3	C4	A3	P3
CO4	C5	A4	-
CO5	C5	-	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	-	-	-	1	-	-	1
CO2	3	2	3	2	3	3	-	-	2	2	-	2
CO3	3	3	3	2	3	-	-	-	2	2	-	3
CO4	3	-	1	-	1	-	-	-	1	-	-	2
CO5	3	1	1	3	2	-	-	-	1	3	-	2

Relevance of the Syllabus to various indicators

Unit I	**Introduction to Transfer Learning**
Local	Applying transfer learning to address specific local challenges, utilizing local frameworks and libraries, and evaluating the performance of transfer learning models on local datasets
Regional	Exploring regional datasets and case studies to understand the effectiveness of transfer learning in addressing regional challenges

National	Understanding the national context and specific needs for transfer learning applications
Global	Exploring transfer learning applications and advancements on a global scale, collaborating with international research communities, and addressing global challenges through the development of transfer learning models and frameworks
Employability	Developing practical skills in transfer learning, enhancing job prospects in various domains such as computer vision, natural language processing, and data analysis,
Entrepreneurship	Empowering students to explore innovative applications of transfer learning, fostering an entrepreneurial mindset to create new products, services, and solutions
Skill Development	Enhancing technical skills, problem-solving abilities, critical thinking, and collaboration in transfer learning
Professional Ethics	
Gender	
Human Values	
Environment & Sustainability	
Unit II	**Transfer Learning Techniques and Algorithms**
Local	Addressing local challenges and requirements with advanced transfer learning techniques
Regional	Leveraging transfer learning to address regional data patterns and challenges.
National	Using transfer learning to tackle national-level data characteristics and requirements.
Global	Leveraging transfer learning for global-scale data analysis and knowledge sharing.
Employability	Enhancing employability through the application of transfer learning in real-world scenarios

Entrepreneurship	Exploring entrepreneurial opportunities in transfer learning for developing innovative solutions
Skill Development	Enhancing technical skills and expertise in transfer learning methodologies and applications.
Professional Ethics	Adhering to ethical principles and responsible conduct in transfer learning research and applications.
Gender	
Human Values	
Environment & Sustainability	
Unit III	**Practical Implementation of Transfer Learning**
Local	Developing expertise in data preprocessing and feature extraction techniques relevant to local data and domain-specific tasks
Regional	Implementing fine-tuning and model adaptation techniques suitable for regional datasets and specific regional tasks
National	Transferring knowledge across different domains and tasks to address national-level challenges and improve performance on national datasets.
Global	Understanding and implementing transfer learning in popular deep learning frameworks used globally to solve diverse problems
Employability	Acquiring practical skills in experimentation, analysis, and fine-tuning of transfer learning models, enhancing employability in the field of machine learning and artificial intelligence.
Entrepreneurship	Exploring real-world applications and identifying opportunities for entrepreneurial ventures using transfer learning techniques
Skill Development	Developing proficiency in data preprocessing, feature extraction, model adaptation, and experimentation, fostering overall skill development in the field of transfer learning.
Professional	

Ethics	
Gender	
Human Values	
Environment & Sustainability	
Unit IV	**Transfer Learning Applications and Challenges**
Local	Applying transfer learning techniques in computer vision, NLP, and speech recognition tasks specific to the local context
Regional	Exploring transfer learning applications in specific regional domains like healthcare, finance, and social media analysis
National	Addressing national challenges and opportunities by leveraging transfer learning in various domains.
Global	Staying updated with the latest research trends and future directions in transfer learning, contributing to the global knowledge base
Employability	Acquiring skills in transfer learning for computer vision, NLP, and speech recognition, enhancing employability in diverse industries.
Entrepreneurship	Identifying innovative applications of transfer learning in domains like healthcare, finance, and social media to create entrepreneurial opportunities.
Skill Development	Developing expertise in addressing challenges like negative transfer and overfitting, advancing overall skill development in transfer learning.
Professional Ethics	
Gender	
Human Values	
Environment & Sustainability	

SDG	SDG 4
NEP 2020	Under NEP 2020, collaborative learning environments are promoted to foster interactive and engaging teaching practices, which are supported by the implementation of transfer learning.
POE/4th IR	Transfer learning is highly relevant in the context of the Fourth Industrial Revolution (4th IR), facilitating the adaptation and application of existing knowledge and models to drive innovation, efficiency, and social impact across various domains.

TRANSFER LEARNING LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **Transfer Learning Lab**	**Course Code**	**L-T-P**	**Credits**
	ENSP358	0-0-2	1
Type of Course:	Minor		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	Understand the fundamentals of transfer learning, including its motivation and applications.
CO 2	Gain proficiency in implementing transfer learning techniques and algorithms using Python.
CO 3	Apply fine-tuning and model adaptation techniques to transfer knowledge across different domains and tasks
CO 4	Evaluate and measure the performance of transfer learning models using appropriate metrics in Python.
CO5	Analyze case studies and real-world applications of transfer learning to understand its practical implications

Ex. No	Experiment Title	Mapped CO/COs
1	Fine-tuning Pretrained Models using Python	CO1

2	Introduction to Transfer Learning using Python	CO1
3	Exploring Pretrained Models in Python	CO2
4	Implementing Transfer Learning with Pretrained Models in Python	CO2
5	Feature Extraction from Pretrained Models using Python	CO2
6	Implementing a deep transfer learning model using Python libraries like TensorFlow or PyTorch to address domain shift in image classification tasks.	CO3
7	Fine-tuning a pre-trained CNN architecture, such as VGG or ResNet, in Python to transfer knowledge from a source task to a target task.	CO2
8	Implementing a multi-task learning approach using Python libraries like Keras or TensorFlow to train an RNN model for multiple related tasks in natural language processing.	CO3
9	Building an ensemble of transfer learning models in Python by combining predictions from multiple pre-trained models to improve performance in image recognition tasks.	CO3
10	Utilizing Python libraries like TensorFlow or PyTorch to implement generative models, such as GANs, to handle dataset bias and generate synthetic data for transfer learning.	CO3
11	Preprocess a dataset using Python libraries like NumPy and Pandas, perform data augmentation techniques, and extract relevant features for transfer learning tasks.	CO4
12	Implement fine-tuning techniques using Python and deep learning frameworks like TensorFlow or PyTorch to adapt pre-trained models to new target tasks.	CO3
13	Transfer knowledge from a pre-trained model in one domain to a different domain or task using Python and transfer learning techniques like domain adaptation or multi-task learning.	CO2

14	Implement transfer learning using popular deep learning frameworks like TensorFlow or PyTorch. Students can choose a specific framework, load pre-trained models, and fine-tune them for their desired tasks.	CO3
15	Design experiments to evaluate different transfer learning strategies and techniques, analyze the performance of transfer learning models using Python, and fine-tune the models based on the analysis results	CO4
16	Implement transfer learning techniques using Python and deep learning frameworks like TensorFlow or PyTorch for computer vision tasks such as image classification, object detection, or image segmentation.	CO3
17	Apply transfer learning methods in Python and NLP libraries like NLTK or spaCy for tasks like sentiment analysis, text classification, or named entity recognition.	CO3
18	Utilize Python and speech recognition libraries like SpeechRecognition or PyAudio to develop transfer learning models for speech recognition tasks.	CO3
19	Choose a specific domain like healthcare, finance, or social media analysis and implement transfer learning techniques in Python to address domain-specific tasks such as medical image classification, financial sentiment analysis, or social media text classification.	CO5
20	Apply transfer learning concepts to time-series data using Python and deep learning frameworks like TensorFlow or PyTorch to solve tasks like forecasting, anomaly detection, or sensor data analysis	CO4
21	Study recent research papers on transfer learning and implement cutting-edge transfer learning algorithms or architectures in Python to stay updated with the latest trends in the field	CO5

Semester: 7

(DEPARTMENT ELECTIVE-II)

SECURE CODING AND VULNERABILITIES

Department:	**Department of Computer Science and Engineering**		
Course Name: **Secure Coding & Vulnerabilities**	**Course Code**	**L-T-P**	**Credits**
	ENSP301	4-0-0	4
Type of Course:	Minor (DEPARTMENT ELECTIVE-II)		
Pre-requisite(s), if any:			

Brief Syllabus:

Secure Coding and Vulnerabilities is a comprehensive course that focuses on understanding and mitigating application security threats and attacks. The course covers various aspects such as security requirements gathering, secure application design and architecture, and secure coding practices for input validation, authentication, cryptography, session management, and error handling. Students will learn about common application vulnerabilities and the potential consequences of security breaches. They will also gain knowledge and skills in static and dynamic application security testing methods, as well as secure deployment and maintenance practices. The course aims to equip students with the necessary tools and techniques to develop robust and secure applications while adhering to best practices in the field of application security.

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to coding and Security**	**No. of hours: 10**

Content Summary:

Introduction-security concepts-CIA Triad, Viruses, Trojans, and Worms, threat, vulnerability, risk, attack. Coding Standards: Dirty Code and Dirty Compiler, Dynamic Memory Management functions, Common memory management Errors (Initialization Errors, Forget to Check Return Values, accessing already freed memory, Freeing the

same memory multiple times, Forget to free the allocated memory), Integer Security –Introduction to integer types: Integer Data Types, data type conversions, Integer vulnerabilities and mitigation strategies

Unit Number: 2	**Title: Secure Application Design and Architecture**	**No. of hours: 10**
Content Summary: Security requirements gathering and analysis, Secure software development life cycle (SSDLC), Security issues while writing SRS, Design phase security, Development Phase, Test Phase, Maintenance Phase, Writing Secure Code – Best Practices SD3 (Secure by design, default and deployment), Security principles and Secure Product Development Timeline.		
Unit Number: 3	**Title: Secure Coding Practices and Vulnerabilities**	**No. of hours: 10**
Content Summary: Input validation Techniques-whitelist validation, regular expressions, authentication and authorization, Cryptography, buffer overflows, Session management and protection against session-related attacks, Secure error handling and logging practices, SQL Injection Techniques and Remedies, Race conditions		
Unit Number: 4	**Title: Application Security Testing and Deployment**	**No. of hours: 10**
Content Summary: Security code overview, Secure software installation. The Role of the Security Tester, Building the Security Test Plan. Testing HTTP-Based Applications, Testing File-Based Applications, Testing Clients with Rogue Servers, Static and Dynamic Application Security Testing (SAST & DAST), Secure Deployment and Maintenance, Patch management and software updates, Vulnerability scanning and penetration testing.		

***Self-Learning Components: mention 4-5 topics for students in bullet points**

Please Note:

1) Code Review Tools: Students can explore open-source code review tools such as SonarQube, ESLint, or FindBugs to understand how these tools can help identify security vulnerabilities in code.
2) Security Frameworks such as OWASP (Open Web Application Security Project) and their associated resources.
3) Secure Development Tools: Students can explore tools like Burp Suite, ZAP

(Zed Attack Proxy), or WebInspect to understand how these tools can be used for dynamic application security testing (DAST) and penetration testing.

4) Secure Coding in Web Applications: Students can dive deeper into web application security topics, such as Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), or security measures like Content Security Policy (CSP) and HTTP security headers.

Please Note:

1)Students are supposed to learn the components on self-basis

2) At least 5-10 % syllabus will be asked in end term exams from self-learning components.

Reference Books:

- Writing Secure Code, Michael Howard and David LeBlanc,Microsoft Press, 2nd Edition, 2004
- Buffer Overflow Attacks: Detect, Exploit, Prevent by Jason Deckard ,Syngress,1st Edition, 2005
- Threat Modeling, Frank Swiderski and Window Snyder,Microsoft Professional, 1st Edition ,2004
- Secure Coding: Principles and Practices by Mark G. Graff, Kenneth R. van Wyk, Publisher(s): O'Reilly Media, Inc., 2003
- The Software Vulnerability Guide (Programming Series) by H. Thompson (Author), Scott G. Chase, 2005

Reference Links:

- **"Secure Coding Practices" on Udemy - Offered by The App Brewery. Link: https://www.udemy.com/course/secure-coding-practices/**
- "**Secure Coding: Preventing Software Vulnerabilities" on Pluralsight - Offered by Pluralsight**. Link: Secure Coding: Preventing Software Vulnerabilities
- "**Software Security" on edX - Offered by University of Maryland, College Park**. Link: Software Security
- Identifying Security Vulnerabilities in C/C++Programming | Coursera
- Principles of Secure Coding | Coursera
- Identifying Security Vulnerabilities | Coursera

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** different types of application security threats and their potential impact.
CO2	**Apply** secure design principles and architectures to develop robust and secure applications.
CO3	**Implement** secure coding practices for input validation, authentication, cryptography, session management, and error handling.
CO4	**Conduct** static and dynamic application security testing to identify vulnerabilities and implement secure deployment and maintenance practices.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A2	P2
CO2	C3	A3	P3
CO3	C3	A3	P3
CO4	C4	A4	P4

CO-PO Mapping

CO-PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	-	2	-	2	2	2	2	3
CO2	3	2	3	2	-	-	-	-	-	3	3	3
CO3	3	3	3	2	-	-	-	-	-	3	3	3
CO4	2	2	1	3	-	2	-	1	1	2	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

CO	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	-
CO2	3	-	-	-
CO3	2	3	3	1
CO4	2	-	-	-

Relevance of the Syllabus to various indicators

Unit I	**Introduction to coding and Security**
Local	-
Regional	-
National	-
Global	Enhancing cybersecurity capabilities and promoting secure software development.
Employability	-
Entrepreneurship	-
Skill Development	Developing coding skills with a focus on security.
Professional	Develop applications that prioritize data security and user

Ethics	privacy.
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Secure Application Design and Architecture**
Local	Applying security requirements and following secure software development life cycle (SSDLC) practices aligns with local needs to protect sensitive data and ensure secure application design.
Regional	-
National	-
Global	Promotes global standards in application security, fostering a global culture of secure software development.
Employability	Proficiency in secure application design and adherence to security principles enhances students' employability in organizations seeking professionals with secure development skills
Entrepreneurship	-
Skill Development	Enhances students' skills in secure software design, architecture, and implementation, preparing them to tackle application security challenges.
Professional Ethics	Ethical considerations of data privacy and security, fostering responsible development practices.
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Secure Coding Practices and Vulnerabilities**

Local	Understanding input validation techniques, cryptography, and secure error handling directly addresses local needs for developing secure applications and mitigating common vulnerabilities.
Regional	-
National	Addressing vulnerabilities such as SQL injection and race conditions through secure coding practices aligns with national objectives of securing critical applications and preventing cyber attacks.
Global	Knowledge of secure coding practices and vulnerability mitigation strategies helps establish global standards for secure software development and promotes a secure digital environment worldwide.
Employability	-
Entrepreneurship	-
Skill Development	Hones students' skills in secure coding, vulnerability identification, and remediation, enhancing their technical capabilities in application security.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Application Security Testing and Deployment**
Local	-
Regional	-
National	-
Global	Understanding static and dynamic application security testing methods and secure deployment practices promotes global standards for secure software deployment and mitigating

	application vulnerabilities.
Employability	Expertise in application security testing and secure deployment enhances students' employability in roles focused on ensuring application security and secure software deployment.
Entrepreneurship	-
Skill Development	Develops students' skills in application security testing, penetration testing, and secure deployment, equipping them with practical expertise in securing applications.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG-4,9,16
NEP 2020	Skill development, employability, and entrepreneurship
POE/4th IR	Emphasizes the importance of cybersecurity in the digital era.

K.R. MANGALAM UNIVERSITY

SECURE CODING AND VULNERABILITIES LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Secure Coding & Vulnerabilities Lab	**ENSP351**	0-0-2	1
Type of Course:	Minor (DEPARTMENT ELECTIVE-II)		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Apply** Secure Coding Techniques for enhancing application security.
CO 2	**Analyze** and Evaluate Security Vulnerabilities
CO 3	**Evaluate** and Communicate Importance of Secure Coding by analyzing potential vulnerabilities
CO 4	**Design** and Implement Secure Applications using secure cryptographic libraries.

Ex. No	Experiment Title	Mapped CO/COs
1	Write code to convert between different data types	CO1
2	Implement dynamic memory allocation and deallocation operations and analyze potential errors and	CO2

	vulnerabilities.	
3	Write code snippets with initialization errors, memory leaks, and double free issues, and use tools like Valgrind to detect and fix these errors.	CO2
4	Analyze a given code snippet with dirty code practices	CO2
5	Perform static code analysis on a sample codebase using a secure coding tool SonarQube	CO3
6	Conduct dynamic code analysis on a web application using OWASP	CO2
7	Configure the tool to intercept and analyze HTTP requests and responses.	CO2
8	Implement encryption algorithms (e.g., AES) using secure cryptographic libraries or frameworks.	CO4
9	Implement and test whitelist validation techniques to ensure secure input handling.	CO1
10	Develop a simple web application that requires user authentication.	CO4
11	Implement cryptographic functions for secure data protection	CO4
12	Implement input sanitization and validation techniques to prevent SQL injection attacks.	CO1
13	Conduct a security audit and penetration testing on a provided application to identify SQL injection vulnerabilities.	CO2
14	Identify common memory management errors such as forgetting to check return values or accessing already freed memory.	CO2
15	Write a sample code that requires input validation, such as user input or data from external sources.	CO1
16	Write a sample code that involves cryptographic operations, such as encryption or hashing.	CO4

17	Conduct security testing on an HTTP-based application to identify vulnerabilities and security weaknesses.	CO2
18	Set up a local or web-based application that operates over HTTP. Perform security testing using appropriate tools and techniques, such as vulnerability scanners and penetration testing	CO2
19	Perform security testing on a file-based application to assess its security posture and identify potential vulnerabilities.	CO2
20	Utilize appropriate tools and techniques to conduct static analysis on the application's source code to identify potential vulnerabilities	CO3
21	Identify and configure important HTTP security headers, such as Strict-Transport-Security (HSTS), X-Frame-Options, X-XSS-Protection, and X-Content-Type-Options.	CO1
22	Develop a sample web application that includes error handling and logging functionality.	CO4
23	Implement secure error handling techniques, such as displaying generic error messages to users and logging detailed errors only to authorized personnel.	CO4
24	Apply secure coding best practices, such as input validation, output encoding, proper error handling, and secure use of APIs and libraries.	CO1
25	Test the code for vulnerabilities and discuss the importance of writing secure code to prevent potential exploitation.	CO3

Projects:

- Implement a secure software development lifecycle
  http://www.owasp.org/index.php/Category:OWASP_CLASP_Project

- Establish secure coding standards
  http://www.owasp.org/index.php/Category:OWASP_Guide_Project

- Build a re-usable object library
  http://www.owasp.org/index.php/Category:OWASP_Enterprise_Security_API

- Verify the effectiveness of security controls
  http://www.owasp.org/index.php/Category:OWASP_Application_Security_Verification_Standard_Project

- Establish secure outsourced development practices including defining security requirements and verification methodologies in both the request for proposal (RFP) and contract.
  http://www.owasp.org/index.php/Category:OWASP_Legal_Project

CYBER CRIME INVESTIGATION & DIGITAL FORENSICS

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Cyber Crime Investigation & Digital Forensics</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP303</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Minor (DEPARTMENT ELECTIVE-II)</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="4">Brief Syllabus:

Introduces the principles and practices of digital forensics including digital investigations, data and file recovery methods, and digital forensics analysis and invalidation. Topics include data acquisition, digital forensics tools, virtual machines, network, mobile devices and cloud forensics.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Title: Introduction</td><td>No. of hours: 10</td></tr>
<tr><td colspan="4">Content Summary:

Introduction to Digital Forensics, Definition and types of cybercrimes, electronic evidence and handling, electronic media, collection, searching and storage of electronic media, introduction to internet crimes, hacking and cracking, credit card and ATM frauds, web technology, cryptography, emerging digital crimes and modules.</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Types of Cyber Crimes</td><td>No. of hours: 10</td></tr>
<tr><td colspan="4">Content Summary:

Crimes targeting Computers: Unauthorized Access Packet Sniffing Malicious Codes including Trojans, Viruses, Logic Bombs, etc. Online based Cyber Crimes: Phishing</td></tr>
</table>

and its variants Web Spoofing and E-mail Spoofing Cyber Stalking Web defacement Financial crimes, ATM and Card Crimes etc Spamming Commercial espionage and Commercial Extortion online Software and Hardware Piracy Money Laundering Fraud& Cheating Other Cyber Crimes.		
Unit Number: 3	**Title: Investigation of Cyber Crimes**	**No. of hours: 10**
Content Summary: Investigation of malicious applications Agencies for investigation in India, their powers and their constitution as per Indian Laws Procedures followed by First Responders; Evidence Collection and Seizure Procedures of Digital mediums Securing the Scene, Documenting the Scene, Evidence Collection and Transportation Data Acquisition Data Analysis Reporting		
Unit Number: 4	**Title : Forensic Tools and Processing of Electronic Evidence**	**No. of hours: 10**
Content Summary: Introduction to Forensic Tools, Usage of Slack space, tools for Disk Imaging, Data Recovery, Vulnerability Assessment Tools, Encase and FTK tools, Anti Forensics and probable counters, retrieving information, process of computer forensics and digital investigations, processing of digital evidence, digital images, damaged SIM and data recovery, multimedia evidence, retrieving deleted data: desktops, laptops and mobiles, retrieving data from slack space, renamed file, ghosting, compressed files.		
***Self-Learning Components**: **1. Open-Source Digital Forensics Tools: Introduction to popular open-source digital forensics tools such as Autopsy, Sleuth Kit, and Volatility.** **2. Exploring open-source threat intelligence platforms like MISP and AlienVault OTX.** **3. Discussing the benefits of information sharing and collaborative efforts in combating cyber threats.** **4. Digital Forensics and Cyber-Crime Investigation, https://www.udemy.com/course/digital-forensics-and-cyber-crime-investigation/**		

Please Note: 1)Students are supposed to learn the components on self-basis 2) At least 5-10 % syllabus will be asked in end term exams from self-learning components.
Reference Books: • Moore, Robert, (2011). Cybercrime, investigating high-technology computer crime(2nd Ed.). Elsevie • C. Altheide& H. Carvey Digital Forensics with Open Source Tools, Syngress, 2011. • Majid Yar, "Cybercrime and Society", SAGE Publications Ltd, Hardcover, 2nd Edition, 2013. • Robert M Slade, "Software Forensics: Collecting Evidence from the Scene of a Digital Crime", Tata McGraw Hill, Paperback, 1st Edition, 2004. **Web references:** • https://www.coursera.org/learn/digital-forensics-concepts • https://www.udemy.com/course/computer-forensics-and-digital-forensics-for-everyone/

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the nature and classification of conventional and cyber-crimes.
CO2	**Analyze** and **identify** various types of cyber-crimes and their modes of operation.
CO3	**Evaluate** the impact of cyber-crimes on individuals, organizations, and society**.**
CO4	**Develop** an understanding of digital forensics and the investigative

	procedures used in cyber-crime cases.
CO5	**Apply** forensic tools and techniques to retrieve and analyze digital evidence.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A1	-
C02	C3	-	-
CO3	C4	A2	-
CO4	C5	-	P5
CO5	C6	-	P2

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	1	-	2	2	-	2	2	1
CO2	-	3	3	-	3	2	-	2	3	-
CO3	-	1	3	-	3	2	2	3	3	-
CO4	2	2	2	3	3	3	2	2	2	-
CO5	-	2	2	3	3	3	-	2	2	-

Justification for mapping must be relevant.

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PSO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1
CO2	3	1	2	1
CO3	2	1	3	2
CO4	2	2	2	3
CO5	3	1	2	2

Relevance of the Syllabus to various indicators

Unit I	Introduction
Local	The knowledge and understanding of cybercrime and computer crime can help local communities and law enforcement agencies address and prevent such crimes in their area.
Regional	Cybercrime is a regional concern, and understanding its types and emerging trends can help in regional collaboration for combating cyber threats.
National	Cybercrime is a significant concern at the national level. Developing expertise in digital forensics and cybercrime investigation can enhance national security and protect critical infrastructure.
Global	Cybercrime has a global impact, and knowledge in this area can contribute to international efforts in combating cyber threats and promoting cybersecurity.
Employability	The skills and knowledge gained in this unit can enhance employability in the field of cybersecurity, law enforcement, digital forensics, and related industries.
Entrepreneurship	-
Skill Development	Developing skills in digital forensics, evidence handling, and understanding emerging digital crimes, contributing to skill development in the field.
Professional	Studying cybercrime and computer crime can raise awareness of ethical issues related to information security, privacy, and

Ethics	responsible use of technology.
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Types of Cyber Crimes
Local	-
Regional	-
National	Cyber crimes pose significant challenges to national security and the economy. Understanding different types of cyber crimes allows governments and law enforcement agencies to develop robust policies, laws, and strategies to address cyber threats at the national level.
Global	Cyber crimes have a global reach and impact. By studying the types of cyber crimes, individuals and organizations can contribute to global efforts in promoting cybersecurity, sharing threat intelligence, and developing international frameworks to combat cyber threats.
Employability	Acquiring knowledge about various types of cybercrimes enhances employability in the field of cybersecurity.
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in internet technologies and network protocols
Professional Ethics	Awareness of different types of cybercrimes raises ethical considerations surrounding privacy, data protection, and responsible use of technology.
Gender	-
Human Values	-
Environment & Sustainability	-

Unit III	Investigation of Cyber Crimes
Local	-
Regional	Collaboration among regional investigation agencies can be improved through the knowledge of investigation procedures and digital evidence handling.
National	Investigating cyber crimes is a critical aspect of national security, and this unit's content can enhance the investigation capabilities of agencies at the national level.
Global	Aligns with global Cooperation and sharing of best practices in cybercrime investigation.
Employability	Proficiency in cybercrime investigation and evidence handling is in high demand, offering employment opportunities in the field of digital forensics and cybersecurity.
Entrepreneurship	Knowledge in cybercrime investigation can inspire entrepreneurs to develop innovative tools and services for digital forensics and incident response.
Skill Development	Developing skills in evidence collection, data analysis, and reporting, contributing to skill development in the field of cybercrime investigation.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Forensic Tools and Processing of Electronic Evidence
Local	The knowledge and skills gained in this unit are relevant at the local level as local law enforcement agencies and forensic professionals need to be equipped with the tools and techniques to effectively process electronic evidence in cybercrime investigations within their jurisdiction

Regional	-
National	Protecting national security and upholding the rule of law in the digital realm requires a strong capability in digital forensics. The knowledge and proficiency in forensic tools and processing of electronic evidence contribute to national efforts in preventing and investigating cybercrimes.
Global	Cybercrimes are a global concern, and international cooperation is vital in addressing them.
Employability	Proficiency in forensic tools and processing of electronic evidence enhances employability in the field of digital forensics and cybersecurity.
Entrepreneurship	Knowledge of forensic tools and techniques can inspire entrepreneurs to develop innovative solutions, tools, and services in the field of digital forensics.
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4,9,16
NEP 2020	Its aligns with the policy's objective of developing skills relevant to the current and future job market, particularly in the field of cyber security.
POE/4th IR	The Fourth Industrial Revolution by providing knowledge and skills necessary to combat cyber threats and protect digital assets in an increasingly interconnected and digital world

CYBER CRIME INVESTIGATION & DIGITAL FORENSICS LAB

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Cyber Crime Investigation & Digital Forensics Lab</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP353</td><td>0-0-2</td><td>1</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Minor (DEPARTMENT ELECTIVE-II)</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
</table>

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Understand** the fundamental concepts and principles of digital forensics and cybercrimes.
CO 2	**Apply** the knowledge of digital forensics techniques and procedures to collect, analyse, and preserve electronic evidence in various types of cybercrimes.
CO 3	**Evaluate** and utilize forensic tools and technologies for data acquisition, analysis, and recovery in the investigation of cybercrimes.
CO 4	**Analyse** and interpret digital evidence obtained from different sources, such as electronic media, internet crimes, malicious applications, and various forms of cybercrimes.

Ex. No	Experiment Title	Mapped CO/COs
1	Experiment on collecting and preserving electronic media for forensic analysis.	CO 2
2	Experiment on searching and retrieving digital evidence from various storage devices.	CO 2
3	Experiment on handling and analyzing malicious codes, such as Trojans, viruses, and logic bombs.	CO 2
4	Experiment on investigating unauthorized access to computer systems.	CO 2
5	Experiment on packet sniffing and analyzing network traffic for evidence.	CO 2
6	Experiment on identifying and investigating phishing attacks and their variants.	CO 2
7	Experiment on detecting and investigating web spoofing and email spoofing incidents.	CO 2
8	Experiment on cyber stalking investigation techniques.	CO 2
9	Experiment on investigating web defacement incidents and identifying the perpetrators.	CO 2
10	Experiment on investigating financial crimes, including ATM and credit card frauds.	CO 2
11	Experiment on tracing and investigating spamming activities.	CO 2
12	Experiment on investigating cases related to software and hardware piracy.	CO 2
13	Experiment on tracing and investigating money laundering activities.	CO 2
14	Experiment on investigating fraud and cheating cases in the digital realm.	CO 2
15	Experiment on analyzing malicious applications and	CO 4

	their impact on digital devices.	
16	Experiment on understanding the role and capabilities of investigation agencies in India.	CO 1
17	Experiment on following proper evidence collection and seizure procedures in digital investigations.	CO 2
18	Experiment on securing and documenting the crime scene in digital forensics.	CO 2
19	Experiment on acquiring and analyzing data from digital devices.	CO 3
20	Experiment on using forensic tools like EnCase and FTK for digital investigations.	CO 3
21	Experiment on countering anti-forensics techniques and retrieving hidden information.	CO 3
22	Experiment on recovering data from damaged SIM cards and other multimedia evidence.	CO 2
23	Experiment on recovering deleted data from desktops, laptops, and mobile devices.	CO 2
24	Experiment on analyzing data from slack space and renamed files.	CO 4
25	Experiment on forensic imaging, including ghosting and analysis of compressed files.	CO 3

Description of experiments:

Session 1:

Topic: Experiment on collecting and preserving electronic media for forensic analysis

- Introduction to electronic media collection and preservation in digital forensics
- Techniques for ensuring the integrity and authenticity of collected data

- Chain of custody and documentation procedures

Exercise: Practice collecting electronic media and preserving it for forensic analysis.

Project: Create a comprehensive report on the collection and preservation of electronic media: Document the process of collecting electronic media, maintain a chain of custody, and ensure the integrity of the collected data.

Session 2:

Topic: Experiment on searching and retrieving digital evidence from various storage devices

- Different types of storage devices and their characteristics
- Techniques for searching and retrieving digital evidence from storage devices
- File systems analysis and data carving

Exercise: Search for and retrieve digital evidence from different storage devices.

Project: Analyze and document the process of searching and retrieving digital evidence: Perform data recovery and analysis on different storage devices, document the findings, and present a comprehensive report.

Session 3:

Topic: Experiment on handling and analyzing malicious codes, such as Trojans, viruses, and logic bombs

- Introduction to different types of malicious codes
- Techniques for analyzing and understanding malicious code behavior
- Anti-malware tools and techniques

Exercise: Analyze and dissect different types of malicious codes to understand their behavior.

Project: Develop a comprehensive report on the analysis of malicious codes: Analyze and document the behavior of various malicious codes, identify their impact, and propose countermeasures.

Session 4:

Topic: Experiment on investigating unauthorized access to computer systems • Understanding the concept of unauthorized access • Techniques for investigating unauthorized access incidents • Log analysis and intrusion detection systems Exercise: Investigate and analyze unauthorized access incidents in computer systems. Project: Create a detailed investigation report on unauthorized access incidents: Analyze log files, identify the extent of unauthorized access, determine the entry points, and propose preventive measures.
Session 5:
Topic: Experiment on packet sniffing and analyzing network traffic for evidence • Introduction to packet sniffing and network traffic analysis • Tools and techniques for capturing and analyzing network packets • Identifying and extracting relevant evidence from network traffic Exercise: Capture and analyze network packets to extract evidence. Project: Prepare a comprehensive report on network traffic analysis for a given scenario: Analyze captured network packets, extract relevant evidence, and present the findings in a structured report.
Session 6:
Topic: Experiment on identifying and investigating phishing attacks and their variants • Understanding phishing attacks and their impact • Techniques for identifying and investigating phishing incidents • Analyzing phishing emails and websites Exercise: Identify and investigate phishing attacks by analyzing phishing emails and websites. Project: Perform a comprehensive analysis of a phishing attack: Analyze phishing emails and websites, identify the modus operandi, and propose countermeasures

to prevent future attacks.
Session 7:
Topic: Experiment on detecting and investigating web spoofing and email spoofing incidents • Understanding web spoofing and email spoofing techniques • Techniques for detecting and investigating web and email spoofing incidents • Analyzing spoofed web pages and email headers Exercise: Detect and investigate web spoofing and email spoofing incidents by analyzing spoofed web pages and email headers. Project: Prepare a detailed investigation report on web and email spoofing incidents: Analyze spoofed web pages and email headers, identify the perpetrators, and suggest preventive measures.
Session 8:
Topic: Experiment on cyber stalking investigation techniques • Understanding cyber stalking and its implications • Techniques for investigating cyber stalking incidents • Gathering digital evidence and documenting the case Exercise: Investigate and gather digital evidence for a cyber stalking case. Project: Create a comprehensive investigation report on a cyber stalking incident: Analyze the digital evidence, document the case details, and propose measures to protect the victim.
Session 9:
Topic: Experiment on investigating web defacement incidents and identifying the perpetrators • Understanding web defacement and its impact • Techniques for investigating web defacement incidents • Analyzing web defaced pages and server logs

Exercise: Investigate web defacement incidents and analyze defaced web pages and server logs.

Project: Prepare a detailed investigation report on web defacement incidents: Analyze defaced web pages and server logs, identify the perpetrators, and suggest measures to enhance website security.

Session 10:

Topic: Experiment on investigating financial crimes, including ATM and credit card frauds

- Understanding financial crimes in the digital realm
- Techniques for investigating ATM and credit card frauds
- Analyzing financial transaction records and digital evidence

Exercise: Investigate financial crimes related to ATM and credit card frauds by analyzing financial transaction records and digital evidence.

Project: Create a comprehensive report on the investigation of financial crimes: Analyze financial transaction records, identify fraudulent activities, and propose preventive measures.

Session 11:

Topic: Experiment on tracing and investigating spamming activities

- Understanding spamming activities and their impact
- Techniques for tracing and investigating spamming incidents
- Analyzing spam emails and tracking email senders

Exercise: Trace and investigate spamming activities by analyzing spam emails and tracking email senders.

Project: Prepare a detailed investigation report on spamming activities: Analyze spam emails, trace email senders, identify the source of spamming, and propose measures to mitigate spamming incidents.

Session 12:

Topic: Experiment on investigating cases related to software and hardware piracy

- Understanding software and hardware piracy and its consequences

- Techniques for investigating piracy cases
- Analyzing pirated software and counterfeit hardware

Exercise: Investigate cases related to software and hardware piracy by analyzing pirated software and counterfeit hardware.

Project: Develop a comprehensive report on software and hardware piracy investigations: Analyze pirated software, identify counterfeit hardware, determine the extent of piracy, and propose measures to combat piracy.

Session 13:

Topic: Experiment on tracing and investigating money laundering activities

- Understanding money laundering in the digital realm
- Techniques for tracing and investigating money laundering incidents
- Analyzing financial transaction records and blockchain data

Exercise: Trace and investigate money laundering activities by analyzing financial transaction records and blockchain data.

Project: Prepare a detailed investigation report on money laundering activities: Analyze financial transaction records, track money flow, identify money laundering techniques, and propose measures to prevent money laundering.

Session 14:

Topic: Experiment on investigating fraud and cheating cases in the digital realm

- Understanding fraud and cheating in the digital realm
- Techniques for investigating fraud and cheating cases
- Analyzing digital evidence and transaction records

Exercise: Investigate fraud and cheating cases in the digital realm by analyzing digital evidence and transaction records.

Project: Create a comprehensive investigation report on fraud and cheating cases: Analyze digital evidence, identify fraudulent activities, document the case details, and propose preventive measures.

Session 15:

Topic: Experiment on analyzing malicious applications and their impact on digital devices

- Understanding malicious applications and their impact
- Techniques for analyzing and identifying malicious applications
- Analyzing malware behavior and reverse engineering techniques

Exercise: Analyze and identify malicious applications and study their impact on digital devices.

Project: Prepare a detailed analysis report on malicious applications: Analyze the behavior of different types of malicious applications, identify their impact on digital devices, and propose measures to prevent malware infections.

Session 16:

Topic: Experiment on understanding the role and capabilities of investigation agencies in India

- Introduction to investigation agencies in India
- Understanding the roles and responsibilities of investigation agencies
- Case studies and examples of investigations conducted by Indian agencies

Exercise: Study and understand the roles and capabilities of investigation agencies in India through case studies and examples.

Project: Prepare a report highlighting the role and capabilities of investigation agencies in India: Discuss the functions, powers, and responsibilities of key investigation agencies, and analyze their notable investigations.

Session 17:

Topic: Experiment on following proper evidence collection and seizure procedures in digital investigations

- Understanding the importance of proper evidence collection and seizure
- Techniques and procedures for collecting and preserving digital evidence
- Documentation and chain of custody requirements

Exercise: Practice following proper evidence collection and seizure procedures in digital investigations.

Project: Create a comprehensive report on evidence collection and seizure procedures: Document the process of evidence collection, maintain the chain of custody, and ensure compliance with legal and procedural requirements.

Session 18:

Topic: Experiment on securing and documenting the crime scene in digital forensics

- Importance of securing the crime scene in digital forensics
- Techniques for securing and documenting the crime scene
- Best practices for maintaining the integrity of digital evidence

Exercise: Secure and document the crime scene in a simulated digital forensics case.

Project: Prepare a detailed report on securing and documenting the crime scene: Describe the steps taken to secure the crime scene, document the process, and provide recommendations for improving crime scene management.

Session 19:

Topic: Experiment on acquiring and analyzing data from digital devices

- Techniques for acquiring data from digital devices
- Best practices for preserving the integrity of acquired data
- Analyzing acquired data using forensic tools and techniques

Exercise: Acquire and analyze data from different digital devices using forensic tools and techniques.

Project: Analyze and document the process of acquiring and analyzing data from digital devices: Perform data acquisition, analyze the acquired data, and present the findings in a structured report.

Session 20:

Topic: Experiment on using forensic tools like EnCase and FTK for digital investigations

- Introduction to popular forensic tools like EnCase and FTK
- Familiarization with the features and capabilities of forensic tools

- Hands-on practice with forensic tool usage in digital investigations

Exercise: Use forensic tools like EnCase and FTK to conduct digital investigations on simulated cases.

Project: Prepare a comprehensive report on the usage of forensic tools in digital investigations: Describe the features and capabilities of EnCase and FTK, document the usage in specific investigations, and evaluate their effectiveness.

Session 21:

Topic: Experiment on countering anti-forensics techniques and retrieving hidden information

- Understanding anti-forensics techniques used to hide digital evidence
- Techniques for countering anti-forensics and retrieving hidden information
- Analysis of steganography, encryption, and file obfuscation methods

Exercise: Counter anti-forensics techniques and retrieve hidden information from digital evidence.

Project: Develop a comprehensive report on countering anti-forensics techniques: Analyze different anti-forensics methods, propose countermeasures, and demonstrate the retrieval of hidden information.

Session 22:

Topic: Experiment on recovering data from damaged SIM cards and other multimedia evidence

- Techniques for recovering data from damaged SIM cards
- Recovering data from damaged multimedia evidence like CCTV footage and audio recordings
- Best practices for data recovery from different types of damaged media

Exercise: Recover data from damaged SIM cards and analyze multimedia evidence from various sources.

Project: Prepare a detailed report on data recovery from damaged media: Document the process of recovering data from damaged SIM cards and analyze recovered multimedia evidence.

Session 23:

Topic: Experiment on recovering deleted data from desktops, laptops, and mobile devices

- Techniques for recovering deleted data from different devices
- Understanding file systems and data storage mechanisms
- Analyzing recovered deleted data for evidence

Exercise: Recover deleted data from desktops, laptops, and mobile devices and analyze the recovered data for evidence.

Project: Analyze and document the process of recovering deleted data: Recover deleted data from different devices, analyze the recovered data, and present the findings in a comprehensive report.

Session 24:

Topic: Experiment on analyzing data from slack space and renamed files

- Understanding slack space and its significance in digital forensics
- Techniques for analyzing data from slack space and renamed files
- Extracting hidden information and evidence from slack space and renamed files

Exercise: Analyze data from slack space and renamed files to extract hidden information and evidence.

Project: Prepare a detailed report on the analysis of data from slack space and renamed files: Analyze the data, extract hidden information, and present the findings in a structured report.

Session 25:

Topic: Experiment on forensic imaging, including ghosting and analysis of compressed files

- Understanding forensic imaging and its importance in digital forensics
- Techniques for creating forensic images and conducting analysis
- Analyzing ghost images and compressed files for evidence

Exercise: Create forensic images, analyze ghost images, and conduct analysis on compressed files.

Project: Develop a comprehensive report on forensic imaging and analysis: Describe the process of creating forensic images, analyze ghost images, and analyze compressed files for evidence. Present the findings in a structured report.

AI IN CYBER SECURITY

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
AI in Cyber Security	**ENSP305**	4-0-0	4
Type of Course:	Minor (DEPARTMENT ELECTIVE-II)		

Pre-requisite(s), if any: basic understanding of web development technologies such as HTML, CSS, and JavaScript. Additionally, students should have some familiarity with networking concepts, operating systems, and databases.

Brief Syllabus:

This syllabus covers essential topics in web application security, including injection attacks, authentication and access control, cryptography, testing, security standards, best practices, and risk management. It is divided into four units and may be completed in a semester-long course. Students will gain an understanding of common web application vulnerabilities and how to prevent and mitigate them. They will also learn about authentication and access control mechanisms, cryptography techniques, and web application security testing. Finally, students will explore best practices for secure web application development and incident response and disaster recovery planning.

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to AI and Cyber Security**	**No. of hours: 10**

Content Summary:

Overview of Artificial Intelligence and its applications in Cyber Security History and evolution of AI in cyber security, Understanding of the Cyber Security threats landscape, Familiarization with the latest trends and techniques of AI in Cyber Security, Basic principles of Machine Learning and Deep Learning in Cyber Security, Ethical considerations and challenges of using AI in cyber security.

Unit Number: 2	**Title: Machine Learning Techniques for Cyber Security**	**No. of hours: 10**

Content Summary: An introduction to Machine Learning techniques, Supervised and unsupervised Machine Learning models in Cyber Security, Feature engineering and data preparation for Machine Learning models, Case studies demonstrating the application of Machine Learning to Cyber Security problems.		
Unit Number: 3	**Title: Deep Learning Techniques for Cyber**	**No. of hours: 10**
Content Summary: Introduction to Deep Learning techniques ,Convolutional Neural Networks (CNNs) and their application in Cyber Security ,Recurrent Neural Networks (RNNs) and their application in Cyber Security ,GANs and their application in Cyber Security ,Case studies demonstrating the application of Deep Learning to Cyber Security problems.		
Unit Number: 4	**Title: AI for Cyber Security: Threat Detection and Prevention**	**No. of hours: 10**
Content Summary: Introduction to AI and its applications in threat detection and prevention ,Overview of different types of threats in cyber security and their characteristics ,Understanding the limitations of traditional threat detection and prevention methods ,Fundamentals of machine learning and deep learning for threat detection and prevention ,Supervised machine learning algorithms for threat detection, such as decision trees, support vector machines, and random forests ,Unsupervised machine learning algorithms for anomaly detection, such as clustering and outlier detection ,Deep learning techniques for threat detection, such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) ,Feature selection and feature engineering for machine learning in threat detection, Emerging trends and challenges in AI for threat detection and prevention, including adversarial machine learning, explainable AI, and privacy concerns.		
***Self-Learning Components:** **1)** Anomaly Detection **2)** Malware Detection **3)** Adaptive Access Control **4)** Network Traffic Analysis		

Please Note: 1)Students are supposed to learn the components on self-basis 2) At least 5-10 % syllabus will be asked in end term exams from self-learning components.
Reference Books: 1. Artificial Intelligence for Cybersecurity" by Bhaskar Sinha (Auerbach Publications) **2.** Machine Learning and Security: Protecting Systems with Data and Algorithms" by Clarence Chio and David Freeman (O'Reilly Media)

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** Understand the concepts and applications of AI in the field of cyber security.
CO2	**Express** the ethical and legal considerations associated with the use of AI in cyber security.
CO3	**Determine** emerging trends and technologies in AI for cyber security, and their potential impact on the field.
CO4	**Identify** strategies for integrating AI-driven solutions into existing cyber security frameworks, policies, and practices.
CO5	**Articulate** critical thinking and problem-solving skills to address real-world cyber security challenges using AI techniques.

CO6	**Design** machine learning techniques for threat detection and prevention in cyber security, including supervised and unsupervised algorithms.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A1	P1
C02	C3	A3	P2
CO3	C3	A3	P3
CO4	C1	A2	-
CO5	C2	A3	P5
CO6	C6	A4	-

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	2	-	-	1	1	1	1
CO2	3	2	3	2	2	1	1	1	1	2	1	2
CO3	3	3	3	3	3	2	2	1	2	1	2	1
CO4	2	2	3	3	3	1	-	-	1	2	1	1
CO5	3	2	3	3	3	2	-	1	2	1	1	1
CO6	3	3	2	3	3	2	1	1	2	1	1	1

Justification for mapping must be relevant.

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-
CO2	2	1	-	-
CO3	3	3	-	3
CO4	2	1	-	2
CO5	3	3	-	-
CO6	2	3	-	2

Relevance of the Syllabus to various indicators

Unit I	**Introduction to AI and Cyber Security**
Local	Addresses local understanding of the Cyber Security and its impact on society
Regional	Addresses regional Cyber Security infrastructure requirements.
National	Contributes to national Cyber Security literacy and its impact to the nation.
Global	Aligns with global trends in Cyber Security technologies and network protocols
Employability	Develops skills in using Cyber Security and its tools for network protocols
Entrepreneurship	Build entrepreneurship
Skill Development	Develops basic knowledge and skills in Cyber Security technologies and network protocols
Professional Ethics	-

Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Machine Learning Techniques for Cyber Security**
Local	Addresses local understanding of the Internet and its impact on society
Regional	-
National	Contributes to national digital literacy and internet connectivity strategies
Global	Aligns with global trends in internet technologies and network protocols
Employability	Develops skills in using Machine learning techniques and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in Machine learning techniques technologies and network protocols
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Deep Learning Techniques for Cyber**
Local	Addresses local network security needs and practices
Regional	-
National	Contributes to national network security strategies and protocols

Global	Aligns with global trends in network security techniques and protocols
Employability	Develops skills in Deep learning techniques and network security techniques
Entrepreneurship	-
Skill Development	Develops knowledge and skills in Deep learning techniques and network security
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**AI for Cyber Security: Threat Detection and Prevention**
Local	Addresses local understanding of Threat Detection and Prevention. and implementation of internet-based services
Regional	-
National	Contributes to national digital communication strategies and multimedia applications
Global	Aligns with global trends in internet telephony, multimedia applications, and SEO
Employability	Develops skills in Threat Detection and Prevention.
Entrepreneurship	-
Skill Development	Develops knowledge and skills in Threat Detection and Prevention
Professional Ethics	-
Gender	-

Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO

AI IN CYBER SECURITY LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **AI in Cyber Security Lab**	**Course Code**	**L-T-P**	**Credits**
	ENSP355	0-0-2	1
Type of Course:	Minor (DEPARTMENT ELECTIVE-II)		
Pre-requisite(s), if any: basic understanding of web development technologies such as HTML, CSS, and JavaScript. Additionally, students should have some familiarity with networking concepts, operating systems, and databases.			

Proposed Lab Experiments

Defined Course Outcomes

COs	Comprehensive Understanding of AI in Cyber Security:
CO 1	**Practical** Experience with AI Tools and Techniques
CO 2	**Enhanced** Malware Detection and Classification Skills
CO 3	**Critical** Thinking and Problem-Solving Abilities
CO 4	**Research** and Innovation in AI Cyber Security

Ex. No	Experiment Title	Mapped CO/COs
1	Malware detection: Develop an AI model to detect and classify different types of malwares.	CO 2

2	Intrusion detection: Build an AI system to identify and alert on network intrusions and suspicious activities.	CO 1
3	Phishing detection: Train an AI algorithm to recognize and flag phishing emails or websites.	CO 1, CO 3
4	Vulnerability assessment: Use AI techniques to identify potential vulnerabilities in software or systems.	CO 1, CO 3
5	Botnet detection: Develop an AI model to detect and track botnet activities on a network.	CO 1
6	Password cracking: Build an AI system to analyze and crack weak passwords.	CO 1, CO 3
7	Network traffic analysis: Use AI algorithms to analyze network traffic and identify patterns or anomalies.	CO 1, CO 3
8	Behavioral authentication: Develop an AI model to authenticate users based on their behavioral patterns.	CO 1, CO 3
9	Anomaly detection: Train an AI system to detect anomalous behavior in user activities or system logs.	CO 1
10	Zero-day vulnerability detection: Use AI techniques to identify unknown or previously undiscovered vulnerabilities.	CO 1, CO 3
11	Social engineering detection: Build an AI system to recognize and alert on social engineering attempts.	CO 1, CO 3
12	Web application security: Develop an AI model to identify and mitigate web application vulnerabilities.	CO 3, CO 4
13	Data exfiltration detection: Train an AI algorithm to detect and prevent unauthorized data exfiltration attempts.	CO 3, CO 4
14	Ransomware detection: Use AI techniques to identify and block ransomware attacks in real-time.	CO 3, CO 4
15	Firewall optimization: Employ AI algorithms to optimize firewall rules and configurations for better security.	CO 3, CO 4
16	Network anomaly prediction: Build an AI system to	CO 1, CO 3

	predict network anomalies before they occur.	
17	Security log analysis: Use AI techniques to automatically analyze and correlate security logs for identifying threats.	CO 3, CO 4
18	DDoS attack detection: Develop an AI model to detect and mitigate Distributed Denial of Service (DDoS) attacks.	CO 3, CO 4
19	Mobile application security: Train an AI algorithm to identify security vulnerabilities in mobile applications.	CO 3, CO 4
20	Network segmentation optimization: Employ AI techniques to optimize network segmentation for enhanced security.	CO 1, CO 3
21	Threat intelligence analysis: Use AI algorithms to analyze and extract insights from threat intelligence feeds.	CO 1, CO 3
22	Security incident response automation: Develop an AI system to automate and streamline security incident response processes.	CO 3, CO 4
23	Deepfake detection: Train an AI model to identify and flag manipulated or forged media content.	CO 1, CO 3
24	Network forensics: Use AI techniques to analyze network traffic and digital artifacts for forensic investigations.	CO 3, CO 4
25	Security policy compliance: Develop an AI system to assess and ensure compliance with security policies and regulations.	CO 3, CO 4

SOCIAL MEDIA SECURITY

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Social Media Security</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP307</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Minor (DEPARTMENT ELECTIVE-II)</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="4">Brief Syllabus:

Social media has become an integral part of our lives, shaping our online behaviors and interactions in numerous ways. People join social media platforms to share information, connect with friends, and engage in online communities. While social media offers these advantages, it also brings forth concerns regarding privacy and security. The constant flow of personal information shared on these platforms makes individuals vulnerable to various risks. Therefore, it is crucial for all of us to understand and address the issues surrounding privacy and security in the realm of social media. By acquiring knowledge about these challenges, we can adopt safer practices and protect ourselves from potential threats while enjoying the benefits of social media platforms. Being aware and proactive about social media security empowers us to navigate the digital landscape responsibly and ensure our online safety.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td>Title: Social Media Overview</td><td colspan="2">No. of hours: 10</td></tr>
<tr><td colspan="4">Content Summary:

Introduction to Social media. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, challenges, opportunities, and pitfalls in online social networks, APIs, Collecting data from Online Social Media, Social Media Content Analysis - BoW Model, TF-IDF; Network Analysis - Node Centrality Measures, Degree Distribution, Average Path Length, Clustering Coefficient, Power Law; Synthetic Networks - Random Graphs, Preferential</td></tr>
</table>

<table>
<tr><td colspan="3">Attachment Model.</td></tr>
<tr><td>Unit Number: 2</td><td>Title: Security Issues in Social Media</td><td>No. of hours: 10</td></tr>
<tr><td colspan="3">Content Summary:

Overview, Review of Machine Learning, The evolution of privacy and security concerns with networked technologies, Contextual influences on privacy attitudes and behaviours, Anonymity in a networked world, Identity Theft - Profile Cloning, Social Phishing, Fake, Compromised, Sybil accounts and their behaviour, Spamming, Rumour or Misinformation, Cyberbullying, Collective Misbehaviours, Flagging and reporting of inappropriate content.</td></tr>
<tr><td>Unit Number: 3</td><td>Title: Privacy Issues in Social Media</td><td>No. of hours: 10</td></tr>
<tr><td colspan="3">Content Summary:

Overview, Privacy Settings, PII Leakage, Identity vs Attribute Disclosure Attacks, Inference Attacks, De-anonymization Attacks, Privacy Metrics - k-anonymity, l-diversity, Personalization vs Privacy, Differential Privacy, Social Media and User Trust.</td></tr>
<tr><td>Unit Number: 4</td><td>Title: Social Media Security: Laws, Best Practices, and Case Studies</td><td>No. of hours: 10</td></tr>
<tr><td colspan="3">Content Summary:

Laws regarding posting of inappropriate content, Best practices for the use of Social media, Content Moderation and Removal Policies, User Authentication and Access Control, Security Awareness and Education, Social media Case studies-Facebook, Twitter, Instagram, YouTube, LinkedIn, StackOverflow, GitHub, Quora, SnapChat, Reddit, FourSquare, Yelp.</td></tr>
<tr><td colspan="3">*Self-Learning Components:

1. Social Media Security 101 - Stop The Hackers!
2. Privacy and Security in Online social media
3. CompTIA Social Media Security

Please Note:</td></tr>
</table>

1)Students are supposed to learn the components on self-basis

2) At least 5-10 % syllabus will be asked in end term exams from self-learning components.

References:

1. https://www.udemy.com/course/social-media-security-101-stop-the-hackers/
2. https://onlinecourses.nptel.ac.in/noc20_cs31/preview
3. https://niccs.cisa.gov/education-training/catalog/certfirst/comptia-social-media-security

Reference Books:

6. Mastering Social Media Mining, Bonzanini Marco, Packt Publishing Limited
7. Mining the Social Web, Mikhail Klassen and Matthew A. Russell, O'Reilly Media, Inc
8. Social media mining: an introduction, Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu, Cambridge University Press
9. Social Media Security: Leveraging Social Networking While Mitigating Risk, Michael Cross, Syngress
10. Social Media and the Law: A Guidebook for Communication Students and Professionals, Daxton R. Stewart, Taylor & Francis Ltd
11. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.

Online References:

1. https://media.defense.gov/2021/Sep/16/2002855950/-1/-1/0/CSI_KEEPING_SAFE_ON_SOCIAL_MEDIA_20210806.PDF
2. https://www.technology.pitt.edu/security/best-practices-safe-social-networking
3. https://www.mdpi.com/1999-5903/10/12/114

Course Outcomes (CO)

COs	Statements
CO1	**Demonstrate an understanding** of the different types of social media platforms, their features, and their impact on communication, marketing, and society.
CO2	**Acquire knowledge and skills** in social media monitoring techniques, including data collection, analysis, and the use of relevant tools and technologies.

CO3	**Develop** the ability to analyze and evaluate viral content on social media, understand the factors contributing to its spread, and recognize its implications for marketing and online engagement.
CO4	**Identify and analyze** the challenges, opportunities, and pitfalls associated with social media marketing, and formulate strategies for effective audience targeting, engagement, and brand promotion.
CO5	**Develop** strategies to safeguard personal information, foster user trust, and mitigate associated risks.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels(C) 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A3	P1
C02	C2	A2	P2
CO3	C4	A5	-
CO4	C4	A3	P4
CO5	C6	A4	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	1	-	3	-	-	-	-	-	-
CO2	2	3	-	1	-	-	-	2		-	-	-
CO3	-	3	-	2	-	-	1		3	-	-	-
CO4	-	3	3	2	-	-	-	2		-	-	2
CO5	-	-	-	1	2	2	3	-	-	-	-	2

1=weakly mapped
2= moderately mapped

3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	1		-
CO2	-	2	1	-
CO3	-	-	2	1
CO4	-	-	-	2
CO5	-	-	-	-

Relevance of the Syllabus to various indicators

Unit I	Social Media Overview
Local	-
Regional	-
National	Provides essential knowledge and skills related to social media platforms, social media marketing, and data collection from online social media.
Global	Covers key aspects of social media platforms, social media marketing, and data analysis techniques that have global applicability
Employability	Highly valued in the job market.
Entrepreneurship	Explore entrepreneurial opportunities in the digital marketing and social media industry.
Skill Development	Enhances students' technical skills in understanding and utilizing social media effectively.
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit II	Security Issues in Social Media
Local	Addresses local indicators by covering security issues in social media.
Regional	-
National	Provides essential knowledge and skills related to security issues in social media, which are relevant at the national level for ensuring online safety.
Global	Covers key aspects of security issues in social media that have global relevance.
Employability	Highly valued in the job market, particularly in roles related to cybersecurity, digital risk management, and social media governance.
Entrepreneurship	Equips with knowledge of security issues in social media, allowing to identify entrepreneurial opportunities in developing innovative solutions for securing social media platforms.
Skill Development	Enhances technical skills in identifying, analyzing, and addressing security threats.
Professional Ethics	Indirectly promotes professional ethics by emphasizing the importance of protecting user privacy, preventing cyberbullying, and addressing collective misbehaviors in social media platforms.
Gender	-
Human Values	Indirectly supports human values by fostering a safe and inclusive online environment.
Environment & Sustainability	-
Unit III	Privacy Issues in Social Media
Local	Addresses local indicators by covering privacy issues in social media that are relevant to the local context.

Regional	-
National	Provides essential knowledge and skills related to privacy issues in social media, which are relevant at the national level for ensuring data protection and privacy rights.
Global	Covers key aspects of privacy issues in social media that have global relevance, such as identity and attribute disclosure attacks.
Employability	Highly valued in the job market, particularly in roles related to data privacy, information security, and compliance with privacy regulations.
Entrepreneurship	Equips with knowledge of privacy issues in social media, allowing them to identify entrepreneurial opportunities in developing privacy-enhancing solutions for social media platforms.
Skill Development	Enhances technical skills in privacy settings, data protection, and privacy metrics.
Professional Ethics	Indirectly promotes professional ethics by emphasizing the importance of respecting user privacy, protecting personal information, and ensuring transparency.
Gender	-
Human Values	Indirectly supports human values by fostering a culture of privacy and user trust in social media platforms. .
Environment & Sustainability	-
Unit IV	Social Media Security: Laws, Best Practices, and Case Studies
Local	Addresses local indicators by covering laws regarding posting of inappropriate content that are relevant to local jurisdictions and regulations.
Regional	Provides regional relevance by including case studies of popular social media platforms that are widely used in the regional context, such as Facebook, Twitter, Instagram, and LinkedIn.

National	Covering laws related to social media and best practices for the use of social media platforms
Global	Includes case studies of various global social media platforms.
Employability	Highly valued in roles related to social media management, digital marketing, content moderation, and information security..
Entrepreneurship	Equips with knowledge of social media security laws, best practices, and case studies, allowing them to identify entrepreneurial opportunities in providing social media security services
Skill Development	Enhances students' skills in content moderation, user authentication, access control, security awareness, and education.
Professional Ethics	Emphasizing the importance of adhering to social media laws.
Gender	-
Human Values	Indirectly supports human values by promoting responsible use of social media, ensuring user privacy and safety, and addressing ethical considerations.
Environment & Sustainability	-
SDG	-
NEP 2020	Digital literacy, Critical thinking, Ethical use of technology
POE/4th IR	Technological advancements, innovation, adaptability, digital fluency, problem-solving, collaboration, and lifelong learning.

SOCIAL MEDIA SECURITY LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **Social Media Security Lab**	**Course Code**	**L-T-P**	**Credits**
	ENSP357	0-0-2	1
Type of Course:	Minor (DEPARTMENT ELECTIVE-II)		
Pre-requisite(s), if any:			

Course Outcomes (CO)

COs	Statements
CO1	**Understand** the risks and vulnerabilities associated with social media platforms.
CO2	**Understand** the social and ethical implications of social media security.
CO3	**Develop** practical skills to secure social media accounts and data.
CO4	**Analyze** and respond to social media security incidents.
CO5	**Evaluate** the effectiveness of social media security controls.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/COs
1	Exploring Different Social Media Platforms a. Research and analyze various social media platforms. b. Identify their key features, target audiences, and unique characteristics. c. Compare and contrast their usage, advantages, and challenges.	CO1, CO2, CO5
2	Monitoring Social Media Trends a. Use social media monitoring tools to track	CO1, CO5

	popular hashtags and viral content. b. Analyze the patterns and trends in social media conversations. c. Identify the factors contributing to the popularity of certain content.	
3	Social Media Marketing Analysis a. Study real-world social media marketing campaigns. b. Analyze their strategies, target audience engagement, and impact. c. Evaluate the challenges and opportunities in social media marketing.	CO2, CO3
4	Collecting and Analyzing Social Media Data a. Utilize APIs to collect data from online social media platforms. b. Perform content analysis using techniques like Bag-of-Words (BoW) model and TF-IDF. c. Extract insights and patterns from the collected data.	CO3
5	Social Network Analysis a. Perform network analysis on social media data. b. Calculate node centrality measures, degree distribution, average path length, and clustering coefficient. c. Identify key influencers and community structures within the social network.	CO3, CO5
6	Creating Synthetic Networks a. Generate random graphs and preferential attachment models to simulate social networks. b. Analyze the characteristics of the synthetic networks. c. Compare and contrast them with real-world social networks.	CO1, CO5
7	Profile Cloning and Identity Theft a. Study different types of identity theft in social media. b. Analyze profile cloning, social phishing, and compromised accounts. c. Understand the behavioral patterns and impacts of these attacks.	CO1, CO2
8	Dealing with Spam and Misinformation a. Analyze the spread of spam and misinformation in social media. b. Identify techniques to detect and mitigate spamming activities. c. Evaluate the effectiveness of flagging and	CO4

	reporting mechanisms.	
9	Privacy Settings Evaluation a. Evaluate the privacy settings of popular social media platforms. b. Assess the level of protection they provide for Personally Identifiable Information (PII). c. Propose recommendations for enhancing user privacy.	CO2, CO5
10	Privacy Attacks and Anonymity a. Study different privacy attacks in social media, such as inference attacks and de-anonymization attacks. b. Analyze the impact of identity disclosure and attribute disclosure attacks. c. Explore techniques like differential privacy for preserving user privacy.	CO2
11	Privacy Metrics Analysis a. Investigate privacy metrics like k-anonymity and l-diversity. b. Apply these metrics to analyze the privacy risks in social media datasets. c. Discuss the trade-offs between personalization and privacy in social media.	CO2
12	Understanding Social Media Laws and Regulations a. Study the laws and regulations related to social media usage. b. Analyze the legal implications of posting inappropriate content. c. Explore content moderation policies and user responsibilities.	CO2
13	User Authentication and Access Control a. Evaluate user authentication mechanisms in popular social media platforms. b. Analyze access control policies and user permissions. c. Discuss best practices for ensuring secure user authentication.	CO3
14	Security Awareness and Education a. Develop security awareness campaigns for social media users. b. Design educational materials to raise awareness about social media security risks. c. Evaluate the effectiveness of these campaigns through surveys or assessments.	CO2
15	Case Study Analysis - Facebook a. Analyze the security and privacy practices of	CO1, CO2,

	Facebook. b. Explore the challenges faced by Facebook in maintaining user data privacy. c. Discuss notable security incidents and their impact on user trust.	CO4
16	Case Study Analysis - Twitter a. Investigate the security measures implemented by Twitter. b. Analyze the response to cybersecurity incidents on the platform. c. Discuss the role of Twitter in addressing misinformation and cyberbullying.	CO1, CO2, CO4
17	Case Study Analysis - Instagram a. Analyze the privacy and security features of Instagram. b. Investigate the effectiveness of content moderation policies. c. Discuss the impact of influencer marketing and brand safety on Instagram.	CO1, CO2, CO4
18	Case Study Analysis - YouTube a. Evaluate the security controls and privacy settings of YouTube. b. Analyze the challenges of content moderation and copyright infringement. c. Discuss the role of YouTube in combating hate speech and harmful content.	CO1, CO2, CO4
19	Case Study Analysis - LinkedIn a. Study the security and privacy considerations on LinkedIn. b. Analyze the protection of professional user data and connections. c. Discuss the impact of LinkedIn in job search and professional networking.	CO1, CO2
20	Case Study Analysis - StackOverflow a. Investigate the security practices implemented on StackOverflow. b. Analyze the trust and reputation systems within the community. c. Discuss the role of StackOverflow in knowledge sharing and code collaboration.	CO1, CO2
21	Case Study Analysis - GitHub a. Analyze the security measures adopted by GitHub for source code repositories. b. Investigate the role of vulnerability reporting and code review processes.	CO1, CO2

	c. Discuss the importance of secure coding practices in open-source projects.	
22	Case Study Analysis - Quora a. Evaluate the privacy controls and content moderation on Quora. b. Analyze the impact of user-generated content and knowledge sharing. c. Discuss the challenges of maintaining a respectful and inclusive community.	CO1, CO2
23	Case Study Analysis - SnapChat a. Study the privacy and security features of SnapChat. b. Analyze the ephemeral messaging and privacy-by-design approach. c. Discuss the challenges of preventing data leaks and unauthorized access.	CO1, CO2
24	Case Study Analysis - Reddit a. Analyze the security and privacy considerations on Reddit. b. Investigate the moderation policies and community-driven content curation. c. Discuss the challenges of maintaining a balance between free speech and harmful content.	CO1, CO2

(DEPARTMENT ELECTIVE-III)

MOBILE APPLICATION DEVELOPMENT USING IOS

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

Mobile Application Development using iOS</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP409</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Departmental Elective III (Minor)</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: Basics of Android</td></tr>
<tr><td colspan="4">Brief Syllabus:

The objective of the course is to provide skills to develop applications for OS X and iOS. It includes introduction to development framework Xcode. Objective-C is used as programming language to develop the applications. Objective-C is the superset of the C programming language and provides object-oriented capabilities and a dynamic runtime. Objective-C inherits the syntax, primitive types, and flow control statements of C and adds syntax for defining classes and methods.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Introduction to IDE and SDK of iOS App Development</td><td>No. of hours: 10</td></tr>
<tr><td colspan="4">Content Summary:

Xcode-The SDK environment, Supporting tools, Advance settings. Development Technique, Fundamental of Object-Oriented Programming, The MVC architecture.</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Objective-C</td><td>No. of hours: 10</td></tr>
</table>

Content Summary:

Introduction to Objective C, Primitive Data Types, Conditions, Loops, Functions, Arrays, Pointers, Structures, Classes, Objects, Foundation, Memory Management, Inheritance, Categories, Protocols, Predicates, Blocks, Multi-Threading.

Objects Send and Receive Messages concept, Use of Pointers to Keep Track of Objects, Methods - Return Values.

Unit Number: 3	**Title: Encapsulating Data**	**No. of hours: 10**

Content Summary:

Properties of Encapsulation of an Object's Values, Declare Public Properties for Exposed Data, Use Accessor Methods to Get or Set Property Values, Concept of Dot Syntax, Properties Are Backed by Instance Variables.

Dealing with Errors: Use NSError for Most Errors, Some Delegate Methods Alert You to Errors, Some Methods Pass Errors by Reference

Unit Number: 4	**Title: Developing iOS Applications**	**No. of hours: 10**

Content Summary:

iOS App Anatomy, Design Principles, Creating a Basic Hello World App with interface elements, UI View & Controller, UI Elements, Trigger Actions, Storyboard, Device Orientations, Using Gestures, Popovers and Modal Dialogs, Creating Universal Apps, Status Bar, Navigation Bar, Tab Bar, Content Views (e.g. Image view, Map View etc.), UI Table View and Table View Controller, Core Data, Test your App, Publishing your App.

***Self-Learning Components**:

XCode Documentation

References:

1. https://www.tutorialspoint.com/objective_c/objective_c_quick_guide.htm
2. https://www.coursera.org/learn/introduction-to-ios-mobile-application-development
3. https://www.geeksforgeeks.org/classes-objects-in-objective-c/

Please Note:

At least 5-10 % syllabus will be asked in end term exams from self-learning components
Text Book: 1. Effective objective C 2.0, Matt Galloway, Effective software development series, Scott Meyers. Reference Books: 1. Programming in Objective-C (5th Edition) (Developer's Library) by Stephen G. Kochan. 2. iOS 6 Development Unleashed: Developing Mobile Applications for Apple iPhone, iPad, and iPod Touch by Robert McGovern Online References: 1. https://developer.apple.com/library/archive/documentation/Cocoa/Conceptual/ProgrammingWithObjectiveC/Introduction/Introduction.html 2. https://www.digitalocean.com/community/tutorials/objective-c-hello-world-tutorial

Course Outcomes (CO)

COs	Statements
CO1	Create iPhone apps using Objective-C and Apple's new programming language, use industry tools and frameworks such as Cocoa, Xcode, UIKit, Git.
CO2	Understand and know how to use properly UIKit, asynchronous code, Core Image, NSURL Session and JSON Map Kit and Core Location, Auto Layout, Source Control, Core Data, Animation, and the app submission process.
CO3	Read and write programs based on Objective-C, also have a strong grasp of Objective-C objects
CO4	Organize their code professionally using objects and blocks, prototype several entry- level apps and try to publish on App store.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels(C) 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A1	P1
C02	C3	A4	P1
CO3	C5	A2	P2
CO4	C6	A1	P4

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	-	3	2	-	-	-	-	-	-	-	-	-
CO3	-	-	-	3		-	-	-	-	-	-	3
CO4	-	-	3	-	-		-	-	-	-	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	2			3
CO2	2	2		2
CO3		2		
CO4				3

Relevance of the Syllabus to various indicators

Unit I	Introduction to IDE and SDK of iOS App Development
Local	-
Regional	-
National	-
Global	Xcode is the official IDE provided by Apple for iOS app development. It is available globally and widely used by

	developers worldwide. Xcode includes a suite of tools, such as Interface Builder, Instruments, and iOS Simulator, along with an extensive SDK for building iOS apps.
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Objective-C
Local	-
Regional	-
National	
Global	Objective C can be used globally with its syntax and syntactic rules
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit III	Encapsulating Data
Local	In programming, "local" usually refers to variables, data, or methods that are confined to a specific scope, such as within a function or a block. Local variables are only accessible within the block or function where they are declared.
Regional	-
National	-
Global	
Employability	
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Developing iOS Applications
Local	-
Regional	-
National	"National" might represent initiatives or policies related to iOS app development adopted or regulated at the national level. For example, it could include national-level educational programs or government-supported initiatives promoting digital skills and app development.
Global	

Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4, SDG 8, SDG 9
NEP 2020	Promoting universal access to education, holistic development, multidisciplinary approach, skill development, critical thinking, creativity, ICT integration, research and development, global competencies, and professional ethics.
POE/4th IR	Skill Development / Coding / Programming Software

MOBILE APPLICATION DEVELOPMENT USING IOS LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **Mobile Application Development using iOS Lab**	**Course Code**	**L-T-P**	**Credits**
	ENSP459	0-0-2	1
Type of Course:	Departmental Elective III (Minor)		
Pre-requisite(s), if any: Basics of Android			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	Create iPhone apps using Objective-C and Apple's new programming language, use industry tools and frameworks such as Cocoa, Xcode, UIKit, Git.
CO 2	Understand and know how to use properly UIKit, asynchronous code, Core Image, NSURL Session and JSON Map Kit and Core Location, Auto Layout, Source Control, Core Data, Animation, and the app submission process.
CO 3	Read and write programs based on Objective-C, also have a strong grasp of Objective-C objects
CO 4	Organize their code professionally using objects and blocks, prototype several entry- level apps and try to publish on App store.

Ex No	Experiment Title	Mapped CO/COs
1	Case Study of Objective-C language.	CO2
2	Case study of Windows and MAC systems	CO2
3	Case Study of XCode based on MAC Systems	CO2
4	Design an App for UISwitch based on Objective-C language	CO1
5	Design an App for UISlider based on Objective-C language	CO1
6	Design an App for UIStepper based on Objective-C language	CO1
7	Write a program for creating Story Boards	CO1
8	Design an App for UIAnimation based on Objective-C language	CO1
9	Create a Simple Calculator using Objective-C Language	CO1
10	Design an App for UIProgress Bar based on Objective-C language	CO1
11	Design an App for UIDatePicker Bar based on Objective-C language	CO1
12	Write an Objective-C program to print factorial of a given number	CO3
13	Write an Objective-C program to print Fibonacci series	CO3
14	Write an Objective-C program that displays the Phrase "Hello World"	CO3
15	Write an Objective-C program for displaying the value of variables	CO3
16	Write an Objective-C program for displaying the sum and subtraction of two variables	CO3
17	Write an Objective-C program for displaying the	CO3

	multiplication and division of the two variables	
18	Write an Objective-C program that demonstrate control structure of Objective-C language	CO3
19	Create a Button using Objective-C	CO3
20	Write an Objective-C program to print the value of a variable inside a text, place it in parentheses, and insert a backslash just prior to the opening parenthesis	CO3
21	Write an Objective-C program to print Floyd's Triangle.	CO3
22	Write an Objective-C program to print palindrome of a number.	CO3
23	Write an Objective-C program to print pyramid.	CO3
24	Write an Objective-C program to find greatest number in between three numbers	CO3
25	Write an Objective-C program to check whether a number is even or odd.	CO3
	Mini Project 1: Make an interactive project based on iOS App using Objective-C Language	CO4
	Mini Project 2: Upload your iOS App in Apple AppStore and Publish it	CO4

DEVOPS & AUTOMATION

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:

DevOps & Automation</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP411</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Departmental Elective III (Minor)</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: Nil</td></tr>
<tr><td colspan="4">Brief Syllabus:

Throughout the subject, students will engage in hands-on exercises and projects to gain practical experience with various DevOps tools and practices. By the end of the course, students will be well-equipped to embrace the DevOps culture and apply automation techniques to enhance software development, delivery, and operations processes.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td>Title: Introduction to DevOps</td><td colspan="2">No. of hours: 10</td></tr>
<tr><td colspan="4">Content Summary:

Overview of DevOps: Definition, objectives, and benefits.

DevOps Principles: Collaboration, automation, continuous integration, continuous delivery, and continuous deployment.

DevOps Tools: Introduction to popular DevOps tools like Git, Jenkins, Docker, Kubernetes, and Ansible.

Version Control with Git: Branching, merging, and collaborative development using Git.

Continuous Integration (CI): Setting up CI pipelines with Jenkins for automated building and testing.

Continuous Delivery and Deployment: Implementing CD pipelines for deploying</td></tr>
</table>

applications to various environments.		
Unit Number: 2	**Title: Containerization and Orchestration**	**No. of hours: 10**
Content Summary: Introduction to Containers: Docker and containerization concepts. Container Management: Working with Docker containers, images, and registries. Docker Compose: Managing multi-container applications. Introduction to Kubernetes: Container orchestration and Kubernetes architecture. Deploying Applications with Kubernetes: Deploying, scaling, and managing applications on Kubernetes.		
Unit Number: 3	**Title: Configuration Management and Infrastructure as Code (IaC)**	**No. of hours: 10**
Content Summary: Introduction to Configuration Management: Need for configuration management tools. Managing Infrastructure with Ansible: Ansible architecture and playbooks for automated configuration management. Infrastructure as Code (IaC) Concepts: Managing infrastructure using code, benefits of IaC. IaC with Terraform: Infrastructure provisioning using Terraform and cloud service providers (e.g., AWS, Azure).		
Unit Number: 4	**Title: Monitoring, Logging, and Security in DevOps**	**No. of hours: 10**
Content Summary: Application Monitoring: Monitoring tools and techniques for tracking application performance and health. Log Management: Centralized log collection, analysis, and visualization. Security in DevOps: Implementing security best practices in CI/CD pipelines and containerized environments.		

DevOps Culture and Collaboration: Encouraging collaboration between development and operations teams.
***SELF-LEARNING COMPONENTS**: https://elearn.nptel.ac.in/shop/iit-workshops/completed/cicd-devops-automation-and-devsecops-automation/ **Please Note:** 1)Students are supposed to learn the components on self-basis 2) At least 5-10 % syllabus will be asked in end term exams from self-learning components.
Reference Books: 1. Jez Humble and David Farley, "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation," Pearson Education, Inc., 2011. 2. Nigel Poulton, "The Kubernetes Book," Independently published, 2018. 3. Sam Newman, "Building Microservices: Designing Fine-Grained Systems," O'Reilly Media, Inc., 2015. 4. Eberhard Wolff, "Microservices Patterns: With examples in Java," Manning Publications, 2018. 5. Yevgeniy Brikman, "Terraform: Up & Running: Writing Infrastructure as Code," O'Reilly Media, Inc., 2017.

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the principles and benefits of DevOps, and its role in enhancing collaboration and efficiency between development and operations teams.
CO2	**Acquire** hands-on experience with popular DevOps tools such as Git, Jenkins, Docker, Kubernetes, and Ansible for implementing continuous integration, continuous delivery, and automated deployment processes.

CO3	**Demonstrate** proficiency in containerization and orchestration techniques using Docker and Kubernetes for efficient and scalable application deployment and management.
CO4	**Implement** configuration management and Infrastructure as Code (IaC) using Ansible and Terraform to automate the provisioning and management of infrastructure resources.
CO5	**Develop** skills in monitoring, logging, and security practices in the context of DevOps, ensuring application performance, resilience, and adherence to security best practices.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	-	-	P1
C02	C2	-	P2
CO3	C3	L3	P3
CO4	C4	-	-
CO5	C5	L5	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	3	-	3	-	-	-	3
CO2	3	3	-	3	3	-	-	3	-	-	-	3
CO3	3	3	2	2	3	2	2	3	-	-	-	3
CO4	-	3	2	3	3	-	2	3	2	-	-	3
CO5	-	3	2	3	-	-	3	3	-	-	-	3

Justification for mapping must be relevant.

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PO1	PO2	PO3	PSO4
CO1	3	-	1	-
CO2	2	1	-	1
CO3	3	-	-	-
CO4	1	1	1	1
CO5	-	2	-	-

Relevance of the Syllabus to various indicators

Unit I	Introduction
Local	Addresses local understanding of the Internet and its impact on society
Regional	Addresses regional internet connectivity and network infrastructure requirements
National	Contributes to national digital literacy and internet connectivity strategies
Global	Aligns with global trends in internet technologies and network

	protocols
Employability	Develops skills in using internet-based services and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in internet technologies and network protocols
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	
Local	Addresses local understanding of the Internet and its impact on society
Regional	-
National	Contributes to national digital literacy and internet connectivity strategies
Global	Aligns with global trends in internet technologies and network protocols
Employability	Develops skills in using internet-based services and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in internet technologies and network protocols
Professional Ethics	-
Gender	-

Human Values	-
Environment & Sustainability	-
Unit III	
Local	Addresses local network security needs and practices
Regional	-
National	Contributes to national network security strategies and protocols
Global	Aligns with global trends in network security techniques and protocols
Employability	Develops skills in network programming and network security techniques
Entrepreneurship	-
Skill Development	Develops knowledge and skills in client-server programming and network security
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	
Local	Addresses local understanding and implementation of internet-based services
Regional	-
National	Contributes to national digital communication strategies and multimedia applications
Global	Aligns with global trends in internet telephony, multimedia

	applications, and SEO
Employability	Develops skills in internet telephony, multimedia applications, and SEO
Entrepreneurship	-
Skill Development	Develops knowledge and skills in internet telephony, multimedia applications, and SEO
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO

DEVOPS & AUTOMATION LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **DevOps & Automation Lab**	**Course Code**	**L-T-P**	**Credits**
	ENSP461	0-0-2	1
Type of Course:	Departmental Elective III (Minor)		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

COs	**Course Outcomes (COs)**
CO 1	**Gain** hands-on experience in setting up version control using Git and performing collaborative software development with branching and merging techniques.
CO 2	**Acquire** practical knowledge in implementing continuous integration and continuous deployment (CI/CD) pipelines using Jenkins, automating the build, test, and deployment processes.
CO 3	**Develop** proficiency in containerization with Docker, including managing Docker containers and images, and deploying applications on Kubernetes for efficient and scalable orchestration.
CO 4	**Demonstrate** skills in infrastructure automation and configuration management using Ansible and Terraform to provision and manage cloud resources and application configurations.
CO 5	**Understand** and **apply** monitoring, logging, and security practices in DevOps, ensuring application performance, resilience, and adherence to

	security best practices throughout the software development lifecycle.

Ex. No.	Experiment Title	Mapped CO(s)
1	Setting up version control with Git	CO1
2	Implementing a basic Jenkins CI/CD pipeline	CO2
3	Automating application deployment with Jenkins	CO2
4	Containerizing an application using Docker	CO3
5	Managing Docker containers and images	CO3
6	Deploying applications with Kubernetes	CO3
7	Implementing Kubernetes deployment strategies	CO3
8	Continuous deployment with Kubernetes	CO3
9	Configuring infrastructure with Ansible	CO4
10	Automating application configuration with Ansible	CO4
11	Implementing Infrastructure as Code (IaC) with Terraform	CO4
12	Creating scalable and resilient infrastructure with Terraform	CO4
13	Monitoring application performance with Prometheus	CO5
14	Logging and centralized log management	CO5
15	Implementing security measures in CI/CD pipelines	CO5
16	Implementing feature flags for controlled feature rollout	CO5
17	Load testing and performance optimization	CO5

18	Automating application tests with Selenium	CO2, CO5
19	Integrating automated testing in CI/CD pipelines	CO2, CO5
20	Blue-green deployment for zero-downtime updates	CO3, CO5
21	Canary deployment for testing new features	CO3, CO5
22	Implementing GitOps for application deployments	CO3, CO5
23	Managing secrets and sensitive data securely	CO5
24	Disaster recovery planning and testing	CO5
25	Creating a DevOps project integrating multiple tools	CO1, CO2, CO3, CO4, CO5

1. **Setting up version control with Git**: Exercise: Initialize a Git repository, create branches, perform commits, and push changes to a remote repository. Project: Collaboratively work on a project using branching and merging techniques in Git.

2. **Implementing a basic Jenkins CI/CD pipeline**: Exercise: Set up a simple Jenkins pipeline to build and test a sample application from version control. Project: Develop a complete CI/CD pipeline that includes code building, automated testing, and deployment to a staging environment.

3. **Automating application deployment with Jenkins**: Exercise: Configure Jenkins to automatically deploy the application to a test server upon successful build. Project: Implement a full-fledged CD pipeline with Jenkins, including deployment to production after successful testing.

4. **Containerizing an application using Docker**: Exercise: Dockerize a basic application and run it in a container. Project: Containerize a multi-service application with Docker Compose for easier deployment.

5. **Managing Docker containers and images**: Exercise: Explore Docker commands to manage containers and images, such as starting, stopping, and cleaning up. Project: Implement a container registry and manage images for different application versions.

6. **Deploying applications with Kubernetes**: Exercise: Set up a Kubernetes cluster and deploy a basic application using YAML manifests. Project: Deploy a microservices-based application with Kubernetes, configuring services and network policies.

7. **Implementing Kubernetes deployment strategies**: Exercise: Implement rolling updates and rollbacks in Kubernetes. Project: Use Kubernetes deployment strategies like blue-green and canary deployments for a real-world application.

8. **Continuous deployment with Kubernetes**: Exercise: Set up a Jenkins pipeline for continuous deployment to Kubernetes. Project: Create an end-to-end automated CD pipeline with Jenkins and Kubernetes.

9. **Configuring infrastructure with Ansible**: Exercise: Use Ansible to provision and configure virtual machines. Project: Create a playbook to configure a complete development environment for an application.

10. **Automating application configuration with Ansible**: Exercise: Create Ansible playbooks to automate application-specific configurations. Project: Implement dynamic inventory and use Ansible roles for better code organization.

11. **Implementing Infrastructure as Code (IaC) with Terraform**: Exercise: Set up a basic Terraform configuration to create cloud resources. Project: Use Terraform to define infrastructure for a scalable and fault-tolerant application.

12. **Creating scalable and resilient infrastructure with Terraform**: Exercise: Implement auto-scaling and load balancing in Terraform. Project: Design a Terraform template for a highly available architecture using multiple availability zones.

13. **Monitoring application performance with Prometheus**: Exercise: Set up Prometheus for monitoring application metrics. Project: Create custom Prometheus metrics and use Grafana for visualization and alerting.

14. **Logging and centralized log management**: Exercise: Configure centralized log collection using tools like Fluentd or Logstash. Project: Set up ELK (Elasticsearch, Logstash, and Kibana) stack for efficient log analysis.

15. **Implementing security measures in CI/CD pipelines**: Exercise: Use Jenkins plugins to implement security checks in CI/CD pipelines. Project:

Implement security scanning tools like SonarQube and integrate them into the pipeline.

16. **Implementing feature flags for controlled feature rollout**: Exercise: Add feature flags to a sample application to enable/disable specific features. Project: Implement a feature flag service for a real-world application and manage feature rollout.

17. **Load testing and performance optimization**: Exercise: Use load testing tools to evaluate application performance under heavy traffic. Project: Analyze performance bottlenecks and optimize the application for scalability.

18. **Automating application tests with Selenium**: Exercise: Use Selenium WebDriver for automating browser-based tests. Project: Develop an automated testing suite covering multiple application features.

19. **Integrating automated testing in CI/CD pipelines**: Exercise: Integrate automated tests into the Jenkins CI/CD pipeline. Project: Implement a complete testing strategy, including unit, integration, and end-to-end tests.

20. **Blue-green deployment for zero-downtime updates**: Exercise: Perform blue-green deployment for a sample application update. Project: Set up a blue-green deployment strategy for a production application.

21. **Canary deployment for testing new features**: Exercise: Implement canary deployment for a specific application feature. Project: Use canary deployment to gradually release new features to a subset of users.

22. **Implementing GitOps for application deployments**: Exercise: Use GitOps principles to manage Kubernetes manifests with Git. Project: Implement a GitOps workflow for application deployment and configuration management.

23. **Managing secrets and sensitive data securely**: Exercise: Utilize Kubernetes secrets or HashiCorp Vault to manage sensitive data. Project: Set up a secure secret management system for a production environment.

24. **Disaster recovery planning and testing**: Exercise: Design a disaster recovery plan for a sample application. Project: Test the disaster recovery plan and validate its effectiveness.

25. **Creating a DevOps project integrating multiple tools**: Exercise: Choose and integrate various DevOps tools into a sample project. Project: Create an end-to-end DevOps project showcasing the integration of tools and best practices.

.NET FRAMEWORK

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:
.NET Framework</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP413</td><td>4-0-0</td><td>4</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Departmental Elective III (Minor)</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="4">Brief Syllabus:
The ".NET Framework" syllabus covers introduction and components of .NET, programming languages, Visual Studio, OOP, exception handling, memory management, Windows Forms/WPF, ASP.NET, web services, .NET Core, Entity Framework, and WCF. Emphasis on practical application and development skills for building robust and secure applications.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Introduction to .NET Framework</td><td>No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:
Overview of .NET Framework ,Introduction to the .NET platform, Evolution and history of .NET Framework, Key components and architecture of .NET Framework, Common Language Runtime (CLR) and Just-In-Time (JIT) compilation, Common Intermediate Language (CIL) and Intermediate Language (IL), Programming Languages in .NET (C# as the primary language for .NET development & Visual Basic .NET) ,Introduction to Visual Studio IDE, Installation and configuration of .NET Framework and Visual Studio, NuGet package manager and third-party libraries</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: .NET Framework Fundamentals</td><td>No. of hours: 8</td></tr>
</table>

Object-Oriented Programming (OOP) in .NET, Classes, objects, and inheritance, Exception Handling and Debugging, Debugging techniques and tools in Visual Studio, Logging and error reporting in .NET applications, Memory Management and Garbage Collection, Automatic memory management in .NET, Garbage collection concepts and algorithms, Finalizers and the Dispose pattern, Performance considerations and best practices		
Unit Number: 3	**Title: Building Applications with .NET Framework**	**No. of hours: 12**
Windows Forms and WPF Applications, Introduction to Windows Forms and Windows Presentation Foundation (WPF), Designing user interfaces using WinForms/WPF controls, Event-driven programming and event handling, Data binding and data access in WinForms/WPF applications, ASP.NET Web Development, Data access and validation in ASP.NET applications, Web Services and RESTful APIs, Creating and consuming web services in .NET, Authentication and security considerations in web services.		
Unit Number: 4	**Title: Advanced Topics in .NET Framework**	**No. of hours: 12**
Content Summary: .NET Core and Cross-Platform Development, Introduction to .NET Core and its advantages, Building cross-platform applications with .NET Core, Deploying and hosting .NET Core applications, Entity Framework and Database Connectivity, Overview of Entity Framework and Object-Relational Mapping (ORM), Creating and manipulating databases with Entity Framework, Querying data using LINQ (Language Integrated Query), Handling database migrations and versioning, Windows Communication Foundation (WCF), Introduction to WCF and service-oriented architecture (SOA), Creating and consuming WCF services, Message exchange patterns and bindings in WCF, Security and reliability in WCF applications		
*Self-Learning Components: 1. Online Tutorials and Documentation: Direct students to the official Microsoft documentation for .NET Framework, which provides comprehensive guides and resources. Microsoft .NET Documentation 2. Hands-on Coding Exercises: Assign coding exercises from platforms like LeetCode or HackerRank that focus on implementing concepts of .NET		

Framework. LeetCode HackerRank

3. Project-Based Learning: Encourage students to work on small projects using different aspects of the .NET Framework. Provide examples of project ideas and resources like GitHub repositories for inspiration. GitHub

**students will demonstrate the self-learning components through classroom presentations*

Reference/Text Books:

1. "Mastering C# and .NET Framework" by Jayantha Dhanapala
2. "Pro C# and .NET Framework" by Andrew Troelsen
3. ".NET Framework Programming with C#" by G. Shankar
4. ".NET Programming: Concepts and Practice" by Atul Kumar

Define Course Outcomes (CO)

COs	Statements
CO1	Knowledge: Understanding the fundamental concepts and components of the .NET Framework.
CO 2	Application: Applying knowledge to design and develop applications using Windows Forms, WPF, and ASP.NET.
CO 3	Analysis: Analyzing performance considerations and troubleshooting errors in the .NET Framework.
CO 4	Synthesis: Integrating advanced topics like .NET Core, Entity Framework, and WCF for cross-platform development and service creation.
CO 5	Evaluation: Assessing security, reliability, scalability, and performance of applications developed using the .NET Framework.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1	A1	P1
C02	C3	A2	P2
CO3	C2	A3	P3
CO4	-	-	-
CO5	C5	-	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	2	-	-	-	-	1	-	3
CO2	1	3	3		1	-	-	-	-	2	-	3
CO3	1		3	2	1	-	-	-	-	1	-	3
CO4	-	-	3	1	2	-	-	-	-	-	-	3
CO5	-	2	3	-	2	-	-	-	-	1	-	3

Relevance of the Syllabus to various indicators

Unit I	**Introduction to .NET Framework**
Local	
Regional	
National	Understanding the evolution and history of the .NET Framework provides context specific to the national software development landscape.
Global	

Employability	Understanding the .NET Framework provides valuable skills and knowledge sought by employers in the software development industry.
Entrepreneurship	Understanding the .NET platform can support the development of innovative software products and services.
Skill Development	Studying the .NET Framework helps develop technical skills in application development and programming.
Professional Ethics	Familiarity with the .NET Framework enables professionals to adhere to ethical practices while developing software applications.
Gender	
Human Values	-
Environment & Sustainability	-
Unit II	**NET Framework Fundamentals**
Local	Understanding OOP in .NET can have local relevance in terms of specific programming practices and patterns adopted within the local software development community.
Regional	-
National	Understanding classes, objects, and inheritance in the .NET Framework is relevant at all levels of software development.
Global	Aligns with global trends in internet technologies and network protocols
Employability	Knowledge of classes, objects, and inheritance enhances employability in the software development field.
Entrepreneurship	Knowledge of OOP in .NET supports the development of innovative software products and services by entrepreneurs.
Skill Development	Learning about classes, objects, and inheritance improves technical skills required
Professional	

Ethics	
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Building Applications with .NET Framework**
Local	Understanding Windows Forms and WPF applications is relevant at a local level as it involves designing user interfaces and developing desktop applications specific to the local context.
Regional	Understanding Windows Forms and WPF applications is relevant at a regional level as these frameworks are commonly used in software development within a specific region.
National	Introduction to Windows Forms and WPF is important at a national level as these frameworks serve as the foundation for developing various types of applications used nationwide.
Global	Introduction to Windows Forms and WPF is important globally as these frameworks are fundamental to developing user interfaces and applications used on a global scale.
Employability	Understanding the basics of Windows Forms and WPF is crucial for employability in software development roles. Proficiency in these frameworks demonstrates competence and versatility, making individuals more desirable to potential employers.
Entrepreneurship	Knowledge of Windows Forms and WPF applications enables entrepreneurs to create innovative software products and services, driving business growth and success.
Skill Development	Understanding Windows Forms and WPF applications enhances technical skills in software development, enabling individuals to design and develop user-friendly and visually appealing applications.
Professional Ethics	Familiarity with Windows Forms and WPF applications ensures adherence to ethical standards in software development, including data privacy, accessibility, and industry best

	practices for usability and security.
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Advanced Topics in .NET Framework**
Local	the content on .NET Core, Entity Framework, and Windows Communication Foundation (WCF) has local relevance as it addresses the specific development and database connectivity needs within the local context.
Regional	-
National	The content on .NET Core, Entity Framework, and Windows Communication Foundation (WCF) is nationally relevant as it addresses specific development and database connectivity needs within the country, considering national requirements and technologies.
Global	addresses development and database connectivity needs on a global scale, considering international requirements and technologies.
Employability	Content equips individuals with the skills and knowledge necessary for software development roles. Proficiency in these technologies enhances employability prospects and opens up opportunities in the job market.
Entrepreneurship	Understanding these technologies enables entrepreneurs to create and scale their own software ventures.
Skill Development	Learning and applying these technologies contribute to the development of practical skills that are in demand in the industry, improving professional capabilities and career prospects
Professional Ethics	-
Gender	-

Human Values	-
Environment & Sustainability	-
SDG	SDG 9, SDG 4, and SDG 8,
NEP 2020	-
POE/4th IR	the content on .NET Core, Entity Framework, and Windows Communication Foundation (WCF) addresses professional ethics and aligns with the demands and innovations of the Fourth Industrial Revolution (4IR).

.NET FRAMEWORK LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **.NET Framework Lab**	**Course Code**	**L-T-P**	**Credits**
	ENSP463	0-0-2	1
Type of Course:	Departmental Elective III (Minor)		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	Knowledge and Understanding: Gain a thorough understanding of the core concepts and components of the .NET Framework.
CO 2	Application and Problem Solving: Apply .NET Framework knowledge to design and develop applications, solving programming problems effectively.
CO 3	Analyze and troubleshoot .NET applications, using debugging techniques and optimizing performance.
CO 4	Integrate advanced .NET topics like .NET Core, Entity Framework, and WCF to create cross-platform applications, work with databases, and build services.

Ex. No	Experiment Title	Mapped CO/COs
1	Installing and setting up the .NET Framework, Visual Studio IDE, and NuGet package manager	CO1
2	Creating a basic console application in C# or Visual Basic.NET and running it in Visual Studio.	CO1
3	Write a program to display "Hello World" using C#.	CO2
4	Create a Windows Forms application to design a simple calculator.	CO2
5	Develop a console application to perform basic arithmetic operations	CO2
6	Create a class hierarchy to represent different types of vehicles.	CO2
7	Implement inheritance and polymorphism concepts in a C# program.	CO2
8	Design a Windows Forms application to manage student records.	CO3
9	Create a WPF application to build a simple photo gallery.	CO3
10	Develop a web application to display and manage a list of books using ASP.NET..	CO3
11	Implement form validation and data access in an ASP.NET application.	CO3
12	Build a RESTful API using ASP.NET Web API to perform CRUD operations on a database.	CO3
13	Create a client application to consume a web service and display the retrieved data.	CO2
14	Implement a cross-platform application using .NET Core.	CO3
15	Develop a database-driven application using Entity	CO3

	Framework for data manipulation.	
16	Design and implement a WCF service to provide secure communication between client and server.	CO4
17	Connect a .NET application to a database using ADO.NET and retrieve data.	CO3
18	Use LINQ (Language Integrated Query) to perform data querying and manipulation operations.	CO3
19	Deploy a .NET application to a web server or a cloud platform.	CO4
20	Configure and manage the hosting environment for a .NET application.	CO4
21	Use debugging techniques and tools in Visual Studio to identify and fix bugs in a program.	CO2
22	Create a program to demonstrate the automatic memory management feature in .NET.	CO4
23	Implement a program to analyze and optimize memory usage in a .NET application.	CO2
24	Develop a WCF service to perform CRUD operations on a database.	CO4
25	Design a client application to consume the WCF service and display the retrieved data.	CO4

NEW AGE PROGRAMMING LANGUAGES

Department:	**Department of Computer Science and Engineering**		
Course Name: New-Age programming languages	**Course Code**	**L-T-P**	**Credits**
	ENSP415	4-0-0	4
Type of Course:	Departmental Elective III (Minor)		
Pre-requisite(s), if any:			

Brief Syllabus:

New-Age programming languages (GO, F#, Clojure, Kotlin) provides an introduction to the concepts and applications of modern programming languages. It explore the features and benefits of GO, F#, Clojure, and Kotlin, and develop practical skills in programming using these languages. The course will cover language syntax, data types, control structures, functional programming concepts, concurrency, and integration with other technologies.

UNIT WISE DETAILS

Unit Number: 1	**Title: GO programming Language**	**No. of hours: 10**

Content Summary:

Overview of GO, F#, Clojure, and Kotlin, Comparison with traditional programming languages, Installation and setup of development environment, Introduction to GO syntax and data types, Control structures, Functions and packages in GO, Arrays, slices, and maps in GO, Structs and custom data types, Pointers and memory management, Concurrency and parallelism in GO, Error Handling, Concurrent Programming in GO, Advanced GO Concepts- Function closures and anonymous functions, Reflection and type introspection, Testing and benchmarking in GO, Writing concurrent and parallel programs.

Unit	**Title: F# Programming**	**No. of hours: 10**

Number: 2	**Language**	
Content Summary: Introduction to F# syntax and functional programming concepts, Data Types, Variables, Operators, Decision Making, Loops, Functions, Strings, Options, Immutable data types and pattern matching, Higher-order functions and currying, Asynchronous and parallel programming in F#, Object-Oriented Programming with F#, Database access with F#, Querying and manipulating data using F#, Integration with relational and NoSQL databases		
Unit Number: 3	**Title: Introduction to Clojure Programming**	**No. of hours: 10**
Content Summary: Overview of Clojure and its features, Setting up the development environment, Basic syntax and data structures in Clojure, Functional Programming in Clojure, Immutable data and pure functions, Higher-order functions and recursion, Collections and sequence operations in Clojure, Destructuring and pattern matching, Macros and metaprogramming in Clojure, Concurrency models in Clojure, Asynchronous programming with core.async, Parallel programming with reducers and pmap, Interacting with Java libraries and APIs, Java interoperability in Clojure, Working with Java collections and objects, Web Development with Clojure, Building web applications using Clojure and Ring, Database access and persistence in Clojure, Error Handling and Testing: Exception handling and error management in Clojure, Testing strategies and frameworks in Clojure, Data Manipulation and Transformation: Data manipulation with Clojure's sequence functions, Data transformation with transducers, Data-driven development with data literals and data readers		
Unit Number: 4	**Title: Introduction to Kotlin Programming**	**No. of hours: 10**
Content Summary: Overview of Kotlin and its advantages, Setting up the development environment, Basic syntax and data types in Kotlin, Conditional statements and loops, Function declarations and parameters, Lambda expressions and higher-order functions, Object-Oriented Programming in Kotlin: Classes, objects, and inheritance, Properties and access modifiers, Interfaces and abstract classes, Understanding nullable and non-nullable types, Safe calls and the Elvis operator, Type inference and smart casting, Collections and Functional Programming: Working with lists, sets, and maps in Kotlin, Collection operations and transformations, Introduction to functional programming concepts in Kotlin, Creating extension functions in Kotlin, Using DSLs		

for domain-specific problems, Builder pattern and DSL implementation.

***Self-Learning Components**:

2. Web programming with GO
3. F# for Data Science and Machine Learning:
4. Metaprogramming and DSLs in Clojure:
5. Android App Development with Kotlin:

References:

1. Building Modern Web Applications with Go (Golang) by Udemy
2. https://www.jetbrains.com/academy/
3. https://www.classcentral.com/subject/f-sharp
4. https://www.classcentral.com/subject/clojure

Please Note:

At least 5-10 % syllabus will be asked in end term exams from self-learning components

Reference Books:

12. The Go Programming Language, Alan A. A. Donovan and Brian W. Kernighan, Addison-Wesley Professional.
13. An Introduction to Programming in Go, Caleb Doxsey, CreateSpace Independent Publishing.
14. Real-World Functional Programming: With Examples in F# and C#, Tomas Petricek and Jon Skeet, Manning.
15. Programming F# 3.0: A Comprehensive Guide for Writing Simple Code to Solve Complex Problems, Chris Smith, O'Reilly Media.
16. Getting Clojure: Build Your Functional Skills One Idea at a Time, Russ Olsen, O'Reilly.
17. The Joy of Clojure, Michael Fogus and Chris Houser, Manning Publication.
18. Atomic Kotlin, Bruce Eckel and Svetlana Isakova, Mindview LLC.
19. Kotlin in Action, Dmitry Jemerov and Svetlana Isakova, Manning Publication.

Online References:

1. https://gobyexample.com/ [
2. https://golang.org/doc/
3. https://www.youtube.com/playlist?list=PLlxmoA0rQ-LwgK1JsnMsakYNACYGa1cjR
4. https://kotlinlang.org/docs/home.html
5. https://docs.microsoft.com/en-us/dotnet/fsharp/
6. https://www.udemy.com/course/learning-functional-programming-with-f/

7. https://clojure.org/guides/getting_started

Course Outcomes (CO)

COs	Statements
CO1	**Understand** the fundamental principles and paradigms of modern programming languages, including functional programming, object-oriented programming, and concurrent programming.
CO2	**Develop** proficiency in using the syntax, data structures, and control flow constructs of each language (GO, F#, Clojure, and Kotlin) to solve programming problems.
CO3	**Explore** the unique features and strengths of each language, such as Go's focus on concurrency, F#'s functional programming capabilities, Clojure's emphasis on immutability and simplicity, and Kotlin's interoperability with existing Java code.
CO4	**Apply** the languages' respective development tools, such as Go's gofmt and go vet, F#'s F# Interactive (FSI), Clojure's Leiningen or Boot, and Kotlin's integrated development environment (IDE) support, to improve code quality and productivity.
CO5	**Design and implement** projects that integrate multiple programming languages, using appropriate inter-language communication mechanisms and libraries (e.g., Go and Kotlin interacting via REST APIs, F# and Clojure communicating via message queue

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels(C) 7. Knowledge 8. Understand 9. Apply 10.Analyze 11.Evaluate 12.Create	Affective levels(A) 6. Receiving 7. Responding 8. Valuing 9. Organizing 10.Characterizing	Psychomotor levels(P) 6. Imitation 7. Manipulation 8. Precision 9. Articulation 10.Improving
CO1	C2	A1	-
C02	C3	A2	P2
CO3	C2	A3	-
CO4	C3	A4	P3
CO5	C6	-	P4

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2			2					2		
CO2	2	2			2					2		
CO3	2	2		3								3
CO4					3					3		2
CO5						2				2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3			3
CO2	3	2		
CO3		2		3
CO4		2		3
CO5		2	2	2

Relevance of the Syllabus to various indicators

Unit I	Introduction to New-Age Programming Languages and GO programming Language
Local	-
Regional	-
National	Provides essential knowledge and skills related to modern programming languages like GO, F#, Clojure, and Kotlin, which are widely used in national software development projects and initiatives.
Global	Relevant in the global software development community, as these languages and concepts have international adoption and usage.
Employability	Highly valued in the job market, as these languages are used in various industries and offer opportunities for software development roles.
Entrepreneurship	Equips students with knowledge of modern programming languages and advanced concepts, enabling them to explore entrepreneurial opportunities in software development and innovation using these languages.
Skill Development	Enhances students' technical skills in software development, making them more competent in the field of computer science.
Professional Ethics	While not directly related to professional ethics, the syllabus indirectly promotes ethical practices by emphasizing the importance of error handling, writing efficient and concurrent programs, and following best practices in software development.
Gender	-
Human Values	Indirectly supports human values by fostering the development of software solutions that are efficient, maintainable, and user-friendly, aligning with values such as accessibility, usability, and user-centric design.
Environment &	-

Sustainability	
Unit II	F# Programming Language
Local	-
Regional	-
National	Provides essential knowledge and skills which are relevant at the national level for software development, data analysis, and database management projects.
Global	As a globally recognized programming language used in various industries and research domains.
Employability	Highly valued in the job market, as these skills are sought after by companies and organizations involved in software development, data analysis, and database management.
Entrepreneurship	Equips with knowledge that allows to explore entrepreneurial opportunities in software development, data-centric applications, and database-driven solutions.
Skill Development	Enhances technical skills in programming, functional programming paradigms, and data manipulation, making them more competent in the field of computer science.
Professional Ethics	Indirectly promotes ethical practices by emphasizing good programming practices, data integrity, and security considerations
Gender	-
Human Values	Indirectly supports human values by fostering the development of software solutions that are efficient, maintainable, and user-friendly, aligning with values such as accessibility, usability, and user-centric design.
Environment & Sustainability	-
Unit III	Introduction to Clojure Programming
Local	-

Regional	-
National	Provides essential knowledge and skills which are relevant at the national level for software development, web application development, and data-driven solutions.
Global	As a globally recognized programming language used in various industries and research domains.
Employability	Language is highly valued in the job market. The skills are sought after by companies and organizations involved in software development, web application development, and data analysis.
Entrepreneurship	Explores entrepreneurial opportunities in software development, web application startups, and data-centric solutions
Skill Development	Enhances technical skills, making more competent in the field of computer science
Professional Ethics	Indirectly promotes ethical practices by emphasizing good programming practices, data integrity, and security considerations.
Gender	-
Human Values	Indirectly supports human values by fostering the development of software solutions that are efficient, maintainable, and user-friendly, aligning with values such as accessibility, usability, and user-centric design. .
Environment & Sustainability	-
Unit IV	Introduction to Kotlin Programming
Local	-
Regional	-
National	Provides essential knowledge relevant at the national level for software development, mobile app development, and general-purpose programming.

Global	Language has global applicability.
Employability	Highly valued in the job market. These skills are sought after by companies and organizations involved in software development, mobile app development, and DSL-based solutions.
Entrepreneurship	Explore entrepreneurial opportunities in software development, mobile app startups, and domain-specific language development
Skill Development	Make more competent in the field.
Professional Ethics	Indirectly promotes ethical practices by emphasizing good programming practices, code readability, and modularity.
Gender	-
Human Values	Indirectly by fostering the development of software solutions efficient, maintainable, and user-friendly.
Environment & Sustainability	-
SDG	SDG 4, SDG 8, SDG 9
NEP 2020	Quality education, equity, critical thinking, digital literacy, skill development.
POE/4th IR	Technological advancements, digital transformation, and future-ready skills.

NEW AGE PROGRAMMING LANGUAGES LAB

Department:	**Department of Computer Science and Engineering**		
New Age Programming languages Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP465	0-0-2	1
Type of Course:	Departmental Elective III (Minor)		
Pre-requisite(s), if any:			

Course Outcomes (CO)

COs	Statements
CO1	**Understand** the fundamental principles and paradigms of modern programming languages
CO2	**Develop** proficiency in using the syntax, data structures, and control flow constructs of each language
CO3	**Explore** the unique features and strengths of each language, such as Go's focus on concurrency, F#'s functional programming capabilities, Clojure's emphasis on immutability and simplicity, and Kotlin's interoperability with existing Java code.
CO4	**Apply** the languages' respective development tools and best practices.
CO5	**Design and implement** projects that utilize the strengths of each language to tackle complex problems or tasks.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/ COs
	Practicals on GO Programming Language	
1	Write a program that takes user input and performs basic calculations (e.g., addition, subtraction, multiplication) using different data types like integers and floats. Use control structures like if statements and loops to handle different scenarios and validate user input.	CO2
2	Create a package that contains multiple functions to perform common tasks, such as string manipulation or mathematical operations. Use these functions in a separate program to demonstrate their functionality and reusability.	CO1
3	Implement a program that stores a collection of elements using arrays. Perform operations like adding, removing, or updating elements	CO2
4	Define a struct Person with the following members: name, age, job and salary. Create methods associated with the struct to read data in structure and print data.	CO4
5	Develop a program that utilizes pointers to modify and manipulate data in memory. Explore concepts like referencing, dereferencing, and memory allocation/deallocation.	CO2
6	Write a program that demonstrates the use of Go routines and channels to achieve concurrent execution of tasks.	CO3
7	Create a program that handles various error scenarios and provides appropriate error messages or responses. Write unit tests for critical functions and verify their correctness using Go's testing package.	CO5
8	**Mini Project**: Task Manager Application in Go Create a task manager application using the Go programming language. The application should allow users to manage their tasks by adding, updating, and deleting tasks. The tasks should	CO5

		have attributes such as title, description, due date, and status (e.g., "in progress", "completed").	
		Practicals on F# Programming Language	
9	a.	WAP to read marks of 4subjects and calculate the Percentage of student and find the result according to given conditions 60>=1st Division 60<&& 50>= 2nd Division 50<&& 40>=3rd Division 40<=fail.	CO2
	b.	WAP to accept an integer and check whether it is prime or not.	
10	a.	Write a function that takes a string as input and returns the reverse of the string. Also check if a given string is a palindrome	CO2
	b.	Create a function that takes a string as input and performs the following transformations: i. If the string contains only alphabetic characters, convert it to uppercase. ii. If the string contains only numeric characters, convert it to an integer and double its value. iii. If the string contains a mix of alphabetic and numeric characters, return it as is.	
	c.	Design a function that validates an email address based on specific rules, such as the presence of an '@' symbol and a valid domain name. Use pattern matching to check if the input string matches the expected email format.	
12		Implement a program that performs various operations on lists using higher-order functions (define a list of integers or strings). Write pure functions that demonstrate the map, filter, reduce/fold operations.	CO1
13		Implement a program that performs multiple I/O-bound or computationally intensive tasks concurrently using F#'s asynchronous workflows and parallel programming constructs.	CO3
14		Create a program that demonstrates the object-oriented programming (OOP) capabilities of F#. Define classes, objects,	CO3

	and inheritance hierarchies using F#'s OOP syntax.	
15	Create a program that demonstrates the following tasks: i. Establish a connection to both the relational and NoSQL databases using appropriate database drivers or libraries. ii. Perform basic CRUD operations (Create, Read, Update, Delete) on the databases.	CO4
16	**Mini Project**: Employee Management System Create an Employee Management System using the F# programming language and a relational database. The system should allow users to perform CRUD (Create, Read, Update, Delete) operations on employee records stored in the database. It should provide functionality to add new employees, retrieve employee information, update employee details, and delete employee records.	CO5
	Practicals on Clojure Programming Language	
17	Write a program that demonstrates the basic syntax and data structures in Clojure, such as lists, vectors, maps, and sets.	CO1
18	Write functions that manipulate and transform sequences using operations such as map, filter, reduce, and take.	CO2
19	Implement a program that showcases asynchronous programming using the core.async library.	CO3
20	Write code that calls Java methods, creates Java objects, and works with Java collections and objects from Clojure.	CO4
21	Develop a web application using Clojure and the Ring library. Set up routes, handle HTTP requests and responses, and render dynamic content.	CO5
22	Write functions that interact with the database, perform CRUD operations, and handle transactions.	CO5
23	Implement error handling mechanisms, such as exception handling and error management, in Clojure.	CO4
24	**Mini Project**: Blogging Platform with Clojure Create a Blogging Platform using the Clojure programming language. The platform should allow users to create and publish	CO5

	blog posts, manage user accounts, and provide functionality for reading and commenting on blog posts. It should utilize a relational database for data storage and retrieval.		
	Practicals on Kotlin Programming Language		
25	19	WAP for print following o/p Hello Kotlin!!!	CO2
	20	WAP to take employee's basic salary, dept_code and experience. Calculate bonus according to following criteria i. dept_code = 101 && exp <= 2 bonus = 3% ii. dept_code = 102 && exp <= 4 bonus = 5% iii. dept_code = 103 && exp <= 7 bonus = 8%	
	21	WAP to accept an integer and display average of digit.	
26	Write a program in Kotlin that demonstrates various aspects of function declarations, parameters, and higher-order functions. a. Implement a function that takes two integer parameters and returns their sum. b. Create a function that has default parameter values for an optional third parameter, which is a string representing a greeting. If no greeting is provided, the function should use a default greeting. c. Explore named parameters by creating a function that takes multiple parameters and demonstrate how to call the function by specifying the parameter names explicitly. d. Implement a variable-length argument function that takes a variable number of integers and calculates their average. e. Utilize a higher-order function by creating a function that accepts a lambda expression as a parameter. The lambda should take an integer parameter and return the square of that integer.		CO2
27	WAP to create a class Student with data members' rollno, student name, course and percentage and member functions to accept and display the details of student. a. Implement properties, methods, and constructors in classes. b. Explore access modifiers and visibility scopes in Kotlin.		CO1
28	Implement a program that demonstrates the declaration and usage of nullable and non-nullable variables. Utilize safe calls (?.) and the Elvis operator (?:) to handle nullable values and provide alternative values or perform fallback actions.		CO3

29	WAP to implement various collections like lists, sets, and maps in Kotlin and perform common operations on them. Use collection functions and transformations such as map, filter, and reduce to manipulate data.	CO2
30	Implement a DSL for a domain-specific problem, showcasing Kotlin's expressive syntax and extension functions.	CO5
31	Implement a program that demonstrates the creation and usage of extension functions in Kotlin(Choose a specific class or data type, such as String). For example, you can create an extension function that counts the number of vowels in a string or reverses the string.	CO3
32	**Mini Project**: Quiz App Build a quiz application that presents users with multiple-choice questions on various topics. Users can select their answers, and the app provides instant feedback on correctness. Keep track of the user's score and display the result at the end of the quiz. Include features like a timer, score calculation, and a database of questions.	CO5

K.R. MANGALAM UNIVERSITY

MINOR PROJECT-III

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name: Minor Project-III</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSI451</td><td>---</td><td>2</td></tr>
<tr><td>Type of Course:</td><td colspan="3">Project</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: NA</td></tr>
</table>

- Students expected to develop a basic project that demonstrates the application of learnings from studied subjects.
- Students are required to submit a hard copy of project file as per the template (Provided at the end of Handbook). File needs to be submitted in spiral bind.
- Project will be evaluated on the scale of 100 with following evaluation criteria.
  - Project idea & features (10)
  - Literature review (10)
  - Tools & Techniques employed (10)
  - Methodology (10)
  - Presentation of Results and its usefulness (20)
  - Implementation and its understandability (10)
  - Meetings & comments by guide (20)
  - Research paper (10)

File format for Minor project

37.	Abstract	Page No.
38.	Introduction (description of broad topic)	
39.	Motivation	
40.	Literature Review	
41.	Gap Analysis	
42.	Problem Statement	
43.	Objectives	

44.	Tools/platform used	
45.	Methodology	
46.	Experimental Setup	
47.	Evaluation Metrics	
48.	Results And Discussion	
49.	Conclusion & Future Work	
50.	References	
51.	Annexure I: Responsibility Chart	
52.	Annexure II: Screenshots of all the MS-Team Meetings with links (online)/ handwritten comments(offline) from guide	
53.	Annexure III Complete implementation code	
54.	Annexure IV Research Paper (Published/Submitted)	

Semester: 8

INDUSTRIAL PROJECT/R&D PROJECT/START-UP PROJECT