K.R. MANGALAM UNIVERSITY

SCHOOL OF ENGINEERING

AND

TECHNOLOGY

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

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

Welcome to the exciting world of B.Tech (Computer Science & Engineering) with Specialization in Artificial Intelligence (AI) and Machine Learning (ML). This program is designed to equip students with the necessary skills and knowledge to thrive in the rapidly evolving field of AI and ML, where technological advancements are shaping the future of industries worldwide. In today's digital age, AI and ML have emerged as transformative technologies, revolutionizing various sectors such as healthcare, finance, transportation, and entertainment. As a student specializing in AI and ML, you are embarking on a journey that will enable students to understand and harness the power of intelligent systems, data analysis, and automation.

The field of Computer Science and Engineering is at the forefront of innovation, driving advancements that shape every aspect of our lives. With the rise of AI and ML technologies, the potential for transforming industries, solving complex problems, and creating intelligent systems is limitless. As a B. Tech CSE student, specializing in AI and ML, you will embark on a journey that explores the intersection of computer science, data science, and intelligent algorithms.

This program will challenge and inspire you to think critically, develop creative solutions, and tackle real-world challenges. From fundamental programming and algorithms to advanced topics like neural networks, deep learning, and natural language processing, you will gain a comprehensive understanding of AI and ML concepts. As you delve into the world of AI and ML, you will have the opportunity to work on exciting projects, applying your knowledge to develop intelligent systems, predictive models, and innovative applications. The program's hands-on approach will enable you to gain practical experience, making you industry-ready by the time you graduate.

Our distinguished faculty members, who are experts in their fields, will guide you through a dynamic curriculum that combines theoretical knowledge with practical implementation. Additionally, you will have access to cutting-edge research facilities and state-of-the-art labs, enabling you to explore the latest advancements in AI and ML. This preface serves as an introduction to the incredible journey that awaits you. As you progress through the program, be prepared to immerse yourself in a world of endless possibilities, where your ideas and contributions can shape the future of technology.

We wish you the best of luck in your pursuit of knowledge, and we are confident that with dedication, hard work, and a passion for innovation, you will excel in your B. Tech CSE with a specialization in AI and ML and contribute significantly to the advancement of this transformative field.

Objectives of the program

After the completion of the degree, students would

- Comprehensive Understanding of AI and ML: Students will develop a solid foundation in the principles, theories, and algorithms of artificial intelligence and machine learning.
- Proficiency in Programming and Data Handling: Students will acquire strong programming skills and be proficient in languages commonly used in AI and ML, such as Python and R.
- Application of AI and ML Techniques: Students will learn to apply AI and ML techniques to solve real-world problems across various domains. They will develop the ability to design and implement intelligent systems, develop predictive models, and utilize algorithms for tasks such as natural language processing, computer vision, recommendation systems, and data mining.

- Practical Experience with Industry-Relevant Tools and Technologies: Students will gain hands-on experience with industry-standard tools, libraries, and frameworks used in AI and ML, such as TensorFlow, PyTorch, scikit-learn, and Spark.

Career Avenues

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

B.Tech AI & ML 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 AI & ML Is quite vast whether a graduate chooses to work or study further.

Some of the areas of recruitment are

- Artificial Intelligence Engineer.
- Computer Science.
- Machine Learning Engineer.
- Data Scientist.
- AI Research Scientist.
- AI Consultant.
- AI Product Manager.
- 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.

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University Vision & Mission

Vision

KR 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 Educational Objectives (PEO)

PEO1 - Develop knowledge and abilities in the area of Artificial Intelligence & Machine Learning and create a foundation of lifelong learning to facilitate progressive careers in industry and in pursuit of higher studies.

PEO2 - Apply critical thinking, analytical, and problem-solving skills to develop innovative solutions that address complex real-world problems in the field of AI & Machine Learning

PEO3 - To provide our students with the necessary communication and interpersonal skills, multidisciplinary teamwork, and leadership abilities so they can achieve their professional obligations.

PEO4 - To make students aware of current concerns so they can develop morals and sense of responsibility for themselves, their coworkers, society, and the nation

Program Specific Outcomes (PSO)

PSO1 - Acquire comprehensive knowledge and skills in the field of Artificial Intelligence & Machine Learning, enabling the graduates to excel in their careers and pursue higher studies.

PSO2 - Demonstrate the ability to analyse complex real-world problems in the domain of AI & Machine Learning, apply critical thinking and analytical skills to develop innovative solutions, and effectively communicate the outcomes.

PSO3 - Develop effective communication and interpersonal skills, including the ability to work in multidisciplinary teams, collaborate with diverse stakeholders, and demonstrate leadership abilities in AI & Machine Learning projects.

PSO4 - Cultivate a strong sense of ethics, moral values, and social responsibility, ensuring graduates understand the impact of their work on society, the nation, and their professional obligations.

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 teamwork: 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 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	ENCH151/ENPH151	Engineering Physics lab / Engineering Chemistry lab	-	-	2	1
7	VAC I		Environmental Studies & Disaster Management (Online Moodle)	2	-	-	2
8	SEC	SEC037	Data Visualization using PowerBI	0	0	4	2
TOTAL				12	2	12	20

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	Major	ENCH101/ ENPH101	Engineering Chemistry / Engineering Physics	3	1	-	4
3	Minor	ENSP102	Overview of AI, Data Science, Ethics and Foundation of Data Analysis	4	0	0	4
4	Major	ENEE101	Basics of Electrical & Electronics Engineering	4	-	-	4

5	Major	ENCH151 /ENPH151	Engineering Chemistry Lab/Engineering Physics lab	-	-	2	1
6	Major	ENEE151	Basics of Electrical & Electronics Engineering Lab	-	-	2	1
7	Minor	ENSP152	Overview of AI, Data Science, Ethics and Foundation of Data Analysis Lab	0	0	2	1
8	VAC II		Extension Activities (community engagement service)	2	-	-	2
9	Open Elective		Open Elective-1	3	-	-	3
TOTAL				19	2	6	24

Semester III

SNo	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	Major	ENCS253	Data Structures Lab	-	-	2	1
5	Open Elective		Open Elective -II	3	-	-	3
6	SEC	SEC038	Probabilistic Modelling and Reasoning with Python Lab	-	-	4	2
7	VAC		VAC III	2	-	-	2
8	AEC	AEC011	Life Skills for Professionals-I	3	-	-	3
9	INT	ENSI251	Summer Internship/Project	-	-	-	2
10	Major	ENCS251	Java Programming Lab	-	-	2	1
TOTAL				18	2	8	26

Semester IV

SNo	Category	Course Code	Course Title	L	T	P	C
1	Major	ENCS202	Analysis and Design of Algorithms	3	1	-	4
2	Major	ENCS204	Database Management Systems	3	1	-	4
3	Minor	ENSP202	Machine Learning and Pattern Recognition	4	-	-	4
4	Major	ENCS256	Analysis and Design of Algorithms Lab	-	-	2	1
5	Major	ENCS254	Database Management Systems Lab	-	-	2	1
6	AEC	AEC012	Life Skills for Professionals-II	3	-	-	3
7	Open Elective		Open Elective -III	3	-	-	3
8	VAC		VAC IV	2	-	-	2
9	Minor	ENSP252	Machine Learning Practical with Python, Scikit-learn, Matplotlib, TensorFlow	-	-	2	1
10	Proj	ENSI252	Minor project	-	-	-	2
11	SEC	**SEC039**	R Programming for Data Science and Data Analytics Lab	-	-	4	2
TOTAL				18	2	10	27

Semester V

SNo	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	ENSP302	Natural Language Processing	4	-	-	4

4	AEC	AEC013	Life Skills for Professionals-III	3	-	-	3
5	Minor	ENSP309	Big Data Analysis with Scala and Spark	4	-	-	4
6	Minor	ENSP352	Natural Language Processing Lab	-	-	2	1
7	SEC	**SEC040**	Data Science - Tools and Techniques Lab			4	2
8	Major	ENCS351	Operating System Lab	-	-	2	1
9	Minor	ENSP359	Big Data Analysis Lab	-	-	2	1
10	INT	ENSI351	Summer Internship/Project	-	-	-	2
TOTAL				18	1	10	26

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	4	-	-	4
4	Major	ENSP310	Neural Networks and Deep Learning	4	-	-	4
5	Major	ENCS352	Computer Networks Lab	-	-	2	1
6	Major	ENSP360	Deep Learning Practical with Python, TensorFlow and Keras	-	-	2	1
7	Minor		Department Elective Lab -I	-	-	2	1
8	SEC	**SEC036**	Competitive Coding Lab	-	-	4	2
9	Proj	ENSI352	Minor Project				2
Total				**15**	**1**	**10**	**23**

Semester VII

SNo	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	2	-	-	2
Total				**10**	**0**	**4**	**12**
OR							
INT		ENSI453	Professional Internship from Industry	**-**	**-**	**-**	**12**

Semester VIII

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

	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

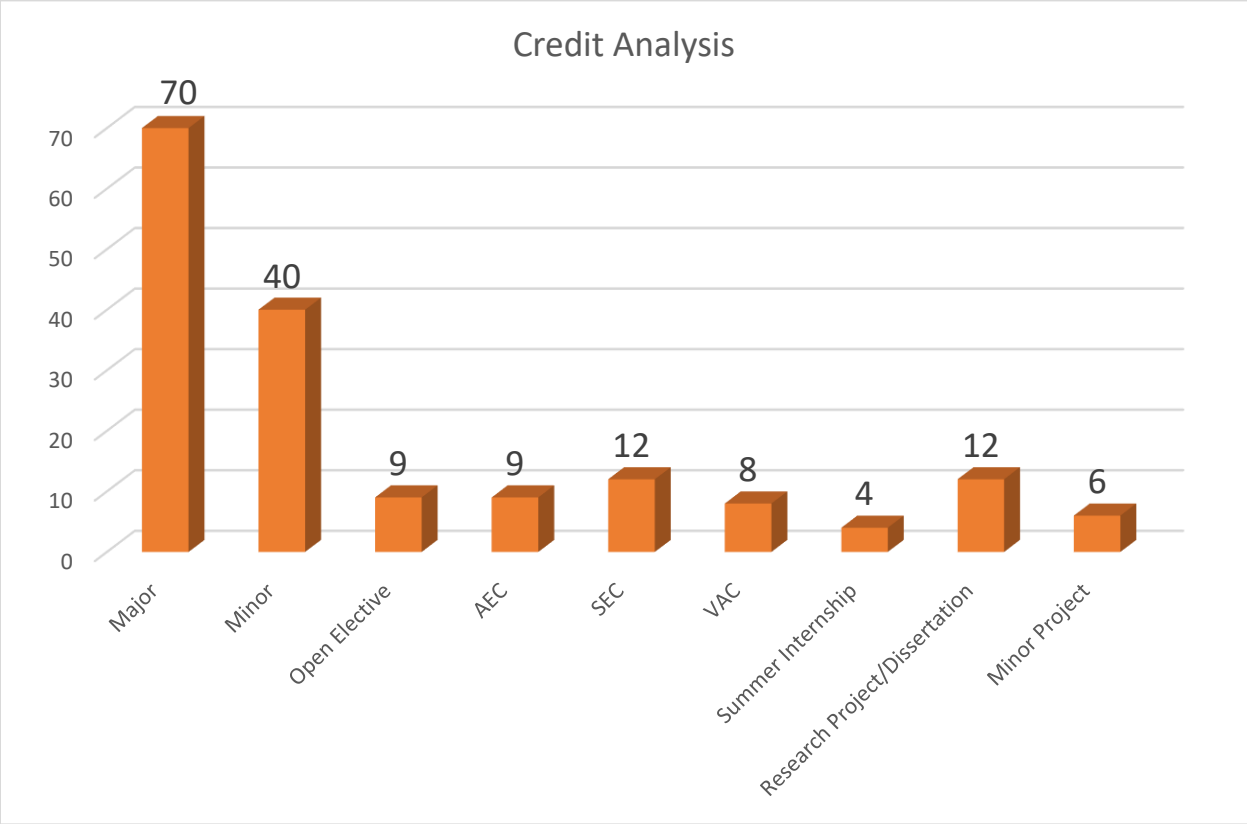
Department Elective II (Cyber Security)							
(i)	Minor	ENSP301	Secure Coding and Vulnerabilities	4	-	-	4
	Minor	ENSP351	Secure Coding and Vulnerabilities lab	-	-	2	1
(ii)	Minor	ENSP303	Cyber Crime Investigation & Digital Forensics	4	-	-	4
	Minor	ENSP353	Cyber Crime Investigation & Digital Forensics 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 - IV (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

Total Credits: 170

Categorization of Courses



Syllabus

Semester: I

ENGINEERING CALCULUS

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

Engineering Calculus</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENMA101</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): Calculus knowledge at higher secondary level</td></tr>
<tr><td colspan="4">Brief Syllabus:
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.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Differential Calculus- I</td><td>No. of hours: 10</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Multivariable Calculus (Partial Differentiation and applications)</td><td>No. of hours: 10</td></tr>
</table>

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 Number: 3	**Title: Multivariable Calculus-II (Integration)**	**No. of hours: 10**

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 Number: 4	**Title: Vector Calculus**	**No. of hours: 10**

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.

***Self-Learning Components:**

https://onlinecourses.nptel.ac.in/noc22_ma75/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

Text Books: -

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, 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

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 center 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

Relevance of the Syllabus to various indicators

Unit I	Differential Calculus- I
Local	Understanding differential calculus can aid in solving local engineering and scientific problems.
Regional	Understanding differential calculus can be applied to regional projects or research in engineering fields.
National	Differential calculus plays a significant role in various national engineering and scientific endeavors.
Global	Differential calculus is fundamental to global scientific research, engineering projects, and innovations.
Employability	Knowledge of differential calculus enhances employability in various technical and engineering professions.
Entrepreneurship	Knowledge of differential calculus can inspire entrepreneurial opportunities in engineering-based ventures.
Skill Development	Learning differential calculus develops analytical and problem-solving skills for engineering applications.
Professional	Applying differential calculus with integrity ensures ethical

Ethics	practices in engineering and scientific fields.
Gender	Differential calculus education is equally important for individuals of all genders pursuing engineering.
Human Values	Applying differential calculus with ethical considerations contributes to human-centered engineering solutions.
Environment & Sustainability	Differential calculus can be used to model and optimize environmentally sustainable engineering practices.
Unit II	**Multivariable Calculus (Partial Differentiation and applications)**
Local	Understanding multivariable calculus can aid in solving local engineering and scientific problems.
Regional	Understanding multivariable calculus can be applied to regional projects or research in engineering fields.
National	Multivariable calculus plays a significant role in various national engineering and scientific endeavors.
Global	Multivariable calculus is fundamental to global scientific research, engineering projects, and innovations.
Employability	Knowledge of multivariable calculus enhances employability in various technical and engineering professions.
Entrepreneurship	Knowledge of multivariable calculus can inspire entrepreneurial opportunities in engineering-based ventures.
Skill Development	Learning multivariable calculus develops analytical and problem-solving skills for engineering applications.
Professional Ethics	Applying multivariable calculus with integrity ensures ethical practices in engineering and scientific fields.
Gender	Multivariable calculus education is equally important for individuals of all genders pursuing engineering.
Human Values	Applying multivariable calculus with ethical considerations contributes to human-centered engineering solutions.
Environment &	Multivariable calculus can be used to model and optimize

Sustainability	environmentally sustainable engineering practices.
Unit III	**Multivariable Calculus-II (Integration)**
Local	Understanding integration can aid in solving local engineering and scientific problems.
Regional	Understanding integration can be applied to regional projects or research in engineering fields.
National	Integration plays a significant role in various national engineering and scientific endeavors.
Global	Integration is fundamental to global scientific research, engineering projects, and innovations.
Employability	Knowledge of integration enhances employability in various technical and engineering professions.
Entrepreneurship	Knowledge of integration can inspire entrepreneurial opportunities in engineering-based ventures.
Skill Development	Learning integration develops analytical and problem-solving skills for engineering applications.
Professional Ethics	Applying integration with integrity ensures ethical practices in engineering and scientific fields.
Gender	Integration education is equally important for individuals of all genders pursuing engineering.
Human Values	Applying integration with ethical considerations contributes to human-centered engineering solutions.
Environment & Sustainability	Integration can be used to model and optimize environmentally sustainable engineering practices.
Unit IV	**Vector Calculus**
Local	Understanding vector calculus can aid in solving local engineering and scientific problems.
Regional	Understanding vector calculus can be applied to regional projects or research in engineering fields.
National	Vector calculus plays a significant role in various national

	engineering and scientific endeavors.
Global	Vector calculus is fundamental to global scientific research, engineering projects, and innovations.
Employability	Knowledge of vector calculus enhances employability in various technical and engineering professions.
Entrepreneurship	Knowledge of vector calculus can inspire entrepreneurial opportunities in engineering-based ventures.
Skill Development	Learning vector calculus develops analytical and problem-solving skills for engineering applications.
Professional Ethics	Applying vector calculus with integrity ensures ethical practices in engineering and scientific fields.
Gender	Vector calculus education is equally important for individuals of all genders pursuing engineering.
Human Values	Applying vector calculus with ethical considerations contributes to human-centered engineering solutions.
Environment & Sustainability	Vector calculus can be used to model and optimize environmentally sustainable engineering practices.
SDG	(SDG) 4, Quality Education.
NEP 2020	Subject aligns with the objectives of the National Education Policy 2020.
POE/4th IR	Subject is relevant to the Fourth Industrial Revolution and emerging technologies.

CLEAN CODING WITH PYTHON

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:
Clean Coding with Python</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP101</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">Frequency of offering (check one): Odd</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Introduction to Python</td><td>No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:
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).</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Python Data Structure</td><td>No. of hours: 8</td></tr>
<tr><td colspan="4">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.</td></tr>
</table>

Unit Number: 3	Title: Python Decorators and generators	No. of hours: 8
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.		
Unit Number: 4	**Title: Python advanced modules**	**No. of hours: 8**
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		
Unit Number: 5	**Title: Working with Excel sheets and CSV files**	**No. of hours: 8**
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		
***Self-Learning Components:** 1. https://onlinecourses.nptel.ac.in/noc19_cs41/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. J. Peterson, A. Silberschatz, and P. Galvin, "Operating System Concepts", Addison Wesley. 2012 2. 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		

Course Outcomes (COs)

COs	Statements
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.
CO5	**Create** simple games with images, animations, and audio using our custom beginner-friendly programming library.

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	C1	A1	P1
CO2	C2	A2	P2
CO3	C3	A3	P3
CO4	C4	A4	P4
CO5	C6	A5	P5

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

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	Statement
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.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/COs
1	Write a program to print a poem.	CO1
2	Write a program to add two numbers using the input function numbers.	CO2
3	Write a program to find the reminder when divided by 2	CO2
4	Using all operators perform the practical on it and also write its data types.	CO1
5	Write a program to find the square root using input function	CO1
6	Write a program of string function and type casting.	CO2
7	Write a program to calculate the grade of student.	CO2
8	Write a program to print a table using for and while	CO3

	loop.	
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.	CO3
10	Write a program to input 8 numbers from the user and display all unique numbers.	CO3
11	Create an empty dictionary allow 4 students to enter their favorite subject as value and use key as their name.	CO3
12	Write a program to find greatest of four number enter by user.	CO3
13	Write a program to find a number is prime or not.	CO2
14	Write a program to find the sum of first 10 natural number using for and while loop.	CO2
15	Write a program to print the name in a list and write in a sorted common list.	CO2
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".	CO1
17	Use list comprehension to create a list of all numbers between 1 to 50 that are divisible by 5.	CO3
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"	CO3
19	Write a program using function to find greatest of three numbers.	CO2
20	Write a program using function to convert Celsius to Fahrenheit.	CO1
21	Write a program using function to print good morning +"name".	CO1
22	Write a program using lambda, find the square and cube.	CO2
23	Write a program using function and to find the length of a variable using arguments.	CO2
24	Write a program using arguments, key arguments to find out the sum, multiplication of n numbers.	CO2
25	Write a program using map, lambda, and filter to find the even numbers from the list.	CO3

Projects to be covered: (at least 4-5 projects).

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**

ENGINEERING PHYSICS

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Engineering Physics	**ENPH101**	3-1-0	4
Type of Course:	Major		
Pre-requisite(s), if any: Integration/Differentiation			

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

UNIT WISE DETAILS

Unit Number: 1	**Title: Mechanics**	**No. of hours: 10**

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)

Unit Number: 2	**Title: Optics**	**No. of hours: 10**

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, 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	-	-	-	-	-	-	-	3
CO3	3	-	--	-	-	-	2	-	-	-	-	3
CO4	-	-	3	-	-	-	-	-		-	2	2
CO5	3	2	-	-	-	-	-	-	-	-	-	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	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 PHYSICS LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Engineering Physics Lab	**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 center 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

ENGINEERING DRAWING & WORKSHOP LAB

<table>
<tr><td>Department:</td><td colspan="3">Department of Mechanical Engineering</td></tr>
<tr><td rowspan="2">Course Name: Engineering Drawing and Workshop Lab</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>SEC033</td><td>0-0-4</td><td>2</td></tr>
<tr><td>Type of Course:</td><td colspan="3">SEC</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any:</td></tr>
<tr><td colspan="4">Brief Syllabus:
This course is to acquaint engineering students regarding drawings, projections of planes, projection of solid and isometric projection and workshop Technology.</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title:</td><td>No. of hours: 01 hours</td></tr>
<tr><td colspan="4">Content Summary:
Introduction of drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning line conventions and free hand practicing, AUTO CAD Commands
Orthographic Projections: Introduction, Definitions - Planes of projection, reference line and conventions employed, Projections of points in all the four quadrants, Projections of straight lines.</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title:</td><td>No. of hours: 01 hours</td></tr>
<tr><td colspan="4">Content Summary:
Orthographic Projections of Plane Surfaces: Introduction, Definitions–projections of plane surfaces
Projections of Solids: Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions.
Isometric Projection: Introduction, Isometric scale, Isometric projection of simple plane</td></tr>
<tr><td>Unit Number: 3</td><td colspan="2">Title: Wood Working and Fitting Shop</td><td>No. of hours: 01 hours</td></tr>
<tr><td colspan="4">Wood Working Shop: Making of various joints, Pattern making.
Fitting Shop: Learning use of fitting hand tools, marking tools, marking gauge. Exercises: Jobs made out of MS Flats, making saw - cut filling V-cut taper at the corners, circular cut, fitting square in square, triangle in square</td></tr>
</table>

Unit Number: 4	Title: Welding and Sheet Metal Shop	No. of hours: 01 hours
Welding Shop: Electric Arc Welding, Edge Preparations, Exercises making of various joints. Bead Formation in horizontal, Vertical and Overhead positions. Gas Welding: Oxy-Acetylene welding and cutting of ferrous metals. **Sheet Metal Shop**: Learning use of sheet-metal tools, Exercises: Making jobs out of GI sheet metal.		
Reference Books: 1. Engineering Graphics - K.R. Gopala Krishna, edition Subash Publishers Bangalore. 2. Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production-Luzadder Warren J., Duff John M., Eastern Economy Edition, -Prentice-Hall of India Pvt. Ltd., New Delhi. 3. Workshop practice manual - K.Venkata Reddy, B.S.Publications. 4. Mechanical workshop practice.- K.C. John, PHI.		

Course Outcomes (CO)

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.

CO-PO Mapping

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

CO5	3		3	2	3							

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	
Local	Understanding tools used in local industries.
Regional	Adhering to regional standards.
National	Following national guidelines for clear text.
Global	Applying universal practices for dimensions.
Employability	Enhancing skills for CAD-based jobs.
Entrepreneurship	Basis for design-oriented businesses.
Skill Development	Improving technical drawing proficiency.
Professional Ethics	Integrating honesty in representations.
Gender	Promoting inclusivity and diversity in engineering.
Human Values	Integrating ethical considerations.
Environment & Sustainability	Designing eco-consciously.
Unit II	

Local	Applying local standards in technical drawings.
Regional	Incorporating regional drafting practices.
National	Adhering to national guidelines for technical representations.
Global	Using universal projection techniques for global consistency.
Employability	Enhancing skills relevant to CAD and technical drawing jobs.
Entrepreneurship	Providing a basis for design-focused entrepreneurial ventures.
Skill Development	Improving technical drawing and projection skills.
Professional Ethics	Integrating accuracy and integrity into technical drawings.
Gender	Promoting inclusivity and diversity in engineering fields.
Human Values	Addressing ethical considerations in technical representation.
Environment & Sustainability	Designing with eco-consciousness and sustainability in mind.
Unit III	**Wood Working and Fitting Shop**
Local	Applying local woodworking and fitting practices.
Regional	Incorporating regional techniques and materials.
National	Adhering to national woodworking and fitting standards.
Global	Utilizing universal woodworking and fitting methods.
Employability	Developing skills relevant to woodworking and fitting jobs.
Entrepreneurship	Providing skills for starting woodworking or fitting businesses.
Skill Development	Enhancing woodworking and fitting craftsmanship.
Professional Ethics	Integrating precision and quality into woodworking.
Gender	Encouraging diversity and inclusivity in skilled trades.
Human Values	Demonstrating patience, attention to detail, and quality.
Environment & Sustainability	Promoting sustainable wood use and waste reduction.

Unit IV	**Welding and Sheet Metal Shop**
Local	Applying local welding and sheet metal techniques.
Regional	Incorporating regional welding and metalwork practices.
National	Adhering to national welding and sheet metal standards.
Global	Utilizing universal welding and metalwork methods.
Employability	Developing skills relevant to welding and metalwork jobs.
Entrepreneurship	Providing skills for starting welding or metalwork businesses.
Skill Development	Enhancing welding and sheet metal craftsmanship.
Professional Ethics	Integrating safety and precision into welding and metalwork.
Gender	Encouraging inclusivity and diversity in skilled trades.
Human Values	Demonstrating patience, accuracy, and craftsmanship.
Environment & Sustainability	Promoting proper waste disposal and resource use.
SDG	SDG4, SDG8, SDG9
NEP 2020	Aligns with the focus on skill-oriented education, Introducing AutoCAD commands aligns with technological advancement, Supports skill development and vocational education, Fosters practical skills and vocational education.
POE/4th IR	Introducing AutoCAD commands aligns with technological advancement, Incorporates traditional drawing techniques with modern concepts, Nurtures craftsmanship and precision in traditional trades, Combines traditional metalworking with modern welding techniques.

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:

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.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/COs
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 cut in fitting shop.	CO4

DATA VISUALIZATION USING POWERBI

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name: Data Visualization using PowerBI</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>SEC037</td><td>0-0-4</td><td>2</td></tr>
<tr><td>Type of Course:</td><td colspan="3">SEC</td></tr>
<tr><td colspan="4">Pre-requisite(s), if any: Basic knowledge of Excel & data numbers</td></tr>
<tr><td colspan="4">Frequency of offering (check one): Odd</td></tr>
<tr><td colspan="4">Brief Syllabus:
• Understand manage and manipulate data in order to extract useful information and insights.
• Help to understand manipulate data is by using functions that are pre-built sets of code that perform specific tasks or operations on data.
• It will be able to analyze data via power BI, purchasing habits, and other behaviours in order to develop insights that can be used to improve marketing and sales strategies.
• To understand different data science processes, tools and techniques.To understand data fundamental, analyse the data methodology, techniques, powerful dashboards, Power BI & Visualization power of data along with a strong focus on case studies to ensure hands on learning</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td colspan="2">Title: Foundation to Data Analytics</td><td>No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:
Introduction to Data Analytics: Working with Formula and Functions, Introduction to Power BI & Charts, Logical functions using Excel, Analysing Data with Excel.</td></tr>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Data Science Processes</td><td>No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:
Six steps of data science processes, define research goals, data retrieval, cleansing data, and correct errors as early as possible, integrating – combine data from different sources, transforming data, exploratory data analysis, Data modelling, model and variable selection, model execution, model diagnostic and</td></tr>
</table>

model comparison, presentation and automation.		
Unit Number: 3	**Title: Power BI Analytics**	**No. of hours: 8**
Content Summary: Power BI Analytics, Data Validation & data models, Power Map for visualize data, Power BI-Business Intelligence , Data Analysis using statistical methods, Dashboard designing.		
Unit Number: 4	**Title: INTRODUCTION TO DATA MANIPULATION USING FUNCTION**	**No. of hours: 8**
Content Summary: Heat Map, Tree Map, Smart Chart,Azure Machine learning , Column Chart, Line Chart , Pie,Bar, Area, Scatter Chart, Data Series, Axes ,Chart Sheet , Trendline , Error Bars, Sparklines, Combination Chart, Gauge, Thermometer Chart.		
Unit Number: 5	**Title: Advan Function**	**No. of hours: 8**
Content Summary: Gantt Chart , Pareto Chart etc , Frequency Distribution, Pivot Chart, Slicers , Tables: Structured, References, Table Styles , What-If Analysis: Data Tables| Correlation model |Regression model.		
***Self-Learning Components:** **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. Microsoft Power BI Complete Reference: Bring Your Data to Life with the Powerful Features of Microsoft Power BI Book by Brian Knight, Devin Knight, and Mitchell Pearson.		

Course Outcomes (CO)

COs	Statements
CO1	**Build** data design using power BI and manage and manipulate data to extract useful information and insights.
CO2	**Apply** functions to manipulate and analyze data.

CO3	To **understand** different data science processes, tools and techniques
CO4	**Outline** the key concepts of data handling and how data has evolved
CO5	**Identify** the key concepts of data visualization using power BI and will be able to understand the dash board.
CO6	**Distinguish** key Data Science concepts such as structured and unstructured data
CO7	**Infer** the large scale data using Excel

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	C3	A2	P2
CO2	C3	A2	P2
CO3	C2	A3	P4
CO4	C2	A3	P4
CO5	C2	A3	P4
CO6	C2	A3	P2
CO7	C4	A3	P3

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	3	-	3	-	3	3	-	-	3	3
CO2	-	2	-	2	2	-	-	3	-	3	2	3
CO3	3	3	-	3	3	-	-	3	-	-	3	2
CO4	3	-	3	3	3	-	-	3	-	-	3	3
CO5	-	-	-	-	3	-	-	3	-	3	3	-
CO6	3	-	3	-	3	-	3	3	-	-	3	-
CO7	-	3	-	3	3	-	-	3	-	-	3	3

1=weakly mapped

2= moderately mapped
3=strongly mapped

CO-PSO Mapping

PO	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	3
CO2	-	3	3	2
CO3	2	2	3	3
CO4	3	2	-	3
CO5	--	3	3	3
CO6	2	2	2	2
CO7	-	2	2	2

Relevance of the Syllabus to various indicators

Unit I	**Foundation to Data Analytics**
Local	Applying local data analytics techniques.
Regional	Incorporating regional data analysis practices.
National	Adhering to national standards for data analytics.
Global	Using universal data analytics concepts and tools.
Employability	Developing skills relevant to data analytics jobs.
Entrepreneurship	Providing a basis for data-driven entrepreneurial ventures.
Skill Development	Enhancing data analytics skills and techniques.
Professional Ethics	Integrating accuracy and integrity into data analysis.
Gender	Promoting inclusivity and diversity in data science.
Human Values	Addressing ethical considerations in data analysis.
Environment & Sustainability	Applying data analysis for sustainable practices.
Unit II	**Data Science Processes**
Local	Applying local data science processes and techniques.

Regional	Incorporating regional data science practices.
National	Adhering to national data science standards.
Global	Utilizing universal data science processes and methodologies.
Employability	Developing skills relevant to data science jobs.
Entrepreneurship	Providing skills for data-driven entrepreneurial ventures.
Skill Development	Enhancing data science and analytical skills.
Professional Ethics	Integrating ethical considerations into data science.
Gender	Encouraging gender diversity in data science.
Human Values	Demonstrating integrity and responsibility in data science.
Environment & Sustainability	Applying data science for sustainable solutions.
Unit III	**Power BI Analytics**
Local	Applying local Power BI analytics techniques.
Regional	Incorporating regional business intelligence practices.
National	Adhering to national data analysis standards.
Global	Utilizing universal Power BI analytics tools and concepts.
Employability	Developing skills relevant to Power BI analytics jobs.
Entrepreneurship	Providing skills for data-driven business ventures.
Skill Development	Enhancing Power BI analytics and visualization skills.
Professional Ethics	Integrating ethics and accuracy into data visualization.
Gender	Promoting gender diversity in data analytics and BI.
Human Values	Addressing ethical and societal considerations in BI.

Environment & Sustainability	Applying BI for sustainable decision-making.
Unit IV	**Introduction to Data Manipulation Using Function**
Local	Applying local data manipulation techniques.
Regional	Incorporating regional data visualization practices.
National	Adhering to national data manipulation standards.
Global	Using universal data visualization concepts and tools.
Employability	Developing skills relevant to data visualization jobs.
Entrepreneurship	Providing skills for data-driven visualizations in business.
Skill Development	Enhancing data manipulation and visualization skills.
Professional Ethics	Integrating accuracy and ethical considerations in data viz.
Gender	Encouraging diversity in data visualization practices.
Human Values	Addressing ethical and societal aspects in visualization.
Environment & Sustainability	Applying visualization for sustainable solutions.
Unit V	**Advan Function**
Local	Applying advanced data visualization techniques.
Regional	Incorporating regional advanced data analysis practices.
National	Adhering to national standards for advanced data analytics.
Global	Using universal advanced data visualization concepts.
Employability	Developing skills for advanced data analysis jobs.
Entrepreneurship	Providing skills for data-driven innovation and startups.
Skill Development	Enhancing advanced data analysis and visualization skills.

Professional Ethics	Integrating ethics and accuracy in advanced data analysis.
Gender	Promoting gender diversity in advanced analytics.
Human Values	Addressing ethical and social considerations in analytics.
Environment & Sustainability	Applying analytics for sustainable outcomes.
SDG	SDG4, SDG9
NEP 2020	Aligns with skill-oriented education focus of NEP 2020, Aligns with skill development and problem-solving in NEP, Supports skill-oriented education and tech skills, Aligns with skill-oriented education and practical skills, Aligns with practical skills and real-world applications.
POE/4th IR	Provides essential skills for data-driven industries, Provides skills for modern data science practices, Equips for modern business intelligence and analytics, Equips for advanced data manipulation and visualization, Provides skills for advanced data analysis and modeling.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/Cos
1	Write a program that Your first Barchart in Power Bi	CO1, CO5
2	Write a program that uses functions to Maps and Scatterplots	CO2, CO5
3	Write a program that uses functions Building a Robust Bi Dashboard	CO2, CO5, CO6
4	Write a program that uses Data Validation Power Map for visualize data	CO1, CO5
5	Write a program that uses Power Map	CO5
6	Write a program that uses What if Analysis	CO1, CO5

Semester: II

LINEAR ALGEBRA AND ORDINARY DIFFERENTIAL EQUATIONS

Department:	**Department of Computer Science and Engineering**		
Course Name: Linear Algebra and Ordinary Differential Equations	**Course Code**	**L-T-P**	**Credits**
	ENMA102	3-1-0	4
Type of Course:	Major		
Pre-requisite(s): Single variable calculus, Matrices, Differentiation and Integration			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: 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 Number: 2	**Title: 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			

Normal Form Theorem for linear operators on a finite dimensional complex vector space, Quadratic forms, Applications of eigenvalues and eigenvectors.		
Unit Number: 3	**Title: Vector Spaces**	**No. of hours: 10**
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.		
Unit Number: 4	**Title: Ordinary Differential Equations**	**No. of hours: 10**
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		
***Self-Learning Components:** https://archive.nptel.ac.in/courses/111/108/111108081/ **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: • 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.		

Course Outcomes (CO)

COs	Statements

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.

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	-	2	-	1

Relevance of the Syllabus to various indicators

Unit I	**Matrices and Systems of Linear Equations**
Local	Understanding matrices and systems of linear equations can aid in solving local engineering and scientific problems.
Regional	Understanding matrices and systems of linear equations can be applied to regional projects or research in engineering fields.
National	Matrices and systems of linear equations play a significant role in various national engineering and scientific endeavors.
Global	Matrices and systems of linear equations are fundamental to global scientific research, engineering projects, and innovations.
Employability	Knowledge of matrices and systems of linear equations enhances employability in various technical and engineering professions.
Entrepreneurship	Knowledge of matrices and systems of linear equations can inspire entrepreneurial opportunities in engineering-based ventures.
Skill Development	Learning matrices and systems of linear equations develops analytical and problem-solving skills for engineering applications.
Professional Ethics	Applying matrices and systems of linear equations with integrity ensures ethical practices in engineering and scientific fields.
Gender	Matrices and systems of linear equations education is equally important for individuals of all genders pursuing engineering.
Human Values	Applying matrices and systems of linear equations with ethical considerations contributes to human-centered engineering solutions.
Environment & Sustainability	-
Unit II	**Eigenvalues and Eigenvectors**
Local	Understanding eigenvalues and eigenvectors can aid in solving local engineering and scientific problems.
Regional	Understanding eigenvalues and eigenvectors can be applied to regional projects or research in engineering fields.
National	Eigenvalues and eigenvectors play a significant role in various national engineering and scientific endeavors.
Global	Eigenvalues and eigenvectors are fundamental to global

	scientific research, engineering projects, and innovations.
Employability	Knowledge of eigenvalues and eigenvectors enhances employability in various technical and engineering professions.
Entrepreneurship	Knowledge of eigenvalues and eigenvectors can inspire entrepreneurial opportunities in engineering-based ventures.
Skill Development	Learning eigenvalues and eigenvectors develops analytical and problem-solving skills for engineering applications.
Professional Ethics	Applying eigenvalues and eigenvectors with integrity ensures ethical practices in engineering and scientific fields.
Gender	Eigenvalues and eigenvectors education is equally important for individuals of all genders pursuing engineering.
Human Values	Applying eigenvalues and eigenvectors with ethical considerations contributes to human-centered engineering solutions.
Environment & Sustainability	-
Unit III	**Vector Spaces**
Local	Understanding vector spaces can aid in solving local engineering and scientific problems.
Regional	Understanding vector spaces can be applied to regional projects or research in engineering fields.
National	Vector spaces play a significant role in various national engineering and scientific endeavors.
Global	Vector spaces are fundamental to global scientific research, engineering projects, and innovations.
Employability	Knowledge of vector spaces enhances employability in various technical and engineering professions.
Entrepreneurship	Knowledge of vector spaces can inspire entrepreneurial opportunities in engineering-based ventures.
Skill Development	Learning vector spaces develops analytical and problem-solving skills for engineering applications.
Professional Ethics	Applying vector spaces with integrity ensures ethical practices in engineering and scientific fields.
Gender	Vector spaces education is equally important for individuals of all genders pursuing engineering.
Human Values	Applying vector spaces with ethical considerations contributes to human-centered engineering solutions.
Environment & Sustainability	-
Unit IV	**Ordinary Differential Equations**

Local	Understanding ordinary differential equations can aid in solving local engineering and scientific problems.
Regional	Understanding ordinary differential equations can be applied to regional projects or research in engineering fields.
National	Ordinary differential equations play a significant role in various national engineering and scientific endeavors.
Global	Ordinary differential equations are fundamental to global scientific research, engineering projects, and innovations.
Employability	Knowledge of ordinary differential equations enhances employability in various technical and engineering professions.
Entrepreneurship	Knowledge of ordinary differential equations can inspire entrepreneurial opportunities in engineering-based ventures.
Skill Development	Learning ordinary differential equations develops analytical and problem-solving skills for engineering applications.
Professional Ethics	Applying ordinary differential equations with integrity ensures ethical practices in engineering and scientific fields.
Gender	Ordinary differential equations education is equally important for individuals of all genders pursuing engineering.
Human Values	Applying ordinary differential equations with ethical considerations contributes to human-centered engineering solutions.
Environment & Sustainability	**-**
SDG	**SDG 4**
NEP 2020	**-**
POE/4th IR	**-**

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	

ENGINEERING CHEMISTRY LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
ENGINEERING CHEMISTRY LAB	**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 Fe3+ in solution	CO2, CO3, CO5
14	Determination of molar absorptivity of a compound (KMnO4 or any water-soluble food colorant).	CO2, CO3, CO5

15	Preparation of a nickel complex [Ni(NH3)6]Cl2 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

Department:	**Department of Electrical & Electronics Engineering**		
Course Name: Basics of Electrical & Electronics Engineering	**Course Code**	**L-T-P**	**Credits**
	ENEE101	4-0-0	4
Type of Course:	Major		
Pre-requisite(s), if any: NA			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Circuit Analysis:**	**No. of hours: 10**	
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.			
Unit Number: 2	**Title: A.C. Circuits & CRO**	**No. of hours: 10**	
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			
Unit Number: 3	**Title: Semiconductor Physics**	**No. of hours: 10**	

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.

Unit Number: 4	**Title: Digital Electronics**	**No. of hours: 10**

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.

***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:

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/

Course Outcomes (CO)

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	-	-	-	-	-	2	-	1	-	-	-	-
CO 2	-	1	1	-	-	-	1	-	1	1	1	-
CO 3	2	2	-	2	2	3	2	-	-	-	-	-
CO 4	-	-	-	2	2	-	-	2	1	2	2	-
CO 5	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	-	-
C02	C2	-	-
CO3	C3	A4	-
CO4	C6	-	P5
CO5	C4	-	-

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 & Sustainability	Digital Electronics: Advancements in digital 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

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 Course		

Proposed Lab Experiments

Course Outcomes

COs	**Statements**
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

OVERVIEW OF AI, DATA SCIENCE, ETHICS AND FOUNDATION OF DATA ANALYSIS

Department:	**Department of Electrical & Electronics Engineering**		
Course Name: Overview of AI, Data Science, Ethics and Foundation of Data Analysis	**Course Code**	**L-T-P**	**Credits**
	ENSP102	4-0-0	4
Type of Course:	Minor		
Pre-requisite(s), if any: Basic knowledge of Excel			
Brief Syllabus: The students will be studying about Introduction to Data Science, Natural Language, Machine generated Data, Graph based or Network Data, Audio, Image, Video, Streaming data. Also, Six steps of data science processes define research goals, data retrieval, cleansing data, and correct errors as early as possible, integrating – combine data from different sources, transforming data, exploratory data analysis, Data modelling, model and variable selection, presentation and automation would be taught to the students. Introduction to machine Learning and Introduction to Data Analytics are also included in the syllabus.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to Data Science**		**No. of hours: 8**
Content Summary: Defining Data Science and Big Data, Benefits and Uses of Data Science and Big Data, Facets of Data, Structured Data, Unstructured Data, Natural Language, Machine generated Data, Graph based or Network Data, Audio, Image, Video, Streaming data, Data Science. Process, Big data ecosystem and data science, distributed file systems, Distributed programming framework, data integration framework, machine learning framework, No SQL Databases, scheduling tools, benchmarking tools, system deployments			
Unit Number: 2	**Title: Data Science Processes**		**No. of hours: 8**
Content Summary: Six steps of data science processes define research goals, data retrieval, cleansing data, and correct errors as early as possible, integrating – combine data from different sources, transforming data, exploratory data analysis, Data modelling, model and variable selection, model execution, model diagnostic and model comparison, presentation and automation.			

Unit Number: 3	Title: Introduction to Machine Learning	No. of hours: 8

Content Summary:

Data for Machine Learning, Leveraging Machine Learning, Descriptive vs Predictive Analytics, Machine Learning and Statistics, Artificial Intelligence and Machine Learning, Types of Machine Learning – Supervised, Unsupervised, Semi-supervised, Reinforcement Learning, Types of Machine Learning Algorithms, Classification vs Regression Problem, Bayesian, Clustering, Decision Tree, Dimensionality Reduction, Neural Network and Deep Learning, Training machine learning systems.

Unit Number: 4	Title: Introduction to AI	No. of hours: 8

Content Summary:

What is AI, Turing test, cognitive modelling approach, law of thoughts, the relational agent approach, the underlying assumptions about intelligence, techniques required to solve AI problems, level of details required to model human intelligence, successfully building an intelligent problem, history of AI.

Unit Number: 5	Title: Introduction to Data Analytics	No. of hours: 4

Content Summary:

Working with Formula and Functions, Introduction to Power BI & Charts, Logical functions using Excel, Analysing Data with Excel.

***Self-Learning Components:**

1. Artificial Intelligence Professional Program, https://online.stanford.edu/programs/artificial-intelligence-professional-program
2. Artificial Intelligence (AI), https://www.edx.org/course/artificial-intelligence-ai#!
3. 21st-Century Teaching & Learning: Data Science, https://online.stanford.edu/courses/ xeduc315n-21st-century-teaching-learning-data-science
4. Artificial Intelligence: Principles and Techniques, https://online.stanford.edu/courses/ xcs221-artificial-intelligence-principles-and-techniques.
5. Data Visualization, https://online.stanford.edu/courses/cs448b-data-visualization.

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 3e: A Modern Approach Paperback – By Stuart J Russell & Peter Norvig; Publisher – Pearson
2. Artificial Intelligence Third Edition By Kevin Knight, Elaine Rich, B. Nair – McGrawHill

3. Artificial Intelligence Third Edition By Patrick Henry Winston – Addison-Wesley Publishing Company

Course Outcomes (CO)

COs	Statements
CO 1	**Outline** the key concepts of AI and how AI has evolved
CO 2	**Identify** the key concepts of Machine Learning and will be able to differentiate between key algorithms such as supervised learning and unsupervised learning
CO 3	**Distinguish** key Data Science concepts such as structured and unstructured data, SQL and NoSQL Database
CO 4	**Examine** the process required the successfully execute a Machine Learning or Data Science project
CO 5	**Infer** the large scale data using Excel

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	C2	A1	P1
C02	C3	A2	P2
CO3	C3	A5	P5
CO4	C6	A5	P5
CO5	C2	A5	P1

CO-PO Mapping

PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO 1	3	2	2	-	2	-	2	-	-	-	-	2
CO 2	1	2	-	-	3	-	1	-	-	-	-	-

CO 3	-	-	-	-	3	-	2	1	-	3	-	2
CO 4	-	-	-	-	3	-	2	-	-	3	-	-
CO 5	-	-	-	-	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	3
CO3	2	3	1	1
CO4	2	3	2	3
CO5	2	3	2	1

Relevance of the Syllabus to various indicators

Unit I	Introduction to Data Science
Local	-
Regional	-
National	-
Global	-
Employability	Data Science is a rapidly evolving field, requiring professionals to stay updated with the latest tools, techniques, and methodologies. By actively engaging in continuous learning and demonstrating adaptability, individuals can position themselves as valuable assets in the job market.
Entrepreneurship	Data Science enables entrepreneurs to gain a deeper understanding of their customers. By analysing customer data, including demographics, preferences, and purchasing behaviour, entrepreneurs can identify customer segments, tailor their products or services to specific needs, and personalize the customer experience.
Skill Development	Data Science equips individuals with a diverse skill set, including programming, statistical analysis, machine learning, data visualization, and data management. These skills are highly sought after by employers across various industries, ranging from finance and healthcare to marketing and technology.
Professional	Data Science professionals are responsible for handling sensitive data. By implementing privacy protection

Ethics	measures, such as anonymization and secure data storage, professionals can safeguard individuals' privacy rights and comply with applicable regulations. Protecting personal information and respecting privacy are essential ethical considerations in data science.
Gender	-
Human Values	-
Environment & Sustainability	Data Science enables the collection, analysis, and interpretation of environmental data. By leveraging techniques such as remote sensing, sensor networks, and data fusion, data scientists can monitor air quality, water quality, biodiversity, deforestation, climate change, and other environmental indicators. This data helps in understanding environmental trends, identifying critical areas, and informing conservation and management strategies.
Unit II	**Data Science Processes**
Local	-
Regional	-
National	-
Global	-
Employability	Proficiency in data collection and cleaning processes makes individuals valuable assets in any data-centric role.
Entrepreneurship	Data Science techniques allow entrepreneurs to segment their customer base and personalize their offerings. By analyzing customer data, entrepreneurs can identify distinct customer segments with unique characteristics and preferences.
Skill Development	Data Science processes can guide the design and development of skill development curricula. By analyzing industry-specific data and expert knowledge, skill development programs can identify the key competencies and knowledge areas that need to be covered.
Professional Ethics	Data Science professionals can adhere to a professional code of conduct that emphasizes ethical behavior and integrity in their work. Organizations and professional bodies often have established codes of conduct that outline expectations and standards for ethical behavior in the field of Data Science.
Gender	-
Human Values	-
Environment & Sustainability	Data Science contributes to evidence-based environmental policy and planning. By analyzing environmental data and modeling future scenarios, data

	scientists can provide insights to policymakers and planners. These insights can inform the development of sustainable policies, land-use planning, conservation strategies, and disaster management plans.
Unit III	**Introduction to Machine Learning**
Local	-
Regional	-
National	-
Global	With the increasing integration of AI and automation in various sectors, machine learning skills provide a level of future-proofing to careers globally.
Employability	Machine learning skills offer significant advantages in employability, including increased job prospects, industry relevance, high remuneration, versatility, continuous learning, entrepreneurial opportunities, and future-proofing.
Entrepreneurship	Machine learning algorithms can analyse historical sales data and external factors to predict future demand, which helps entrepreneurs optimize inventory levels, minimize stock outs, and reduce excess inventory, leading to cost savings and improved customer satisfaction.
Skill Development	Machine learning is a rapidly growing field, and acquiring machine learning skills can significantly enhance employability.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	The data-driven approach of Machine Learning helps in identifying environmental threats, implementing early warning systems, and developing conservation strategies.
Unit IV	**Introduction to AI**
Local	-
Regional	-
National	Artificial intelligence (AI) can contribute to national development and progress in several ways, such as Economic Growth, Healthcare Advancements, Smart Governance, Public Safety and Security, Environmental Sustainability
Global	AI can help globally in numerous sectors such as healthcare, finance & Banking, Energies & Utilities, Education, Agriculture etc.
Employability	Studying AI fosters personal and professional growth by

	developing valuable skills such as critical thinking, logical reasoning, creativity, and adaptability.
Entrepreneurship	AI-driven start-ups and innovative applications are emerging in areas such as healthcare, finance, e-commerce, and smart technologies.
Skill Development	By understanding AI concepts and techniques, students can identify opportunities to leverage AI for innovative solutions and business ventures.
Professional Ethics	AI systems should be designed and implemented in a transparent manner, with clear explanations of their functioning and decision-making processes. Professionals working with AI should strive to make AI algorithms and models understandable and interpretable, especially in critical domains such as healthcare, finance, and justice.
Gender	-
Human Values	-
Environment & Sustainability	-
Unit V	**Introduction to Data Analytics**
Local	-
Regional	-
National	-
Global	-
Employability	Employers highly value professionals who can make informed decisions based on data. Data Analytics enables individuals to collect, analyze, and interpret data to uncover insights, identify trends, and support decision-making processes. By leveraging data, professionals can make strategic choices, optimize operations, and drive business growth, making them valuable assets in the job market.
Entrepreneurship	Data Analytics helps entrepreneurs identify market trends, customer preferences, and untapped opportunities. By analyzing market data, customer behavior, and competitor insights, entrepreneurs can make informed decisions about target markets, product positioning, and business strategies. Data Analytics allows entrepreneurs to identify gaps in the market, understand customer needs, and develop innovative solutions to meet those needs.
Skill Development	Data Analytics techniques enable the analysis of large-scale learning data to derive meaningful insights. By aggregating and analyzing data on learner behavior, engagement, and performance, skill development programs can identify patterns, trends, and areas for

	improvement. These insights can inform program design, content development, and instructional strategies, leading to continuous improvement in the skill development process.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4, SDG 9
NEP 2020	Aligns with skill development and tech-oriented education, Aligns with problem-solving and critical thinking in NEP, Aligns with practical skills and problem-solving in NEP, Aligns with tech skills and understanding in NEP, Supports skill-oriented education focus of NEP 2020.
POE/4th IR	Provides foundational knowledge for data-driven industries, Provides skills for modern data science processes, Equips for machine learning and AI applications, Provides understanding of AI's role in the 4th IR, Provides foundational skills for data analytics.

OVERVIEW OF AI, DATA SCIENCE, ETHICS AND FOUNDATION OF DATA ANALYSIS LAB

Department:	**Department of Electrical & Electronics Engineering**		
Course Name: Overview of AI, Data Science, Ethics and Foundation of Data Analysis Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP152	0-0-2	1
Type of Course:	Minor Course		

Proposed Lab Experiments

Course Outcomes

COs	**Statements**
CO 1	**Learn** the basics of primary data structures.
CO 2	**Perform** various operations over these data structures.
CO 3	**Learn** the basics of Data Science & Analytics.
CO 4	**Implement** the basics of Data Science & Analytics.

Ex. No	Experiment Title	Mapped CO/COs
1	Write a program that uses functions to perform the following operations on singly linked list: i. Creation ii. Insertion iii. Deletion iv. Traversal	CO1, CO2
2	Write a program that uses functions to perform the following operations on doubly linked list: i. Creation ii. Insertion iii. Deletion iv. Traversal	CO1, CO2
3	Write a program that uses functions to perform the following operations on circular linked list: i. Creation ii. Insertion	CO1, CO2

	iii. Deletion iv. Traversal	
4	Write a program that implement stack and its operations using: i. Arrays ii. Pointers	CO1, CO2
5	Write a program that implement queue and its operations using: i. Arrays ii. Pointers	CO1, CO2
6	Write a program that implements the following sorting methods to sort a given list of integers in ascending order: i. Bubble sort ii. Selection sort iii. Insertion sort	CO1, CO2
7	Write a program that use both recursive and non-recursive functions to perform the following searching operations for a Key value in a given list of integers: i. Linear search ii. Binary search	CO1, CO2
8	Write a program to implement the tree traversal methods.	CO1, CO2
9	Write a program to implement the graph traversal methods.	CO1, CO2
10	Program on Comparative Analysis of Matching Algorithms	CO3, CO4
11	Analyzing the Impact of COVID-19 using Data Science: A Comprehensive Case Study	CO3, CO4
12	Program for Enhancing Data Visualization with Conditional Formatting	CO3, CO4
13	Exploring Pivot Tables in Data Science	CO3, CO4
14	Data Visualization with Power Map	CO3, CO4
15	Write a program for Data Science with Power BI	CO3, CO4
16	Write a program for Building Predictive Models in data science	CO3, CO4
17	Analyzing Sales Wallet Transactions using Data Science: Extracting Insights and Driving Business Growth	CO3, CO4
18	Harnessing the Power of Power Query in Data Science: Extract, Transform, and Analyze Data	CO3, CO4

	with Efficiency and Precision	
19	"Exploring Correlation Methods in Data Science: Unveiling Relationships and Patterns in Complex Datasets	CO3, CO4

Semester III

DISCRETE MATHEMATICS

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Discrete Mathematics	**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: 10**	
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: 10**	
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: 10**	

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: 10**

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

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 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

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

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:	**Course Code**	**L-T-P**	**Credits**
Data Structure	**ENCS205**	4-0-0	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: 10**

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

Unit Number: 2	**Title: Stacks, Queues and Linked List**	**No. of hours: 10**

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

Unit Number: 3	**Title: Trees and Graphs**	**No. of hours: 10**

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: 10**

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)

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. 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.

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(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	C1	A3	P5
C02	C2	A3	P4
CO3	C3, C4	A4	P3
CO4	C5	A2	P2

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

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

Course Outcomes

COs	Statements
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	CO2

	performing Push and Pop operation	
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	CO4

	complexities.	
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.	

K.R. MANGALAM UNIVERSITY

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			
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.			
UNIT WISE DETAILS			
UNIT NUMBER: 1	**TITLE: INTRODUCTION TO JAVA**	**NO. OF HOURS: 10**	
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: 10**	
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: 10**	

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: 10**
CONTENT SUMMARY: 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, **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. HERBERT SCHILDT, —JAVA – THE COMPLETE REFERENCE‖, ORACLE PRESS. 2. CAY S. HORSTMANN, —CORE JAVA VOLUME – I FUNDAMENTALS‖, PEARSON.		

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(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
CO	C2	A1	P1
C02	C3	A2	P2
CO	C3	A5	P5
CO	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
PROFESSIONAL	Encourages ethical programming practices, such as writing

ETHICS	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 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

DEPARTMENT:	**DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING**		
COURSE NAME: JAVA PROGRAMMING LAB	**COURSE CODE**	**L-T-P**	**CREDITS**
	ENCS251	0-0-2	1
TYPE OF COURSE:	Major		
PRE-REQUISITE(S), IF ANY: C PROGRAMMING			

PROPOSED LAB EXPERIMENTS

COURSE OUTCOMES

COs	**Statement**
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	CO1

	taken as input from user at runtime.	
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	CO4

	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.	
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, 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.	CO4
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

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: 6**	
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: 6**	
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: 6**	
Content Summary: Divisibility, Unit digit, Last two digit, Remainder, Number of zero, Factor, LCM & HCF, Simplification, Mixture, Average, Ratio, and Partnership.			
Unit Number: 4	**Title: Number system**	**No. of hours: 6**	
Content Summary: Factor, LCM & HCF, Simplification, Mixture, Average, Ratio, and Partnership.			
Unit Number: 5	**Title: Time Management**	**No. of hours: 6**	
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 components on self-basis
2) At least 5-10 % syllabus will be asked in end term exams from self-learning components

Reference Books:

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

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(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	C3	-	-
C02	C2	-	-
CO3	C2	-	P4
CO4	C6	-	-
CO5	C6	-	P5

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

CO-PSO Mapping

CO	PSO1	PSO2	PSO3	PSO4
CO	3	-	1	-
CO 1	3	1	-	-
CO 2	1	1	-	-
CO 3	2	2	3	-
CO 4	3	1	-	-

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	Develops Skills in public speaking, interpersonal

Development	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

PROBABILISTIC MODELLING AND REASONING WITH PYTHON LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Probabilistic Modelling and Reasoning with Python Lab	**Course Code**	**L-T-P**	**Credits**
	SEC038	0-0-4	2
Type of Course:	SEC		
Pre-requisite(s), if any: Basic knowledge of the Statistics and Python			
Frequency of offering (check one): Odd			
Brief Syllabus: • Help student understand the importance and implementation of various random sampling techniques • Describe probability and various probability distributions such as normal distribution, beta, gamma, students -t, and bivariate distributions • Introduce the concepts of estimation techniques that covers both point and interval estimation • Teach the concepts of hypothesis testing, p value, and Bayesian statistics			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to Statistics**	**No. of hours: 8**	
Content Summary: **Introduction to Statistics**: Role of statistics in scientific methods, current applications of statistics **Scientific data gathering:** Sampling techniques, scientific studies, observational studies, data management. Displaying data on a single variable (graphical methods, measure of central tendency, measure of spread), displaying relationship between two or more variables, measure of association between two or more variables.			
Unit Number: 2	**Title: Probability Theory**	**No. of hours: 8**	
Content Summary: Sample space and events, probability, axioms of probability, independent events, conditional probability, Bayes' theorem. **Random Variables:** Discrete and continuous random variables. Probability distribution of discrete random variables, binomial distribution, poisson distribution. Probability distribution of continuous random variables, The uniform distribution, normal (gaussian) distribution, exponential distribution, gamma distribution, beta distribution, t-distribution, $\chi^{"}$ distribution. Expectations, variance andcovariance. Probability Inequalities. Bivariate distributions.			
Unit Number: 3	**Title: Point Estimations**	**No. of hours: 8**	

Content Summary:
Methods of finding estimators, method of moments, maximum likelihood estimators, bayes estimators. Methods of evaluating estimators, mean squared error, best unbiased estimator, sufficiency and unbiasedness
Interval Estimations: Confidence interval of means and proportions, Distribution free confidence interval of percentiles

Unit Number: 4	**Title: Test of Statistical Hypothesis and p-values**	**No. of hours: 8**

Content Summary:
Tests about one mean, tests of equality of two means, test about proportions, p-values, likelihood ratio test, Bayesian tests
Bayesian Statistics: Bayesian inference of discrete random variable, Bayesian inference of binomial proportion, comparing Bayesian and frequentist inferences of proportion, comparing Bayesian and frequentist inferences of mean
Univariate Statistics using Python: Mean, Mode. Median, Variance, Standard Deviation, Normal Distribution, t-distribution, interval estimation, Hypothesis Testing, Pearson correlation test, ANOVA F-test
about intelligence, techniques required to solve AI problems, level of details required to model human intelligence, successfully building an intelligent problem, history of AI

***Self-Learning Components**:

- Advanced topics on Statistics and probability from the reference books given
- Learn the concepts from https://learning.samatrix.io further
- Download different dataset from Github and practice the EDA, probability distributions
- Participate in Kaggle Competitions on Statistical data 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. Achim Klenke, (2014), Probability Theory A Comprehensive Course Second Edition, Springer, ISBN 978-1-4471-5360-3
2. Christian Heumann, Michael Schomaker Shalabh (2016), Introduction to Statistics and Data Analysis With Exercises, Solutions and Applications in R, Springer International Publishing, ISBN 978-3-319-46160-1
3. Douglas C. Montgomery, (2012), Applied Statistics and Probability for Engineers, 5th Edition, , Wiley India, ISBN: 978-8-126-53719-8

Course Outcomes (COs)

COs	**Statements**
CO 1	**Explain** the data gathering techniques
CO 2	**Inspect** the data using descriptive statistics

CO 3	**Illustrate** the probability and conditional probability concepts
CO 4	**Distinguish** between various probability distributions and analyze the data following different probability distributions
CO5	**Solve** the inferential statistics problems using point and interval estimation techniques. Infer the statistical problems using hypothesis testing and p value

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/COs
1.	Tip collected at restaurant 1. Find out Five-Number summary for "Total Bill" and "Tip" 2. Plot the Box plot diagram for "Total Bill" and "Tip" 3. Analyze the diagram to mark the skewness in the data 4. Find out the outliers for "Total Bill" and "Tip" 5. Find out the IQR 6. Plot the histogram for "Total Bill" and "Tip" 7. Identify skewness in each. Type of skewness and the possible reason for the skewness 8. Plot the cumulative Frequency Polygon for "Total Bill" and "Tip" 9. Prepare the Frequency Table and Bar Chart for "Size". Summarize and explain your findings 10. Prepare two variable frequency tables for "Size" vs "Tip" and "Size" vs "Total Bill". Summarize and explain your findings. 11. Explore if there is any dependency between the variable "Tip" and rest of the variables	
2.	Conduct exploratory data analysis on sales of summer clothes dataset	
3.	Conduct exploratory data analysis on white wine quality data	
4.	Indian Premier League 1. Take the win_by_wickets dataset and plot frequency distribution graph	

	2. Relative frequency distribution graph using the same data set win_by_wickets 3. Plot Cumulative relative frequency graph 4. Find out the probability of winning a match by 6 wickets or less? 5. Find out the probability using the cumulative relative frequency graph 6. Plot the normal distribution for win_by_wickets data. 7. Calculate z-score if the team wins by 35 runs. 8. Calculate mean and standard deviation for win_by_wickets data 9. Calculate percentile using z-score.	
5.	Plotting of continuous and discrete distributions	
6.	Create Q-Q plot using distribution	
7.	Cryptocurrency Financial Data 1. Load the data 2. Print the head 3. Market Cap Column: Remove comma sign and store the values as integer 4. Calculate for nnlf using beta, norm , expon, gamma, uniform distributions 5. Plot the bar plot for showing distributions and nnlf 6. Print the distribution with minimum nnlf	
8.	Analysis of an alloy speciman – normal probability plot, calculate confidence interval	
9.	Check simple random condition and Sample size condition on annual cost of lease data	
10.	Analysis on payroll data.	
11.	Write a program to Evaluate data on a single variable (C6: Evaluation)	
12.	Write a program to Determine Mean, Mode. Median, Variance, Standard Deviation	
13.	Write a program to build a plot Normal Distribution and calculate, z-value, skewness and kurtosis	

14.	Write a program that practice t-distribution and calculate t-score	
15.	Write a program that create exponential distribution	
16.	Write a program that prepare binomial distribution	
17.	Write a program to create poisson distribution	
18.	Write a program to measure maximum likelihood estimators	
19.	Write a program to Evaluate Confidence interval	
20.	Write a program for Design hypothesis test and calculate p-value	

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 IV

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	4-0-0	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 Number: 2	**Title: Fundamental Algorithmic Strategies**		**No. of hours: 10**
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:** https://onlinecourses.nptel.ac.in/noc19_cs47/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. 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.		

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

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

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	**Fundamental Algorithmic Strategies**
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	**Graph and Tree Algorithms**
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	**Tractable and Intractable Problems**
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 Lab	**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

Course Outcomes (Cos)

COs	Statements
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

Department:	**Department of Computer Science and Engineering**		
Course Name: Database Management System	**Course Code**	**L-T-P**	**Credits**
	ENCS204	4-0-0	4
Type of Course:	Major		
Pre-requisite(s), if any: Nil			
Brief Syllabus: Introduction to database, Database modelling languages, E-R modelling, Transaction Processing, Database security.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction**	**No. of hours: 12**	
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.			
Unit Number: 2	**Title: Relational Query Languages**	**No. of hours: 8**	
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, 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**	

Content Summary:
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.

Course Outcomes (CO)

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

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
CO 1	-	-	-	-	-	2	-	1	-	-	-	-
CO 2	-	1	1	-	-	-	1	-	1	1	1	-
CO 3	2	2	-	2	2	3	2	-	-	-	-	-
CO 4	-	-	-	2	2	-	-	2	1	2	2	-

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	-	-
CO2	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

Course Outcomes

COs	Statements
CO 1	**Acquire** fundamental knowledge of relational database concepts, SQL, and database design principles through hands-on experiments.
CO 2	**Develop** proficiency in writing and executing SQL queries for data manipulation, retrieval, filtering, sorting, and grouping.
CO 3	**Gain** practical experience in implementing advanced SQL concepts such as joins, subqueries, aggregate functions, and constraints for complex data operations.
CO 4	**Demonstrate** the ability to design and normalize database schemas to minimize data redundancy and ensure data integrity.
CO 5	Apply theoretical concepts learned in the course to real-world scenarios, such as database connectivity in application development, indexing for query optimization, and implementing triggers and stored procedures for automation and data management.

Ex. No.	Experiment Title	Mapped CO/COs
1	Introduction to SQL: Write SQL queries to create, modify, and delete tables and understand basic SQL commands.	CO1, CO2
2	Data Manipulation with SQL: Perform various data manipulation operations like insertion, deletion, and updating records.	CO2, CO3
3	Retrieving Data using SELECT: Practice using SELECT statements to retrieve data from single and multiple tables.	CO2, CO3
4	Filtering Data with WHERE: Use the WHERE clause to filter data based on specific conditions.	CO2, CO3

5	Sorting and Grouping Data: Sort and group query results using ORDER BY and GROUP BY clauses.	CO2, CO3
6	Working with Joins: Perform inner, left, right, and full joins on multiple tables.	CO2, CO3
7	Subqueries: Use subqueries to solve complex queries and understand their role in SQL.	CO2, CO3
8	Aggregate Functions: Apply aggregate functions like SUM, AVG, COUNT, MAX, and MIN on data.	CO2, CO3
9	Constraints in SQL: Implement various constraints like NOT NULL, UNIQUE, PRIMARY KEY, FOREIGN KEY, and CHECK.	CO2, CO3, CO4
10	Normalization: Normalize a given set of tables to reduce data redundancy and ensure data integrity.	CO4
11	Creating Views: Create and manage views to simplify complex queries and enhance security.	CO2, CO3
12	Indexing: Understand the concept of indexing and create indexes on tables to improve query performance.	CO2, CO3, CO4
13	Triggers: Design and implement triggers to automate certain actions on table events.	CO2, CO3, CO5
14	Stored Procedures: Create stored procedures to execute a set of SQL statements as a single unit.	CO2, CO3, CO5
15	Transactions and Concurrency Control: Implement transactions and handle concurrent access to the database.	CO2, CO3, CO5
16	Data Backup and Recovery: Perform data backup and restore operations to safeguard against data loss.	CO5
17	Database Connectivity: Develop a simple database application using programming languages like Java or Python.	CO5
18	Relational Algebra Operations: Perform relational algebra operations like Union, Intersection, and Difference.	CO2, CO3
19	Nested Relational Model: Practice querying and manipulation on nested relational data.	CO2, CO3
20	Entity-Relationship Diagrams (ERD): Design an ERD to represent the database schema for a given scenario.	CO4
21	Index Selection and Tuning: Analyze query performance and select appropriate indexes for optimization.	CO2, CO3, CO4

22	Schema Evolution: Modify the database schema to incorporate changes in requirements.	CO4
23	Triggers for Auditing: Implement triggers for auditing purposes to track changes in data.	CO5
24	Data Replication: Set up and test database replication for data redundancy and fault tolerance.	CO5
25	Distributed Databases: Understand distributed databases and perform data distribution and integration exercises.	CO5

1. **Introduction to SQL** Exercise: Write SQL queries to create a simple database schema for a library management system. Project: Design and implement a relational database for an online shopping platform.

2. **Data Manipulation with SQL** Exercise: Perform insertion, deletion, and update operations on sample data in a given database. Project: Create a student registration system and write SQL queries to manage student data.

3. **Retrieving Data using SELECT** Exercise: Write SELECT queries to retrieve specific fields from a table and explore data filtering. Project: Develop a database for a hotel and use SELECT queries to extract room availability and pricing details.

4. **Filtering Data with WHERE** Exercise: Practice using the WHERE clause to filter data based on specific conditions (e.g., age, date). Project: Create a database for a movie rental service and use WHERE to retrieve movies of a particular genre.

5. **Sorting and Grouping Data** Exercise: Use ORDER BY to sort query results and GROUP BY to group data based on a common attribute. Project: Develop a database for an inventory system and use sorting and grouping to analyze product sales.

6. **Working with Joins** Exercise: Perform different types of joins to combine data from multiple related tables. Project: Create a database for an e-commerce website and use joins to fetch customer orders with product details.

7. **Subqueries** Exercise: Use subqueries to find specific data from complex queries in a given database. Project: Develop a database for a school and use subqueries to determine students' grades in a subject.

8. **Aggregate Functions** Exercise: Apply aggregate functions (e.g., SUM, AVG, COUNT) to analyze data in a table. Project: Create a database for a financial institution and use aggregate functions to calculate account balances.

9. **Constraints in SQL** Exercise: Implement various constraints (e.g., PRIMARY KEY, FOREIGN KEY) on table attributes. Project: Design a database for a customer management system and apply constraints to ensure data integrity.

10. **Normalization** Exercise: Normalize a set of sample tables to third normal form (3NF) to minimize data redundancy. Project: Create a database for a music streaming platform and ensure proper normalization of the schema.

11. **Creating Views** Exercise: Create views to simplify complex queries and restrict access to certain data. Project: Develop a database for a medical clinic and use views to provide a simplified patient information dashboard.

12. **Indexing** Exercise: Add indexes to specific attributes of a table to enhance query performance. Project: Design a database for an online book store and optimize query response time with appropriate indexing.

13. **Triggers** Exercise: Design triggers to enforce data integrity rules and automate actions on data changes. Project: Create a database for a reservation system and implement triggers for automatic seat allocation.

14. **Stored Procedures** Exercise: Write and execute stored procedures to perform specific tasks in a database. Project: Develop a database for a university and use stored procedures to calculate student GPA.

15. **Transactions and Concurrency Control** Exercise: Implement transactions and handle concurrent access to maintain data consistency. Project: Design a database for a banking system and implement transaction management for fund transfers.

16. **Data Backup and Recovery** Exercise: Perform data backup and restoration operations to safeguard against data loss. Project: Create a database for an HR management system and implement regular data backups.

17. **Database Connectivity** Exercise: Develop a simple database application using JDBC or any appropriate ORM tool. Project: Build a database-backed web application for an online shopping platform using Django or Flask.

18. **Relational Algebra Operations** Exercise: Practice relational algebra operations like Union, Intersection, and Difference. Project: Create a database for a movie database and perform relational algebra to find common movies between actors.

19. **Nested Relational Model** Exercise: Query and manipulate nested relational data in a given database. Project: Design a database for a social networking platform and explore nested data structures for user profiles.

20. **Entity-Relationship Diagrams (ERD)** Exercise: Draw an ERD for a given database scenario with appropriate relationships. Project: Model a database for a real estate agency and create an ERD to represent property listings and client interactions.

21. **Index Selection and Tuning** Exercise: Analyze query performance and select appropriate indexes for optimization. Project: Optimize a database for an e-commerce platform and improve query speed using appropriate indexing techniques.

22. **Schema Evolution** Exercise: Modify the database schema to incorporate changes in requirements. Project: Extend a database for a customer relationship management system and handle schema evolution for new features.

23. **Triggers for Auditing** Exercise: Design triggers for auditing purposes to track changes in data. Project: Implement auditing features in a database for an employee attendance system using triggers.

24. **Data Replication** Exercise: Set up data replication for fault tolerance and redundancy in a distributed database. Project: Implement data replication for a hospital management system to ensure data availability across multiple servers.

25. **Distributed Databases** Exercise: Understand distributed databases and perform data distribution and integration exercises. Project: Design and implement a distributed database for a geographically dispersed organization with multiple locations.

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: 6**	
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: 6**	
Content Summary: Time & Work, Time & Distance, Train, Boat & Stream, Permutation & combination, Probability			
Unit Number: 3	**Title: Arithmetic**	**No. of hours: 6**	
Content Summary: Inequalities, Log, progression, Mensuration, BODMAS			
Unit Number: 4	**Title: Presentation Skills**	**No. of hours: 6**	
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: 6**	

Content Summary: Nurturing future leaders, increasing productivity of the workforce, Imparting Self-leadership, Executive leadership.
***SELF-LEARNING COMPONENTS:** **https://onlinecourses.nptel.ac.in/noc21_hs02/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. Aggarwal, R. S. (2014). Quantitative aptitude (Revised edition). 2. Gladwell, M. (2021). Talking to strangers. 3. Scott, S. (2004). Fierce conversations.

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©	Affective levels(A)	Psychomotor levels(P)
	1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving

CO1	C2	-	-
C02	C3	-	-
CO3	C5	-	-
CO4	-	-	P5
CO5	C5	-	P5

CO-PO Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO 1	3	3	-	-	-	-	-	-	-	-	3	3
CO 2	3	2	-	-	-	-	-	-	-	-		3
CO 3	-	2	3	-	-	2	-	-	-	-	-	2
CO 4	-	3	2	-	-	-	-	2	-	-	-	3
CO 5	-	-	3	2	-	-	-		-	-	-	3

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

CO-PSO Mapping

CO	PSO1	PSO2	PSO3	PSO4
CO 1	3	2	-	-
CO 2		2	-	-
CO 3	1	-	-	3
CO 4		2	-	-
CO 5	-	-	3	-

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

MACHINE LEARNING AND PATTERN RECOGNITION

<table>
<tr><td>Department:</td><td colspan="3">Department of Computer Science and Engineering</td></tr>
<tr><td rowspan="2">Course Name:
Machine Learning and Pattern Recognition</td><td>Course Code</td><td>L-T-P</td><td>Credits</td></tr>
<tr><td>ENSP202</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: Basic knowledge of the Statistics & Python.</td></tr>
<tr><td colspan="4">Frequency of offering (check one): Even</td></tr>
<tr><td colspan="4">Brief Syllabus:
Help student understand what machine learning is. How business can use machine learning in different domains to gain competitive advantage
Student is able to differentiate between different learning algorithms.
To understand different data science processes, tools and techniques
Gain a fundamental understanding of the concepts and techniques that underpin machine learning algorithms</td></tr>
<tr><td colspan="4">UNIT WISE DETAILS</td></tr>
<tr><td>Unit Number: 1</td><td>Title: Introduction</td><td colspan="2">No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:
Learning systems, real world applications of machine learning, why machine learning, variable types and terminology, function approximation
Types of machine learning: Supervised learning, unsupervised learning, Reinforcement learning</td></tr>
<tr><td>Unit Number: 2</td><td>Title: Important concepts of machine learning</td><td colspan="2">No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:
Parametric vs non-parametric models, the trade-off between prediction accuracy and model interpretability, the curse of dimensionality, measuring the quality of fit, bias-variance trade off, overfitting, model selection, no free lunch theorem.</td></tr>
<tr><td>Unit Number: 3</td><td>Title: Linear Regression</td><td colspan="2">No. of hours: 8</td></tr>
<tr><td colspan="4">Content Summary:
Linear regression, estimating the coefficients, accessing the accuracy of coefficient estimates, accessing the accuracy of the model, multiple linear regression, qualitative predictors</td></tr>
<tr><td>Unit Number: 4</td><td>Title: Classification</td><td colspan="2">No. of hours: 8</td></tr>
</table>

Content Summary:

Logistic regression, estimating regression coefficients, making predictions, multiple logistic regressions, linear discriminant analysis, bayes' theorem of classification, LDA for p=1, LDA for p>1, quadratic discriminant analysis

***Self-Learning Components**:

- Advanced topics on Machine Learning from the reference books given
- Learn the concepts from https://learning.samatrix.io further
- Download different dataset from Github and practice different models of Machine Learning
- Participate in Kaggle Competitions on Machine Learning

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. Machine Learning by Tom M. Mitchell - McGraw Hill Education; First edition
2. Pattern Recognition and Machine Learning (Information Science and Statistics) by Christopher M. Bishop - Springer; 1st ed. 2006. Corr. 2nd printing 2011 edition
3. The Elements of Statistical Learning: Data Mining, Inference, and Prediction by Trevor Hastie, Robert Tibshirani, Jerome Friedman - Springer; 2nd ed. 2009, Corr. 9th printing 2017 edition

Course Outcomes (CO)

COs	Statements
CO1	**Explain** the use of Machine Learning Models in business and understand machine learning models can be used to solve business problems.
CO2	**Compare** machine learning algorithms such as supervised, unsupervised, and reinforcement learning models
CO3	**Identify** the performance of different machine learning models and compare them to optimize the results
CO4	**Make use** continuous and discrete data set to fit regression and classification models

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	A2	-
C02	C2	A2	-
CO3	C3	A3	-
CO4	C3	A2	P2

CO-PO Mapping

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

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

CO-PSO Mapping

CO	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	2	2
CO 2	3	3	2	2
CO 3	3	3	2	2
CO 4	2	2	1	1

Relevance of the Syllabus to various indicators

Unit I	**Introduction**
Local	Applying advanced data visualization techniques.
Regional	Incorporating regional advanced data analysis practices
National	Adhering to national standards for advanced data analytics.
Global	Using universal advanced data visualization concepts.
Employability	Developing skills for advanced data analysis jobs.

Entrepreneurship	Providing skills for data-driven innovation and startups
Skill Development	Enhancing advanced data analysis and visualization skills.
Professional Ethics	Integrating ethics and accuracy in advanced data analysis.
Gender	Promoting gender diversity in advanced analytics.
Human Values	Addressing ethical and social considerations in analytics.
Environment & Sustainability	Applying analytics for sustainable outcomes.
Unit II	**Important concepts of machine learning**
Local	Applying advanced data visualization techniques.
Regional	Incorporating regional advanced data analysis practices.
National	Adhering to national standards for advanced data analytics.
Global	Using universal advanced data visualization concepts.
Employability	Developing skills for advanced data analysis jobs.
Entrepreneurship	Providing skills for data-driven innovation and startups.
Skill Development	Enhancing advanced data analysis and visualization skills.
Professional Ethics	Ethics: Integrating ethics and accuracy in advanced data analysis.
Gender	Promoting gender diversity in advanced analytics.
Human Values	Addressing ethical and social considerations in analytics.
Environment & Sustainability	Applying analytics for sustainable outcomes.
Unit III	**Linear Regression**
Local	Applying advanced data visualization techniques.
Regional	Incorporating regional advanced data analysis practices.
National	Adhering to national standards for advanced data analytics.
Global	Using universal advanced data visualization concepts.
Employability	Developing skills for advanced data analysis jobs.
Entrepreneurship	Providing skills for data-driven innovation and startups.
Skill Development	Enhancing advanced data analysis and visualization skills.
Professional Ethics	Integrating ethics and accuracy in advanced data analysis.
Gender	Promoting gender diversity in advanced analytics.
Human Values	Addressing ethical and social considerations in analytics.
Environment & Sustainability	Applying analytics for sustainable outcomes.
Unit IV	**Classification**

Local	Applying advanced data visualization techniques.
Regional	Incorporating regional advanced data analysis practices.
National	Adhering to national standards for advanced data analytics.
Global	Using universal advanced data visualization concepts.
Employability	Developing skills for advanced data analysis jobs.
Entrepreneurship	Providing skills for data-driven innovation and startups.
Skill Development	Enhancing advanced data analysis and visualization skills.
Professional Ethics	Integrating ethics and accuracy in advanced data analysis.
Gender	Promoting gender diversity in advanced analytics.
Human Values	Addressing ethical and social considerations in analytics.
Environment & Sustainability	Applying analytics for sustainable outcomes.
SDG	SDG 3, SDG 4, SDG 9, SDG 16
NEP 2020	Aligning with NEP's emphasis on skill-based education by providing practical understanding of machine learning concepts, Fostering critical thinking and analytical skills as envisioned in NEP, crucial for understanding complex machine learning concepts, Promoting experiential learning and skill development, integral to NEP's vision, Encouraging interdisciplinary learning, vital for understanding machine learning's impact across domains.
POE/4th IR	Addressing the requirements of the Fourth Industrial Revolution by imparting knowledge in machine learning, a crucial aspect of modern technological advancements, Catering to the demands of the Fourth Industrial Revolution by covering important concepts that underpin technological advancements, Catering to the needs of the Fourth Industrial Revolution by teaching foundational machine learning techniques, Addressing the requirements of the Fourth Industrial Revolution by teaching classification methods widely used in data-driven decision-making.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/COs
1	Prediction using simple linear regression	CO4
2	Prediction using multiple linear regression	CO4
3	Classification using Logistics regression	CO2
4	Classification using linear discriminant analysis	CO2
5	Classification using support vector machine	CO2
6	Classification using Guassian Naïve Bayes	CO2
7	Classification using decision Tree	CO2
8	Classification using Random Forest	CO2
9	Classification using K nearest neighbour	CO2
10	Write a program to Retrieve Data for a machine Learning project.	CO1
11	Write a program to Conduct Exploratory Data Analysis using Python.	CO3
12	Write a program to Clean the Data using Python.	CO3
13	Write a program for Data Modeling using Python.	CO4
14	Write a program to analyze and solve Null Value problem.	CO3
15	Write a program to analyze and solve zero values.	CO3
16	Write a program to analyze the categorical values.	CO3
17	Write a program for graphical representation of data.	CO4
18	Write a program for logistic regression using statsmodel.	CO4
18	Write a program to implement multiple logistic regression.	CO2, CO4
20	Write a program to scale the data and implement linear regression using sklearn.	CO2, CO4
21	Write a program to implement multiple linear regression.	CO4

Machine Learning Practical with Python, Scikit-learn, Matplotlib, TensorFlow

Department:	**Department of Computer Science and Engineering**		
Course Name: Machine Learning Practical with Python, Scikit-learn, Matplotlib, TensorFlow	**Course Code**	**L-T-P**	**Credits**
	ENSP252	3-0-2	4
Type of Course:	Minor		
Pre-requisite(s), if any: Basic knowledge of the Statistics & Python			
Frequency of offering (check one): Even			
Brief Syllabus: • Gain a fundamental understanding of the concepts and techniques that underpin machine learning algorithms • Learn how to choose the appropriate regression and classification algorithms, how to prepare data for machine learning models, and how to evaluate model performance			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Resampling Methods, Model Selection and Regularization:**	**No. of hours: 8**	
Content Summary: Cross- validation, leave-one-out cross- validation, k-fold cross-validation, the bootstrap, subset selection, shrinkage methods, ridge and lasso regression, dimension reduction methods, principal components regression, partial least square			
Unit Number: 2	**Title: Tree Based Methods:**	**No. of hours: 8**	
Content Summary: Advantages and disadvantages of trees, regression Trees, classification trees, bagging, random forest, boosting.			
Unit Number: 3	**Title: Support Vector Machine**:	**No. of hours: 8**	
Content Summary: Maximum margin classifier, classification using a separating hyperplane, the maximal margin classifier, support vector classifier, support vector machines, classification with non-linear decision boundaries, support vector machine, one-versus-one classification, one-versus- many classification			
Unit Number:	**Title: Unsupervised**	**No. of hours: 8**	

4	**Learning:**	

Content Summary:
Principle component analysis, what are principal components, clustering methods, k-means clustering, hierarchical clustering, Independent component analysis, latent semantic indexing, Markov Models, Hidden Markov Models

***Self-Learning Components:**

https://www.coursera.org/collections/scikit-learn-machine-learning-projects

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. Machine Learning by Tom M. Mitchell - McGraw Hill Education; First edition
2. Pattern Recognition and Machine Learning (Information Science and Statistics) by Christopher M. Bishop - Springer; 1st ed. 2006. Corr. 2nd printing 2011 edition
3. The Elements of Statistical Learning: Data Mining, Inference, and Prediction by Trevor Hastie, Robert Tibshirani, Jerome Friedman - Springer; 2nd ed. 2009, Corr. 9th printing 2017 edition.

Proposed Lab Experiments

Course Outcomes (COs)

COs	Statements
CO 1	**Explain** the use of Machine Learning Models in business and understand machine learning models can be used to solve business problems.
CO 2	**Compare** machine learning algorithms such as supervised, unsupervised, and reinforcement learning models
CO 3	**Identify** the performance of different machine learning models and compare them to optimize the results
CO 4	**Make use** continuous and discrete data set to fit regression and classification models

Ex. No	Experiment Title	Mapped CO/COs
1	Lasso and Ridge regression implementation	CO4

2	Principal component analysis implementation	CO4
3	Making predictions using multiple Logistics regression	CO2, CO3
4	Implementation of correlation matrix, correlation matrix , ROC curve	CO3
5	Faudulent transaction using classification algorithm	CO2
6	Predict whether a patient have diabetes	CO2
7	Improve sales of product of a company	CO1, CO2
8	Finance - Predict whether a credit card user will default on monthly credit card payment based on annual income and monthly credit card balance	CO1, CO2
9	HR - Predict the Baseball major league player salary based on career and previous season statistics	CO1, CO2
10	Write a program to implement bootstrap	CO4
11	Write a program to implement k-fold validation	CO3
12	Write a program to implement subset selection	CO3
13	Write a program for Ridge Regression	CO4
14	Write a program for lasso regression	CO4
15	Write a program to analyze and solve zero values	CO3
16	Write a program to analyze the categorical values	CO3
17	Write a program for graphical representation of data.	CO4
18	Write a program for principal component analysis.	CO4
19	Write a program to implement clustering.	CO2
20	Write a program to implement decision tree.	CO2
21	Write a program to implement markov model.	CO2

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)	

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**
	SEC039	0-0-4	2
Type of Course:	SEC		
Pre-requisite(s), if any: Basic knowledge of the programming and statistics			
Frequency of offering (check one): Even			

Brief Syllabus:

- The basic concepts and syntax of R programming, including data types, data structures, control structures, functions, and packages
- How to manipulate and transform data using R programming, including importing and exporting data, sub setting data, merging data sets, and cleaning data
- Create visualizations using R programming, including basic and advanced plots, graphs, and charts
- Learn basic programming concepts such as conditional statements, and loops

UNIT WISE DETAILS

Unit Number: 1	**Title: Getting Started with R and R Workspace**	**No. of hours: 8**

Content Summary:

Introducing R, R as programming Language, the need of R, Installing R, RStudio,RStudio's user interface, console, editor, environment pane, history pane, filepane, plots pane, package pane, help and viewer pane R Workspace, R's working directory, R Project in R Studio, absolute andrelative path, inspecting an Environment, Inspect existing Symbols, View the structure of object, removing symbols, Modifying Global Options, Modifying arming level, Library of Packages, getting to know a package, Installing a Package from CRAN, Updating Package from CRAN, Installing packagefrom online repository, Package Function, Masking and name conflicts

Unit Number: 2	**Title: Basic Objects and Basic Expressions**	**No. of hours: 8**

Content Summary:

Vectors, Numeric Vectors, Logical Vectors, Character Vectors, subset vectors, Named Vectors, extracting element, converting vector, Arithmetic operators, create Matrix, Naming row and columns, subsetting matrix, matrix operators, creating and subsetting an Array, Creating a List, extracting element from list, subsetting a list, setting value, creating a value of data frame, subsetting a data frame, setting values,

factors, useful functions of a data frame, loading and writing data on disk, creating a function, calling a function, dynamic typing, generalizing a function. Assignment Operators, Conditional Expression, using if as expression and statement, using if with vectors, vectorized if: ifelse, using switch, using for loop, nested for loop, while loop.		
Unit Number: 3	**Working with Basic Objects and Strings**	**No. of hours: 8**
Content Summary: Working with object function, getting data dimensions, reshaping data structures, iterating over one dimension, logical operators, logical functions, dealing with missing values, logical coercion, math function, number rounding functions, trigonometric functions, hyperbolic functions, extreme functions, finding roots, derivatives and integration, Statistical function, sampling from a vector, Working with random distributions, computing summary statistics, covariance and correlation matrix, printing string, concatenating string, transforming text, Formatting text, formatting date and time, formatting date and time to string, finding string pattern, using group to extract data, reading data		
Unit Number: 4	**Title: Working with Data – Visualize and Analyze Data**	**No. of hours: 8**
Content Summary: Reading and Writing Data, importing data using built-in-function, READR package, export a data frame to file, reading and writing Excel worksheets, reading and writing native data files, loading built-in data sets, create scatter plot, bar chart, pie chart, histogram and density plots, box plot, fitting linear model and regression tree		
***Self-Learning Components:** • Advanced topics on R Programming from the reference books given • Learn the concepts from https://learning.samatrix.io further • Download different dataset from Github and practice the R programming concepts • Participate in Kaggle Competitions on Statistical data analysis using R **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. Hands-On Programming with R by Garrett Grolemund 2. R for Data Science by Hadley Wickham & Garrett Grolemund		

Proposed Lab Experiments

Course Outcomes (COs)

COs	Statements

CO 1	Experiment with basic R code, including creating variables, data types, and functions.
CO 2	Examine and manipulate data using R, including importing and exporting data, subsetting data, merging data sets, and cleaning data
CO 3	Build visualizations using R, including basic and advanced plots, graphs, and charts
CO 4	Examine data with the help of statistical analysis using R, including descriptive statistics, regression analysis

Ex. No	Experiment Title	Mapped CO/COs
1.	Installation of R and Rstudio	CO1
2.	Create Matrix in R and perform following operations	CO1, CO2
3.	Create a matrix A and fill with values from 1 to 12.	CO1, CO2
4.	Create a matrix B and fill with values from 1 to 12.	CO1, CO2
5.	Find the transpose of matrix A and matrix B.	CO1, CO2
6.	Find the multiplication of matrix A and matrix B.	CO1, CO2
7.	Find the addition of matrix A and matrix B.	CO1, CO2
8.	Find the substation of matrix A and matrix B.	CO1, CO2
9.	Subsetting a Matrix.	CO1, CO2
10.	Create a matrix A and fill with values from 4 to 16	CO1, CO2
11.	Get first 2 rows	CO1, CO2
12.	Subset top 2 row and left 2 columns	CO1, CO2
13.	Subset 3 row and 2 column	CO1, CO2
14.	Write a R Program to create a list a_list that contains numbers, strings, logical value, and vectors	CO1, CO2
15.	Add names to the list a_list	CO1, CO2
16.	Add an element at the end of the list a_list	CO1, CO2
17.	Create a function calc This function will accept three arguments that include two numeric vectors x and y and one character vector type. The character vector type will define the kind s operation, the user wants to perform.	CO1, CO2
18.	Write a R program to find the numbers between 1000 and 1100 that satisfy (i ^ 2) %% 11 equals (i ^ 3) %% 17, where ^ is a power operator and %% (modulo	CO1, CO2

	operator) returns the remainder of a division.	
19.	Develop a function that can behave differently according to the type of input object.	CO1, CO2
20.	Create scatter plot using more than one dataset use various point styles and colors.	CO1, CO3
21.	Create multi-period line plot, with mix different line types and create Multi Series Chart with Legend.	CO1, CO3
22.	Create bar chart, pie chart and histogram with random data	CO1, CO3

Semester: V

THEORY OF COMPUTATION

Department:	**Department of Computer Science and Engineering**		
Course Name: Theory of Computation	**Course Code**	**L-T-P**	**Credits**
	ENCS301	3-1-0	4
Type of Course:	Major		
Pre-requisite(s), if any: NA			
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.			
Unit Number: 1	**Title: Introduction to Finite automata**	**No. of hours: 10**	
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			
Unit Number: 2	**Title: PDA and Parser**	**No. of hours: 10**	
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.			
Unit Number: 3	**Title: Chomsky hierarchy and Turing Machine**	**No. of hours: 10**	
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.			
***Self-Learning Components:** https://onlinecourses.nptel.ac.in/noc21_cs83/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.
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. 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

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	-	-	-	-	-	-	-	-	-	3
CO 2	2	2		-	-	-	-	-	-	-	-	3
CO 3	2	3	3	3	-	-	3	-	-	-	-	2
CO 4	3	3	3	3	-	-	3	3	3	-	-	2
CO 5	1	-	-	2	3	-	1	-	-	-	-	3
CO6	-	-	-	-	-	3	-	-	-	-	-	3

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
CO6	2	1	-	-

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, SDG 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

Department:	**Department of Computer Science and Engineering**		
Course Name: OPERATING SYSTEMS	**Course Code**	**L-T-P**	**Credits**
	ENCS303	4-0-0	4
Type of Course:	Major		

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

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: 10**

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: 10**

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:**

- Case study on UNIX and WINDOWS Operating System.
- Practice of System calls
- 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/
- 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.

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. 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

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©	Affective levels(A0	Psychomotor levels(P)
	1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	-	-	-	-	-	-	1	-	-	1
CO 2	3	2	-	-	-	1	-	-	-	-	-	1
CO 3	3	3	2	-	-	-	-	-	-	-	-	1
CO 4	-	3	-	3	-	-	-	-	-	2	-	-
CO 5	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 SYSTEMS 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

Course Outcomes

COs	Statements
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 CPU Scheduling algorithm: Shortest Job First (SJF)	CO1
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:	CO1

	Priority	
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

LIFE SKILLS FOR PROFESSIONALS-III

Department:	**Department of Computer Science and Engineering**		
Course Name: Life Skills for Professionals -III	**Course Code**	**L-T-P**	**Credits**
	AEC013	3-0-0	3
Type of Course:	AEC		
Pre-requisite(s), if any:			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Data interpretation**	**No. of hours: 6**	
Content Summary: Table chart, Line graph, Bar graph, Pie chart			
Unit Number: 2	**Title: Logical Reasoning**	**No. of hours: 6**	
Content Summary: Coding & Decoding, Sitting arrangement, Calendar, Clock, Direction Sense, Blood relation, Syllogism.			
Unit Number: 3	**Title: Logical & Non-verbal reasoning**	**No. of hours: 6**	
Content Summary: Series, Puzzle Text, Statement & Arguments, Cube & Dice, Non-verbal Reasoning			
Unit Number: 4	**Title: Understanding Stress**	**No. of hours: 6**	
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: 6**
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:** https://onlinecourses.nptel.ac.in/noc21_hs02/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. Aggarwal, R. S. (2014). Quantitative aptitude (Revised edition). 2. Gladwell, M. (2021). Talking to strangers. 3. 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 Mapping

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**
CO 1	3	3	-	-	-	-	-	-	-	-	-	3
CO 2	3	2		1	1	-	-	-	-	-	-	3
CO 3	2	3	-	-	-	-	1	-	-	-	-	3
CO 4	2	2	1	1	-	-	-	-	-	3	-	3
CO 5	-	-	1	3	3	-	-	-	-	-	-	3

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

CO-PO Mapping

CO	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO 1	3	1	-	-
CO 2	3	-	-	-
CO 3	2	2	-	-
CO 4	3	-	-	2
CO 5	3	2	3	-

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

NATURAL LANGUAGE PROCESSING

Department:	**Department of Computer Science and Engineering**		
Course Name: Natural language processing	**Course Code**	**L-T-P**	**Credits**
	ENSP302	4-0-0	4
Type of Course:	Minor		
Pre-requisite(s), if any: Strong programming skills, particularly in Python.			
Frequency of offering (check one): Odd			
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.			
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: 8**	
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: 8**	
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: 4	Title: NLP for social media	No. of hours: 8

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:**

- Advanced topics on Natural Language Processing from the reference books given
- Learn the concepts from https://learning.samatrix.io further
- Download different dataset from Github and practice the Natural Language Processing
- Participate in Kaggle Competitions on NLP

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. Natural Language Processing with Python by Steven Bird, Ewan Klein and Edward Loper
2. Foundations of Statistical Natural Language Processing by Christopher Manning and Hinrich Schütze

Course Outcomes (COs)

COs	Statements
CO 1	NLP helps resolve ambiguity in language and adds useful numeric structure to the data for many downstream applications, such as speech 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

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	A2	P2
C02	C2	A2	P2
CO3	C3	A3	P2

CO-PO Mapping

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

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

CO-PSO Mapping

CO	PSO1	PSO2	PSO3	PSO4
CO	3	3	-	-
CO 1	-	3	-	-
CO 2	-	-	-	-
CO 3	-	-	-	-

Relevance of the Syllabus to various indicators

Unit I	**Introduction to NLP**
Local	Understanding local language nuances and context in NLP applications
Regional	Analyzing regional language data for NLP tasks.
National	Building NLP models for national language understanding.
Global	Implementing NLP on global scale projects.
Employability	Acquiring NLP skills for job opportunities.

Entrepreneurship	Exploring NLP-based startup ideas.
Skill Development	Developing advanced NLP techniques.
Professional Ethics	Ensuring ethical handling of language data.
Gender	Addressing gender-neutral language processing.
Human Values	Incorporating cultural sensitivities in language analysis.
Environment & Sustainability	Applying NLP for sustainable communication methods.
Unit II	**Text Representation**
Local	Localizing text classification models for community-specific needs.
Regional	Adapting text classification for regional languages.
National	Developing national-level text classification systems.
Global	Implementing text classification across global languages.
Employability	Enhancing employability with text classification skills.
Entrepreneurship	Creating innovative text classification solutions.
Skill Development	Developing advanced text classification methods.
Professional Ethics	Ensuring unbiased text classification outcomes.
Gender	Addressing gender bias in text classification.
Human Values	Promoting ethical text classification practices.
Environment & Sustainability	Using text classification for eco-friendly communication.
Unit III	**Information Extraction**
Local	Developing localized chatbots for regional language conversations.
Regional	Designing chatbots with regional cultural awareness.
National	Building chatbots for national language understanding.
Global	Implementing chatbots for global customer engagement.
Employability	Enhancing employability with chatbot development skills.
Entrepreneurship	Creating chatbot-based business solutions.
Skill Development	Acquiring advanced chatbot building techniques.
Professional Ethics	Ensuring ethical and unbiased interactions through chatbots.
Gender	Addressing gender-neutral language in chatbot interactions.
Human Values	Promoting respectful and empathetic chatbot conversations.
Environment &	Using chatbots for eco-conscious customer interactions.

Sustainability	
Unit IV	**NLP for social media**
Local	Analyzing local sentiments and trends on social media platforms.
Regional	Identifying regional social media patterns and behaviors.
National	Studying national social media sentiment trends.
Global	Analyzing global social media sentiments and impacts.
Employability	Enhancing employability with social media NLP skills.
Entrepreneurship	Creating social media NLP-based products.
Skill Development	Developing advanced social media NLP techniques.
Professional Ethics	Addressing ethical concerns in social media sentiment analysis.
Gender	Identifying gender-related social media biases.
Human Values	Ensuring respectful and inclusive social media sentiment analysis.
Environment & Sustainability	Using NLP for eco-conscious social media campaigns.
SDG	SDG 4, SDG 9, SDG 10, SDG12, SDG 17
NEP 2020	Aligning with the focus on interdisciplinary education, technology integration, and skill development in the field of NLP.
POE/4th IR	Addressing the technological advancements of the 4th Industrial Revolution by introducing NLP concepts and applications.

NATURAL LANGUAGE PROCESSING LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Natural Language processing Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP352	0-0-2	1
Type of Course:	Minor		
Pre-requisite(s), if any: Basics of programming			

Proposed Lab Experiments

Course Outcomes (Cos)

COs	Statements
CO 1	**Develop** proficiency in implementing various NLP techniques and algorithms for text preprocessing, feature extraction, and linguistic analysis.
CO 2	**Apply** machine learning and deep learning models to solve real-world NLP tasks such as text classification, sentiment analysis, and named entity recognition.
CO 3	**Design and build** end-to-end NLP applications, including chatbots or language translation systems, by integrating different NLP components and models.
CO 4	**Evaluate and assess** the performance of NLP models using appropriate metrics and techniques, and optimize models for enhanced accuracy and efficiency.

Ex. No	Experiment Title	Mapped CO/COs
1.	Write a program to scrap website.	CO1
2.	Write a program to inspect website using developer tool.	CO1
3.	Write a program to request permission to scrap website.	CO1
4.	Write a program to inspect H1 element	CO1
5.	Write a program to inspect table element	CO1
6.	Write a program to create column list	CO1
7.	Write a program to clean column list	CO1
8.	Write a program to word tokenization	CO1

9.	Write a program to implement RegEx for word tokenization	CO1
10.	Write a program to implement stopwords	CO1
11.	Write a program to implement LSTM	CO2, CO3, CO4

BIG DATA ANALYSIS WITH SCALA AND SPARK

Department	**Department of Computer Science and Engineering**		
Course Name: Big Data Analysis with Scala and Spark	**Course Code**	**L-T-P**	**Credits**
	ENSP309	4-0-0	4
Type of Course:	Minor		
Pre-requisite(s), if any: NA			
Frequency of offering (check one): Odd			

Brief Syllabus:
To provide an overview of an exciting field of big data analytics. Develop an understanding of the complete open-source Hadoop ecosystem and its near-term future direction. To introduce the tools required to manage and analyze big data like Hadoop, NoSQL MapReduce. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.To enable students to have skills that will help them to solve complex real-world problems decision support.

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to Big Data**	**No. of hours: 4**

Content Summary:
Develop an understanding of the complete open-source Hadoop ecosystem and its near term future directions, compare and evaluate the major Hadoop distributions and their ecosystem components both their strengths and their limitations, hands-on experience with key components of various big data ecosystem components and roles in building a complete big data, Future of Big Data. Knowledge of data, How to use Big insight

Unit Number: 2	**Title: Hadoop and HDFS**	**No. of hours: 8**

Content Summary:
Why Hadoop? What is Hadoop? Hadoop vs RDBMS, Hadoop vs Big Data, Types of data, Brief history of Hadoop, Problems with traditional large-scale systems, Requirements for a new approach, Anatomy of a Hadoop cluster . Concepts & Architecture, Data Flow (File Read , File Write), Fault Tolerance, Shell Commands, Java Base API, Data Flow Archives, Coherency, Data Integrity, Role of Secondary NameNode, Zookeeper

Unit Number: 3	Title: Hive and Pig	No. of hours: 8

Content Summary:
List the characteristics of representative data file formats including flat/text files CSV XML JSON and YAML, Architecture, Installation, Configuration, Hive vs RDBMS, Tables, DDL & DML, Partitioning & Bucketing, Hive Web Interface, Why Pig, Use case of Pig, Pig Components, Data Model, Pig Latin. Implementation of Real-world case study Using Real Data. List the characteristics of representative data file formats including flat/text files CSV XML JSON and YAML.

Unit Number: 4	Title: Map Reduce	No. of hours: 8

Content Summary:
Describe the MapReduce model v1 • List the limitations of Hadoop 1 and MapReduce 1 • Review the Java code required to handle the Mapper class the • Reducer class and the program driver needed to access MapReduce • Describe the YARN model • Compare Hadoop 2/YARN with Hadoop 1 ,• Understand the nature and purpose of Apache Spark in the Hadoop ecosystem • List and describe the architecture and components of the Spark unified stack • Describe the role of a Resilient Distributed Dataset (RDD) • Understand the principles of Spark programming • List and describe the Spark libraries • Launch and use Spark's Scala and Python shells

Unit Number: 5	Title : Scala and Spark	No. of hours: 4

Content Summary:
Explain the use and advantages of Scala Programming • Explain types of variables in Scala, Functions, Flow Control Statements. • Implement programs to experience hands on. Understand the need and use of Spark. • Explain the Spark Unified Stack. • Explain the Spark Runtime Architecture.

***Self-Learning Components:**
"Big Data Analysis with Scala and Spark" course on coursera

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. Gelman, Andrew, and Jennifer Hill. Data Analysis Using Regression and
2. Multilevel/Hierarchical Models. 1st ed. Cambridge, UK: Cambridge University Press,2006. ISBN:9780521867061.
3. Gelman, Andrew, John B. Carlin, Hal S. Stern, and Donald B. Rubin. Bayesian Data Analysis. 2nd ed. New York, NY: Chapman & Hall, 2003. ISBN:9781584883883
4. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data" by EMC Education Services

Course Outcomes (COs)

COs	Statements

CO1	Understand the vision of Big Data from global context.
CO2	To understand and apply Hadoop in Market perspective of Big Data.
CO3	Applying and analysing architecture and APIs with use of Devices, Gateways and Data Management in Big data.
CO4	To evaluate the application of Big Data in Industrial and Commercial Building Automation, evaluating Big Data performance using MapReduce and Real-World Design Constraints.
CO5	Building and create state of the art architecture in Big Data. Creating projects and research activities based on Pig, Hive, Pig Latin.

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 Big Data**
Local	-
Regional	-
National	Research and Development: Big Data 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:-Big Data community is vibrant and globally connected. By embracing BigData, 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 II	**Hadoop and HDFS**
Local	-
Regional	-
National	Hadoop 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:-Hadoop community is vibrant and globally connected. By embracing HDFS, 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	**Hive and Pig**
Local	
Regional	-
National	Research and Development: Hive 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: Pig 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	Hive and Pig are in high demand in the job market, particularly in fields such as data science, analytics, and research. By promoting the use of hive and pig, 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	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	Helps students to work on social issues
Unit IV	**Map Reduce**
Local	-
Regional	-
National	Infrastructure Planning and Optimization: Map Reduce 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
Global	-
Employability	-
Entrepreneurship	Map Reduce 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.
Skill Development	-
Professional Ethics	Spark and Scala 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.
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	-Public Health and Epidemiology: Scala 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.
NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO

K.R. MANGALAM UNIVERSITY

BIG DATA ANALYSIS LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Big Data Analysis Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP359	0-0-2	1
Type of Course:	Minor		
Pre-requisite(s), if any: Basics of programming			

Proposed Lab Experiments

Course Outcomes

COs	**Statements**
CO1	Develop an understanding of the complete open-source scala and spark and its near term future direction
CO2	To introduce the spark library required to manage and analyze data
CO3	To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
CO4	To enable students to have skills that will help them to solve complex real-world problems in decision support.

Ex. No	**Experiment Title**	**Mapped CO/COs**
1	Implement the following file management tasks in Hadoop: • Adding files & directories • Retrieving files • Deleting files	CO1
2	Install & Run Hive then use Hive to create, alter, & drop databases, tables, joins.	CO1
3	Implement Hive Partitioning & Bucketing with data set.	CO2
4	Install & Run Pig then write Pig Latin scripts to sort, group, join & filter your data	CO3
5	Run a basic Word Count MapReduce program to understand MapReduce Paradigm with data set.	CO2
6	Working with Jupyter Notebooks. Working with notebooks. Creating Notebooks. Using Notebooks with watson studio	CO2
7	Implement Hbase commands with data set.	CO3
8	Data transactions with SQOOP	CO2

9	Create an external table using any data set and load the data in the hive.	CO1
10	Implement an internal table in the hive with the loading of data.	CO2
11	Manipulating Data in Hive a) Data Structures in Hive b) Creating Tables in Hive c) Handling CSV files in Hive d) Bucketing Tables	CO2
12	Implement Pig Latin for the following queries: • How do you load data into Pig from a file in HDFS? • What are the different data types supported in Pig Latin? • How do you filter and transform data using Pig Latin operations like FILTER, FOREACH, and GENERATE?	CO2
13	Create sample bucket with column names such as first_name, job_id, department, salary and country and creat 4 buckets over here. and load the data into 4 buckets	CO2
14	Implement Static partition in hive and Filtering Results with Hive.	CO3
15	Implement below commands in hive using any dataset in hive. 1.Create an internal table using tab-separated data 2. Insert 3. Group by 4. Order by 5. Drop	CO3
16	Perform following task for Dynamic Partitions: You need to create a database in which you want to perform the operation of the creation of a table and enable the dynamic partition, Create any table with a suitable table name to store the data ,load the data	CO3
17	Implement the following commands using Pig Apply Flatten and Tokenize command using Pig Latin	CO3
18	Implement importing commands using Sqoop and MySQL (Using any data sets) a) Creating database and table in MySQL b) Inserting data into MySQL Table c) Importing data from MySQL to HDFS	CO2
19	Implement Exporting commands using Sqoop and MySQL(Using any data sets) Creating database and empty table in MySQL	CO1
20	What are the options for grouping and aggregating data in Pig Latin? Perform the steps.	CO1
21	Exporting data from HDFS and put into MySQL .Write the commands.	CO1

22	Create a partitioned table ,load the data from the first table to the partitioned table and Viewing of the table	CO2
23	Implementing the basic commands of LINUX Operating System: • File/Directory Creation • Deletion	CO2
24	• Cat Command-Creating of empty file, adding data into file, append and viewing of data • Touch command-creating of file, adding data into file, and viewing of data	CO3
25	• VI Editor command and its mode- creating of file, adding data into file and viewing of data	CO3

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

- Medical insurance fraud detection.
- Data warehouse design for an E-Commerce site.
- Tourist behaviour analysis.
- Crime Detection.
- Disease prediction based on symptom

DATA SCIENCE - TOOLS AND TECHNIQUES LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Data Science - Tools And Techniques Lab	**Course Code**	**L-T-P**	**Credits**
	SEC040	3-0-2	4
Type of Course:	SEC		
Pre-requisite(s), if any: General understanding of Scala 2. Experience with Java (preferred), Python, or another object oriented language 3. General understanding of machine learning			
Frequency of offering (check one): odd			
Brief Syllabus: Learn the foundations of the language for developers and data scientists interested in using Scala for data analysis. Tackle data analysis problems involving Big Data, Scala and Spark. Get a solid understanding of the fundamentals of the language, the tooling, and the development process. Develop a good appreciation of more advanced features.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Scala Language**	**No. of hours: 8**	
Content Summary: **Scala Language:** Getting to know Scala programming language, Scala and Java, Statically typed language, Apache Spark and Scala, Scala Performance Benefits, Installing Scala, Using Scala REPL/Shell, getting help from Scala shell, Hello World, Paste mode, retrieving history, auto-complete feature, exiting from Scala REPL			
Unit Number: 2	**Title: Variables, Data Types, Conditional Statements**	**No. of hours: 8**	
Content Summary: **Variables, Data Types, Conditional Statements:** Immutability of variables, define mutable and immutable variables, mutability and type safety, Specifying types for variables, Scala Identifier rules, naming conventions, Scala data types, Boolean types, string type, multiline strings, string operations, string concatenation, string interpolation, length of string, splitting string, extracting part of string, index of character of strings, the ANY type, type casting, Boolean expressions, conditional statement in Scala, nested IF/ELSE statement, pattern matching			
Unit Number: 3	**Title: Code Blocks, Functions, Collections**	**No. of hours: 8**	

Content Summary: **Code Blocks, Functions, Collections:** Code Blocks in Scala, Why use functions in Scala, understanding functions in Scala, define and invoke a function, functions with multiple parameters, positional parameters, functions with no argument, single-line function, passing function as argument, anonymous function, Collections in Scala, Understanding List, list size, convert list to string, iterating over list, map function and collection, foreach, reduce operation, list equality, create set, indexing map, manipulating maps, understanding tuples, indexing tuples, mutable collections, nested collections		
Unit Number: 4	**Title: Loops, Packages, Classes and Exceptional Handling**	**No. of hours: 8**
Content Summary: **Loops, Packages, Classes and Exceptional Handling:** For loop, While loop, Breaking Loop iteration, classes and objects in Scala, Create classes and objects, singleton objects, case classes, equality checks, classes and packages, avoid name space collusion, importing package, fundamental of exception handling, type inferences and exception handling, try, catch, finally, Scala built tool (SBT), Compile Scala applications		
***Self-Learning Components:** • Advanced topics on Scala from the reference books given • Learn the concepts from https://learning.samatrix.io further • Download different dataset from Github and practice the Scala • Participate in Kaggle Competitions on Scala **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. Programming in Scala: A comprehensive Step-by-Step Scala Programming Guide by Martin Odersky, Lex Spoon, Bill Venners 2. Scala for the Impatient by Cay Hortsmann 3. Scala in Depth by Joshua D Suereth		

Proposed Lab Experiments

Course Outcomes

COs	Statements
CO1	Learn to leverage the integration of Apache Spark™ and Scala.
CO2	Learn how use Spark's machine learning pipelines to fit models and search for optimal hyperparameters using Scala in a Spark cluster.
CO3	Understand how parallel collections enable trivial parallelisation of statistical computing algorithms

CO4	Understand the advantages of using Apache Spark as a Big Data analytics platform

Ex. No	Experiment Title	Mapped CO/COs
1.	Write a program to install Scala	CO1
2.	Write a program to use Scala REPL/Shell	CO1
3.	Write a program to implement Hello World in Scala	CO1
4.	Write a program to define mutable and immutable functions in Scala	CO1
5.	Write a program to define Scala Data types	CO1
6.	Write a program to implement string operations in scala	CO1
7.	Write a program to illustrate Boolean expressions in Scala	CO1
8.	Write a program to define and invoke a function	CO1
9.	Write a program to implement Collections in Scala.	CO3
10.	Write a program to implement Loops in Scala	CO3
11.	Write a program to create classes and objects	CO1, CO4
12.	Write a program to implement exceptional handling	CO1, CO4

SUMMER INTERNSHIP/PROJECT-II

Department:	**Department of Computer Science and Engineering**		
Course Name: Summer Internship/Project-II	**Course Code**	**L-T-P**	**Credits**
	ENSI351	3-0-2	4
Type of Course:			
Pre-requisite(s), if any:			
Frequency of offering (check one): odd			

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 VI

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 Number: 2	**Title: Instruction Set Architecture (RISC-V)**	**No. of hours: 10**	
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

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.

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/

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	3	-	-	-	-	-	-	-	-	-	3
CO2	-	3	2	-	1	-	-	-	-	-	2	3

CO3	-	1	2	3		-	-	-	-	-	-	3
CO4	-	2	3	-	2		-	-	-	-	1	3
CO5	-	2	3	-	2	-	-	-	-	-	1	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
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

Department:	**Department of Computer Science and Engineering**		
Course Name: Computer Networks	**Course Code**	**L-T-P**	**Credits**
	ENCS304	4-0-0	4
Type of Course:	Major		
Pre-requisite(s), if any:			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Evolution of Computer Networking**	**No. of hours: 10**	
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.			
Unit Number: 2	**Title: Data Link Layer Design Issues**	**No. of hours: 10**	
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 - Pure ALOHA, Slotted ALOHA, CSMA/CD,CDMA/CA.			
Unit Number: 3	**Title: Introduction to Network Layer and Transport Services**	**No. of hours: 10**	
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: 10**	

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)

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.

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.)

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

CO-PO Mapping

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

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

CO-PSO Mapping

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

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 & Sustainability	Networking can contribute to environmental sustainability by 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 &	Sustainable network design involves optimizing the Network

Sustainability	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:	**Course Code**	**L-T-P**	**Credits**
Computer Networks Lab	**ENCS352**	0-0-2	1
Type of Course:	Major		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Course Outcomes

COs	Statements
CO 1	**Understand** the fundamental concepts of computer networks, including network devices, IP addressing, VLANs, and routing protocols, through hands-on experimentation and network configuration.
CO 2	**Develop** practical skills in setting up and configuring computer networks, including wired and wireless networks, and troubleshoot basic connectivity issues using network commands and tools.
CO 3	**Acquire** proficiency in configuring advanced network features such as VLANs, inter-VLAN routing, static routing, and Network Address Translation (NAT) to design complex network architectures.
CO 4	**Design** and **implement** error detection and correction mechanisms using Hamming Codes and CRC for 7/8 bits ASCII codes to ensure data integrity over a network.

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.	CO3, CO4
22	Design and deploy TCP based Multithreaded Chat client server for your class.	CO3, CO4
23	Design and deploy UDP based Multithreaded Chat client server for your class.	CO3, CO4
24	Examining real-world network deployments.	CO3, CO4
25	Case studies of network failures and their resolutions.	CO2, CO3, CO4

COMPETITIVE CODING LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Competitive Coding 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			

Proposed Lab Experiments

Course Outcomes (Cos)

COs	**Statements**
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.

Ex. No	**Experiment Title**	**Mapped CO/COs**
1	Introduction to Competitive Coding • Overview of competitive coding and its importance in the field of computer science.	CO1

	• Understanding the significance of problem-solving skills and algorithmic thinking in competitive coding.	
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
3	Time and Space Complexity Analysis • Understanding time and space complexity of algorithms. • Analysis of algorithm efficiency and choosing the most optimal 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/	CO5

	• UVa Online Judge: https://onlinejudge.org/ • SPOJ (Sphere Online Judge): https://www.spoj.com/ • Google Code Jam: https://codingcompetitions.withgoogle.com/codejam • Kick Start by Google: https://codingcompetitions.withgoogle.com/kick start • 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 with hands-on coding exercises. Link: https://www.hackerrank.com/domains/tutorials/10-days-of-statistics	CO5

	• "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/

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

K.R. MANGALAM UNIVERSITY

NEURAL NETWORKS & DEEP LEARNING

Department:	**Department of Computer Science and Engineering**		
Course Name: Neural Networks & Deep Learning	**Course Code**	**L-T-P**	**Credits**
	ENSP310	4-0-0	4
Type of Course:	Major		
Pre-requisite(s), if any: Machine Learning, Statistics.			
Frequency of offering (check one): Even			
Brief Syllabus: The objective of this course is to teach students the basic concepts of neural networks, neurons, and deep learning. The student gets an opportunity to learn the programming languages (TensorFlow) to design the deep learning models. The student learns the concepts behind CNN and RNN.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: The neural network**	**No. of hours: 8**	
Content Summary: The neuron, linear perceptron, feed-forward neural network, limitations of linear neurons, sigmoid, tanh, relu neurons, softmax output layer, information theory, cross entropy, Kullback-Leibler divergence			
Unit Number: 2	**Title: Training feed-forward neural network**	**No. of hours: 8**	
Content Summary: Gradient Descent, delta rules and learning rates, gradient descent with sigmoidal neurons, the backpropagation algorithms, stochastic and minibatch gradient descent, test sets, validation sets and overfitting, preventing overfitting.			
Unit Number: 3	**Title: Tensor Flow**	**No. of hours: 8**	
Content Summary: Computation graphs, graphs, sessions and fetches, constructing and managing graph, flowing tensors, sessions, data types, tensor arrays and shapes, names, variables, placeholders and simple optimization, linear regression and logistic regression using tensorflow			
Unit Number: 4	**Title: Implement Neural Network**	**No. of hours: 8**	
Content Summary: Introduction to Keras, Build neural network using Keras, Evaluating models, data preprocessing, feature engineering, feature learning, overfitting, underfitting, weight regularization, dropout, universal workflow of deep learning.			
***Self-Learning Components:** • Advanced topics on Neural Network and Deep Learning from the reference books given • Learn the concepts from https://learning.samatrix.io further			

- Download different dataset from Github and practice the Neural Network and Deep Learning Models
- Participate in Kaggle Competitions on Image Recognition

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. Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach - MIT Press (3 January 2017)
2. Tensor Flow for Deep Learning by Reza Zadeh, Bharath Ramsundar - Shroff/O'Reilly; First edition (2018)

Course Outcomes (COs)

COs	Statements
CO 1	Neural Network, Feed Forward and Backpropogation
CO 2	Tensorflow and Keras
CO 3	RNN, CNN, Autoencoders

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	A2	P3
C02	C2	A2	P2
CO3	C3	A3	P5

CO-PO Mapping

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

1=weakly mapped
2= moderately mapped

3=strongly mapped

CO-PSO Mapping

CO	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	-	-
CO 2	3	3	-	-
CO 3	3	3	3	-

Relevance of the Syllabus to various indicators

Unit I	**The Neural Network**
Local	Understanding neural networks can contribute to local research and development efforts in AI and machine learning.
Regional	Knowledge of neural networks can aid regional tech initiatives and innovation in AI applications.
National	Neural networks have national significance for advancing AI capabilities and research in the country.
Global	Neural networks are a globally recognized AI technique contributing to AI advancements worldwide.
Employability	Proficiency in neural networks enhances employability in AI and machine learning roles.
Entrepreneurship	Neural networks knowledge might slightly contribute to entrepreneurial ventures in AI.
Skill Development	Understanding neural networks is crucial for developing advanced AI skills.
Professional Ethics	Applying neural networks involves ethical considerations, impacting professional conduct.
Gender	Neural networks' impact on gender-related aspects requires awareness and consideration.
Human Values	Neural networks' ethical implications relate to broader human values.
Environment & Sustainability	Neural networks' direct relation to environment and sustainability is limited.
Unit II	**Training Feed-Forward Neural Network**
Local	Applying neural networks locally can contribute to data analysis and processing.
Regional	Knowledge of neural network training can support regional AI projects.
National	Neural network training is essential for advancing AI technology nationally.
Global	Neural network training techniques contribute to global AI

	research.
Employability	Proficiency in neural network training is essential for AI job roles.
Entrepreneurship	Neural network training may contribute minimally to AI entrepreneurship.
Skill Development	Neural network training is integral to developing advanced AI skills.
Professional Ethics	Ethical considerations in neural network training impact professional practice.
Gender	Ethical considerations in neural network training involve gender-related aspects.
Human Values	Neural network training implicates broader human values and ethical concerns.
Environment & Sustainability	Direct relevance of neural network training to environment and sustainability is limited.
Unit III	**Tensor Flow**
Local	Applying TensorFlow can contribute to local AI and machine learning projects.
Regional	Knowledge of TensorFlow supports regional AI technology initiatives.
National	TensorFlow is a fundamental tool for advancing AI technology nationally.
Global	TensorFlow is a globally recognized AI framework used for research and applications.
Employability	Proficiency in TensorFlow is essential for AI job roles.
Entrepreneurship	TensorFlow knowledge may contribute minimally to AI entrepreneurship.
Skill Development	TensorFlow is critical for developing advanced AI skills.
Professional Ethics	Ethical considerations in TensorFlow use affect professional conduct.
Gender	Ethical considerations in TensorFlow use may relate to gender-related aspects.
Human Values	TensorFlow's ethical implications involve broader human values.
Environment & Sustainability	Direct relevance of TensorFlow to environment and sustainability is limited.
Unit IV	**Implement Neural Network**
Local	Implementing neural networks locally can aid data analysis and applications.
Regional	Knowledge of neural network implementation supports regional AI endeavors.
National	Neural network implementation is crucial for advancing AI

	technology in the country.
Global	Neural network implementation contributes to global AI progress.
Employability	Proficiency in neural network implementation is vital for AI jobs.
Entrepreneurship	Neural network implementation may minimally contribute to AI entrepreneurship.
Skill Development	Neural network implementation is integral for developing advanced AI skills.
Professional Ethics	Ethical considerations in neural network implementation impact professional practice.
Gender	Ethical considerations in neural network implementation relate to gender aspects.
Human Values	Neural network implementation's ethical implications involve broader human values.
Environment & Sustainability	Direct relevance of neural network implementation to environment and sustainability is limited.
SDG	SFG 3, SDG 4, SDG 8, SDG 9
NEP 2020	Integrating technology in education and fostering critical thinking skills, integrating AI concepts into education and promoting problem-solving skills.
POE/4th IR	Aligns fundamental AI concepts that are pivotal in driving technological advancements.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/COs
1.	Tensorflow installation, comparison of tensorflow and python	CO2
2.	Code comparison between tensorflow 1.x and 2.x	CO2
3.	Construct and managing the computation graph using tensorflow	CO2
4.	Create constant, variables and placeholders using tensorflow	CO2
5.	Build tensorflow estimator and data pipeline	CO2
6.	Build a regression model on a real dataset (the Boston housing price dataset)	CO2
7.	Write a program to install TensorFlow	CO2

8.	Write a program to write Hello World Program in TensorFlow1.0 and compare with Python	CO2
9.	Write a program to construct and manage graph	CO2
10.	Write a program to implement fetches in TensorFlow	CO2
11.	Write a program to implement constants, variables, placeholders	CO2
12.	Write a program to implement tfprint() command in TensorFlow2.x	CO2
13.	Write a program to compare Lazy Execution vs Eager Execution	CO2
14.	Write a program to implement tf.global_variables_initializer() in TensorFlow 1.x and alternate in TensorFlow2.x.	CO2
15.	Write a program to implement Lazy Execution in TensorFlow 1.x using tf.global_variables_initializer() and without tf.global_variables_initializer() in TensorFlow2.x.	CO2
16.	Write a program to implement Feature Columns in TensorFlow2.x	CO2
17.	Write a program to build data pipelines in TensorFlow	CO2
18.	Write a program to read input data using data pipelines	CO2

DEEP LEARNING PRACTICAL WITH PYTHON, TENSORFLOW AND KERAS

Department:	**Department of Computer Science and Engineering**		
Course Name: Deep Learning Practical with Python, TensorFlow and Keras	**Course Code**	**L-T-P**	**Credits**
	ENSP360	0-0-2	1
Type of Course:	Major		
Pre-requisite(s), if any: Basic Deep learning , ML, Statistics.			
Frequency of offering (check one): Odd			
Brief Syllabus: • The student learns the concepts behind CNN, RNN, LSTM, Autoencoders, and GANs • The hands on learning will help build strong knowledge base for designing advanced deep learning models			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Moving beyond gradient descent**	**No. of hours: 8**	
Content Summary: Local minima vs global minima vs saddle, model identifiability, correcting gradient points in wrong directions, Momentum based optimization, second order methods, learning rate adaption, adagrad, rmsprop, adam			
Unit Number: 2	**Title: Convolutional Neural Network**	**No. of hours: 8**	
Content Summary: Convolution operation, filters and feature maps, motivation, sparse interactions, parameter sharing and equivariant representation, padding and stride, max pooling, full architectural description of convolutional network, build cnn using data augmentation, using pretrained convnet, visualize what convnet learn			
Unit Number: 3	**Title: Embedding and Representation Learning:**	**No. of hours: 8**	
Content Summary: Principle component analysis, working with text data, one-hot encoding of words and characters, word embedding, autoencoder architecture, denoising, sparsity, Word2vec framework, Skip-Gram architecture			
Unit Number: 4	**Title: Models for Sequence Analysis**	**No. of hours: 8**	

Content Summary:
Analysing Variable-length inputs, Seq2seq with neural n-gram, part of speech tagger, dependency parse, syntaxnet, recurrent neural network, challenges with vanishing gradients, long short term memory units

***Self-Learning Components:**

- Advanced topics on Neural Network and Deep Learning from the reference books given
- Learn the concepts from https://learning.samatrix.io further
- Download different dataset from Github and practice the Neural Network and Deep Learning Models
- Participate in Kaggle Competitions on Image Recognition

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. Deep Learning with Python by Francois Chollet - Manning Publications; 1 edition
2. Deep Learning by Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach - MIT Press (3 January 2017)

Proposed Lab Experiments

Course Outcomes (Cos)

COs	Statements
CO 1	Neural Network, Feed Forward and Backpropogation
CO 2	Tensorflow and Keras
CO 3	RNN, CNN, Autoencoders

Ex. No	Experiment Title	Mapped CO/COs
1.	Implement fence row & Column Transformation.	CO1
2.	Build tensorflow estimator and data pipeline	CO2
3.	Build a regression model on a real dataset (the Boston housing price dataset)	CO2
4.	Build a classification model on a real dataset (Titanic dataset)	CO2
5.	Build deep neural networks for single and multiple inputs.	CO2
6.	Installation of keras and simple keras program	CO2

7.	MNIST using keras- build data pipeline, plot training and validation accuracy	CO2
8.	Write a program to load data set with parameter split, shuffle_files, with_info=True, as_supervised=True	CO2
9.	Write a program to convert tf.data.Dataset objects to pandas.DataFrame with tfds.as_dataframe	CO2
10.	Write a program to Build Training Pipeline using ds.map, ds.cache, ds.shuffle, ds.batch, ds.prefetch	CO2
11.	Write a program to build and train CNN	CO3
12.	Write a program to access overfitting and underfitting in CNN	CO3
13.	Write a program to implement padding, stride and max pooling	CO3
14.	Write a program to implement one-hot encoding	CO3
15.	Write a program to implement word embedding	CO3
16.	Write a program to implement Word2vec	CO3
17.	Write a program to implement RNN	CO3
18.	Write a program to implement LSTM	CO3

DEPARTMENT ELECTIVE I (ARTIFICIAL INTELLIGENCE)

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 (Department Elective II)</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 colspan="2">Title: Introduction to Basic Concepts of Image Formation</td><td>No. of hours: 10</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>
<tr><td>Unit Number: 2</td><td colspan="2">Title: Image Restoration and coloring</td><td>No. of hours: 10</td></tr>
<tr><td colspan="4">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.</td></tr>
</table>

Unit Number: 3	Title: Image Compression and Segmentation	No. of hours: 10

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: 10

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:**

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.

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. 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.

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	PSO3	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:	**Course Code**	**L-T-P**	**Credits**
Image Processing & Computer Vision Lab	**ENSP354**	0-0-2	1
Type of Course:	Minor (Department Elective II)		
Pre-requisite(s), if any: (1) Linear Algebra and (2) programming in python			

Proposed Lab Experiments

Course Outcomes (Cos)

COs	Statements
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

Department:	**Department of Computer Science and Engineering**		
Course Name: Introduction to Generative AI	**Course Code**	**L-T-P**	**Credits**
	ENSP306	4-0-0	4
Type of Course:	Minor (Department Elective II)		
Pre-requisite(s), if any:			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Foundations of Generative AI**		**No. of hours: 10**
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.			
Unit Number: 2	**Title: Generative Models**		**No. of hours: 10**
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: 10**
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: 10

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

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. 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/

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©	Affective levels(A)	Psychomotor levels(P)
	1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	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	Develops skills in applying generative models, analyzing

Development	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.

GENERATIVE AI LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Introduction to Generative AI Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP356	0-0-2	1
Type of Course:	Minor (Department Elective II)		
Pre-requisite(s), if any: NA			

Proposed Lab Experiments

Course Outcomes

COs	Statements
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:	**Course Code**	**L-T-P**	**Credits**
Transfer Learning	**ENSP308**	4-0-0	4
Type of Course:	Minor (Department Elective II)		
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: 10**	
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: 10**	
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: 10**	
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: 10**	
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

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. "Transfer Learning" by Sinno Jialin Pan and Qiang Yang (Morgan & Claypool Publishers)
2. "Transfer Learning for Natural Language Processing" by Shervin Minaee and Amirali Abdolrashidi (Springer)
3. "Domain Adaptation in Computer Vision Applications" by Gabriela Csurka (Morgan & Claypool Publishers)
4. "Transfer Learning in Reinforcement Learning" by Panpan Cai, Yang Yu, and Xuewen Yao (Springer)

Text Books

1. "Transfer Learning: Algorithms and Applications" by B. K. Tripathy and Sandipan Roy (Springer)
2. "Transfer Learning and Domain Adaptation in NLP" by Yoshua Bengio, Jian-Yun Nie, and Geoffrey J. Gordon (Morgan & Claypool Publishers)
3. Transfer Learning: Methods, Applications, and Challenges" by R. Sathya and K. S. Devi (CRC Press)

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	1	1	-	-	-	1	-	-	1
CO 2	3	2	3	2	3	3	-	-	-	2	-	2
CO 3	3	1	3	-	3	-	-	-	2	2	-	3
CO 4	-	-	1	-	1	-	-	-	-	-	-	2
CO 5	-	1	1	3	2	-	-	-	1	3	-	2

CO-PSO Mapping

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

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 (Department Elective II)		
Pre-requisite(s), if any: NA			

Proposed Lab Experiments

Course Outcomes

COs	Statements
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	CO3

	Python libraries like Keras or TensorFlow to train an RNN model for multiple related tasks in natural language processing.	
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

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

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 VII

DEPARTMENT ELECTIVE II (CYBER SECURITY)

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:**

- 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.
- Security Frameworks such as OWASP (Open Web Application Security Project) and their associated resources.
- 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.
- 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:

1. Writing Secure Code, Michael Howard and David LeBlanc,Microsoft Press, 2nd Edition, 2004
2. Buffer Overflow Attacks: Detect, Exploit, Prevent by Jason Deckard ,Syngress,1st Edition, 2005
3. Threat Modeling, Frank Swiderski and Window Snyder,Microsoft Professional, 1st Edition ,2004
4. Secure Coding: Principles and Practices by Mark G. Graff, Kenneth R. van Wyk, Publisher(s): O'Reilly Media, Inc., 2003
5. The Software Vulnerability Guide (Programming Series) by H. Thompson (Author), Scott G. Chase, 2005

Reference Links:

1. **"Secure Coding Practices" on Udemy - Offered by The App Brewery.**

Link: https://www.udemy.com/course/secure-coding-practices/

2. "**Secure Coding: Preventing Software Vulnerabilities" on Pluralsight - Offered by Pluralsight**. Link: Secure Coding: Preventing Software Vulnerabilities
3. "**Software Security" on edX - Offered by University of Maryland, College Park**. Link: Software Security
4. Identifying Security Vulnerabilities in C/C++Programming | Coursera
5. Principles of Secure Coding | Coursera
6. Identifying Security Vulnerabilities | Coursera

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	PO1	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 Ethics	Develop applications that prioritize data security and user 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: Secure Coding & Vulnerabilities Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP351	0-0-2	1
Type of Course:	Minor (DEPARTMENT ELECTIVE-II)		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Course Outcomes

COs	**Statements**
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 vulnerabilities.	CO2
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

Department:	**Department of Computer Science and Engineering**		
Course Name: Cyber Crime Investigation & Digital Forensics	**Course Code**	**L-T-P**	**Credits**
	ENSP303	4-0-0	4
Type of Course:	Minor (DEPARTMENT ELECTIVE-II)		
Pre-requisite(s), if any:			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Title: Introduction**	**No. of hours: 10**	
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.			
Unit Number: 2	**Title: Types of Cyber Crimes**	**No. of hours: 10**	
Content Summary: Crimes targeting Computers: Unauthorized Access Packet Sniffing Malicious Codes including Trojans, Viruses, Logic Bombs, etc. Online based Cyber Crimes: Phishing 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:

1. Moore, Robert, (2011). Cybercrime, investigating high-technology computer crime(2nd Ed.). Elsevie
2. C. Altheide& H. Carvey Digital Forensics with Open Source Tools, Syngress, 2011.
3. Majid Yar, "Cybercrime and Society", SAGE Publications Ltd, Hardcover, 2nd Edition, 2013.
4. Robert M Slade, "Software Forensics: Collecting Evidence from the Scene of a Digital Crime", Tata McGraw Hill, Paperback, 1st Edition, 2004.

Web references:

1. **https://www.coursera.org/learn/digital-forensics-concepts**
2. **https://www.udemy.com/course/computer-forensics-and-digital-forensics-for-everyone/**

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	PO11	PO12
CO1	2	1	1	-	2	2	-	2	2	1	-	2
CO2	-	3	3	-	3	2	-	2	3	-	-	3
CO3	-	1	3	-	3	2	2	3	3	-	-	2
CO4	2	2	2	3	3	3	2	2	2	-	-	2
CO5	-	2	2	3	3	3	-	2	2	-	-	2

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 Ethics	Studying cybercrime and computer crime can raise awareness of ethical issues related to information security, privacy, and 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

Department:	**Department of Computer Science and Engineering**		
Course Name: Cyber Crime Investigation & Digital Forensics Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP353	0-0-2	1
Type of Course:	Minor (DEPARTMENT ELECTIVE-II)		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Course Outcomes

COs	**Statements**
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 their impact on digital devices.	CO 4
16	Experiment on understanding the role and capabilities of investigation agencies in India.	CO 1
17	Experiment on following proper evidence collection and	CO 2

	seizure procedures in digital investigations.	
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: AI in Cyber Security	**Course Code**	**L-T-P**	**Credits**
	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)

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

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
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

Course Outcomes

COs	**Statements**
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	CO 1

	anomalous behavior in user activities or system logs.	
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 predict network anomalies before they occur.	CO 1, CO 3
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

Department:	**Department of Computer Science and Engineering**		
Course Name: Social Media Security	**Course Code**	**L-T-P**	**Credits**
	ENSP307	4-0-0	4
Type of Course:	Minor (DEPARTMENT ELECTIVE-II)		
Pre-requisite(s), if any:			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Social Media Overview**	**No. of hours: 10**	
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 Attachment Model.			
Unit Number: 2	**Title: Security Issues in Social Media**	**No. of hours: 10**	
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.			
Unit Number: 3	**Title: Privacy Issues in Social Media**	**No. of hours: 10**	

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.

Unit Number: 4	**Title: Social Media Security: Laws, Best Practices, and Case Studies**	**No. of hours: 10**

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.

***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:
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:

1. Mastering Social Media Mining, Bonzanini Marco, Packt Publishing Limited
2. Mining the Social Web, Mikhail Klassen and Matthew A. Russell, O'Reilly Media, Inc
3. Social media mining: an introduction, Zafarani, Reza, Mohammad Ali Abbasi, and Huan Liu, Cambridge University Press
4. Social Media Security: Leveraging Social Networking While Mitigating Risk, Michael Cross, Syngress
5. Social Media and the Law: A Guidebook for Communication Students and Professionals, Daxton R. Stewart, Taylor & Francis Ltd
6. 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:			

Proposed Lab Experiments

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.

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 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.	CO1, CO5
3	Social Media Marketing Analysis	CO2, CO3

	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.	
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 reporting mechanisms.	CO4
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	CO2, CO5

	privacy.	
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 Facebook. b. Explore the challenges faced by Facebook in maintaining user data privacy. c. Discuss notable security incidents and their impact on user trust.	CO1, CO2, CO4
16	Case Study Analysis - Twitter a. Investigate the security measures implemented by Twitter.	CO1, CO2, CO4

	b. Analyze the response to cybersecurity incidents on the platform. c. Discuss the role of Twitter in addressing misinformation and cyberbullying.	
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. c. Discuss the importance of secure coding practices in open-source projects.	CO1, CO2
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	CO1, CO2

	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.	
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:	Department of Computer Science and Engineering		
Course Name: Cyber Crime Investigation & Digital Forensics	**Course Code**	**L-T-P**	**Credits**
	ENSP303	4-0-0	4
Type of Course:	Programme Core / Programme Elective /Open Elective		
Pre-requisite(s), if any:			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Title: Introduction**		**No. of hours: 8**
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.			
Unit Number: 2	**Title: Types of Cyber Crimes**		**No. of hours: 10**
Content Summary: Crimes targeting Computers: Unauthorized Access Packet Sniffing Malicious Codes including Trojans, Viruses, Logic Bombs, etc. Online based Cyber Crimes: Phishing 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: 12**
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:

1. Moore, Robert, (2011). Cybercrime, investigating high-technology computer crime(2nd Ed.). Elsevie
2. C. Altheide& H. Carvey Digital Forensics with Open Source Tools, Syngress, 2011.
3. Majid Yar, "Cybercrime and Society", SAGE Publications Ltd, Hardcover, 2nd Edition, 2013.
4. Robert M Slade, "Software Forensics: Collecting Evidence from the Scene of a Digital Crime", Tata McGraw Hill, Paperback, 1st Edition, 2004.

Web references:

1. **https://www.coursera.org/learn/digital-forensics-concepts**
2. **https://www.udemy.com/course/computer-forensics-and-digital-forensics-for-everyone/**

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	-

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 Ethics	Studying cybercrime and computer crime can raise awareness of ethical issues related to information security, privacy, and 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

Department:	**Department of Computer Science and Engineering**		
Course Name: Cyber Crime Investigation & Digital Forensics Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP353	0-0-2	1
Type of Course:	Minor		
Pre-requisite(s), if any: -			

Proposed Lab Experiments

Defined Course Outcomes

COs	Statements
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 their	CO 4

	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.

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">Minor (Department Elective IV)</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>
<tr><td colspan="4">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.</td></tr>
<tr><td>Unit Number: 3</td><td colspan="2">Title: Encapsulating Data</td><td>No. of hours: 10</td></tr>
</table>

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:**

1. 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:
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.

Textbook:

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 entries- 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	1	2	-	-	-	-	-	-	-	-	3
CO2	-	3	2	-	2	-	-	-	-	-	-	3
CO3	-	2	2	3	1	-	-	-	-	-	-	3
CO4	-	2	3	-	-		-	-	-	-	-	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

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:	Minor (Department Elective IV)		
Pre-requisite(s), if any: Basics of Android			

Proposed Lab Experiments

Defined Course Outcomes

COs	Statements
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 multiplication and division of the two variables	CO3
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

Department:	**Department of Computer Science and Engineering**		
Course Name: DevOps & Automation	**Course Code**	**L-T-P**	**Credits**
	ENSP411	4-0-0	4
Type of Course:	Minor (Department Elective IV)		
Pre-requisite(s), if any: Nil			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to DevOps**	**No. of hours: 10**	
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 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.		

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

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 to DevOps
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	**Containerization and Orchestration**
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	**Configuration Management and Infrastructure as Code (IaC)**
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	**Monitoring, Logging, and Security in DevOps**
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:	Minor (Department Elective IV)		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Course Outcomes

COs	Statements
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

Department:	**Department of Computer Science and Engineering**		
Course Name: .NET Framework	**Course Code**	**L-T-P**	**Credits**
	ENSP413	4-0-0	4
Type of Course:	Minor (Department Elective IV)		
Pre-requisite(s), if any:			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to .NET Framework**	**No. of hours: 8**	
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			
Unit Number: 2	**Title: .NET Framework Fundamentals**	**No. of hours: 8**	
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

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/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

Course Outcomes (CO)

COs	Statements
CO1	**Understanding** the fundamental concepts and components of the .NET Framework.
CO 2	**Applying** knowledge to design and develop applications using Windows Forms, WPF, and ASP.NET.
CO 3	**Analyzing** performance considerations and troubleshooting errors in the .NET Framework.
CO 4	**Integrating** advanced topics like .NET Core, Entity Framework, and WCF for cross-platform development and service creation.

CO 5	**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

CO-PSO Mapping

PO	PSO1	PSO2	POS3	PSO4
CO1	3	3	-	-
CO2	1	3	1	
CO3	2	1	-	1
CO4	-	1	-	1
CO5	1	2	-	-

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	Learning and applying these technologies contribute to the

Development	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:	Minor (Department Elective IV)		
Pre-requisite(s), if any: Nil			

Proposed Lab Experiments

Course Outcomes

COs	Statements
CO 1	**Gain** a thorough understanding of the core concepts and components of the .NET Framework.
CO 2	**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 Framework for data manipulation.	CO3
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:	Minor (Department Elective IV)		
Pre-requisite(s), if any: Nil			
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 Number: 2	**Title: F# Programming Language**	**No. of hours: 10**	
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:**

1. Web programming with GO
2. F# for Data Science and Machine Learning:
3. Metaprogramming and DSLs in Clojure:
4. 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:

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. The Go Programming Language, Alan A. A. Donovan and Brian W. Kernighan, Addison-Wesley Professional.
2. An Introduction to Programming in Go, Caleb Doxsey, CreateSpace Independent Publishing.
3. Real-World Functional Programming: With Examples in F# and C#, Tomas Petricek and Jon Skeet, Manning.
4. Programming F# 3.0: A Comprehensive Guide for Writing Simple Code to Solve Complex Problems, Chris Smith, O'Reilly Media.
5. Getting Clojure: Build Your Functional Skills One Idea at a Time, Russ Olsen, O'Reilly.
6. The Joy of Clojure, Michael Fogus and Chris Houser, Manning Publication.
7. Atomic Kotlin, Bruce Eckel and Svetlana Isakova, Mindview LLC.
8. 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) 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	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	1	3

CO2	2	2	-	-	2	-	-	-	-	2	2	3
CO3	2	2	-	3	-	-	-	-	-		-	3
CO4	-	-	-	-	3	-	-	-	-	3	1	2
CO5	-	-	-	-		2	-	-	-	2	-	3

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**		
Course Name: New Age Programming languages Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP465	0-0-2	1
Type of Course:	Minor (Department Elective IV)		
Pre-requisite(s), if any: Nil			

Proposed Lab Experiments

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.

Ex. No	Experiment Title	Mapped CO/COs
Practical 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	CO1

	perform common tasks, such as string manipulation or mathematical operations. Use these functions in a separate program to demonstrate their functionality and reusability.	
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 have attributes such as title, description, due date, and status (e.g., "in progress", "completed").	CO5
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, and inheritance hierarchies using F#'s OOP syntax.		CO3
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		CO4

	handling and error management, in Clojure.		
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 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.		CO5
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		CO3

	calls (?.) and the Elvis operator (?:) to handle nullable values and provide alternative values or perform fallback actions.	
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

MINOR PROJECT-III

Department:	**Department of Computer Science and Engineering**		
Course Name: Minor Project-III	**Course Code**	**L-T-P**	**Credits**
	ENSI451	---	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)	