K.R. MANGALAM UNIVERSITY

SCHOOL OF ENGINEERING

AND

TECHNOLOGY

B. Tech (Computer Science & Engineering)

Undergraduate Course

2023-27

Preamble

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

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

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

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

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

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

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

Dean,

School of Engineering and Technology,

K. R. Mangalam University.

Preface

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

Our B. Tech Computer Science & Engineering program is designed to provide students with a comprehensive understanding of the foundational principles and practical skills needed to excel in this dynamic field. Over the course of four years, students will delve into subjects such as programming languages, data structures, operating systems, database management, computer architecture, and software engineering.

At our institution, we emphasize a hands-on approach to learning, combining theoretical knowledge with practical application. Students will have the opportunity to work on real-world projects, engage in laboratory experiments, and participate in internships to gain valuable industry experience. We believe that this experiential learning will not only strengthen technical proficiency but also foster critical thinking, problem-solving abilities, and teamwork skills.

Furthermore, our curriculum is designed to keep pace with the rapidly evolving nature of the computer science and engineering field. We strive to incorporate the latest trends and emerging technologies, ensuring that our graduates are equipped with the knowledge and adaptability necessary to thrive in a competitive industry.

As technology continues to reshape our world, computer scientists and engineers have a pivotal role to play in driving innovation and creating solutions to complex challenges. Our B. Tech Computer Science & Engineering program aims to nurture and empower the next generation of professionals who will shape the future of technology.

We are committed to providing a supportive and inclusive learning environment, where students can explore their passions, develop their skills, and unlock their full potential. Through dedicated faculty, state-of-the-art infrastructure, and a vibrant community, we strive to create an enriching educational experience that prepares students for successful careers in the field of Computer Science & Engineering.

We invite aspiring students to embark on this exciting journey with us, as together, we explore the limitless possibilities of computer science and engineering and make a positive impact on the world.

Objectives of the program

1. Develop a strong foundation: The primary objective of our B. Tech Computer Science & Engineering program is to provide students with a solid foundation in the fundamental principles of computer science and engineering. Through comprehensive coursework, students will gain a deep understanding of programming languages, data structures, algorithms, computer architecture, and software development methodologies.

2. Foster technical competence: We aim to equip students with the necessary technical skills to excel in the field of computer science and engineering. By offering a rigorous curriculum and hands-on learning experiences, students will develop proficiency in designing, implementing, and analyzing complex computer systems, networks, and software applications.

3. Encourage problem-solving abilities: Problem-solving lies at the heart of computer science and engineering. Our program aims to nurture students' analytical and critical thinking skills, enabling them to identify and solve complex problems using innovative approaches and cutting-edge technologies. Through projects, case studies, and practical assignments, students will learn to apply their knowledge to real-world scenarios.

4. Promote interdisciplinary collaboration: In today's interconnected world, computer science and engineering often intersect with other disciplines. Our program encourages interdisciplinary collaboration, enabling students to explore areas such as artificial intelligence, data science, cybersecurity, robotics, and more. This fosters a holistic approach to problem-solving and prepares students for multidisciplinary projects and industry demands.

5. Cultivate creativity and innovation: We believe that creativity and innovation are essential for driving technological advancements. Our program encourages students to think creatively, explore new ideas, and develop innovative solutions to address emerging challenges in the field. Through research-oriented projects and exposure to the latest industry trends, students are encouraged to push the boundaries of what is possible.

6. Instill professional ethics and social responsibility: As future computer science and engineering professionals, students have a responsibility to uphold ethical standards and consider the societal impact of their work. Our program emphasizes the importance of ethical conduct, privacy, security, and responsible use of technology. Students will be encouraged to explore the

ethical implications of their decisions and develop a sense of social responsibility.

7. Foster lifelong learning: Given the ever-evolving nature of computer science and engineering, our program aims to instill a passion for lifelong learning. We encourage students to stay abreast of the latest advancements, trends, and technologies through continuous professional development. By cultivating a love for learning, students will be well-prepared to adapt to the dynamic and evolving landscape of their chosen field.

Career Avenues

Diverse career avenues available to graduates of the B. Tech Computer Science & Engineering program are as follows:

1. Software Development: Graduates can pursue careers as software developers, working on designing, coding, testing, and maintaining software applications and systems. They can specialize in areas such as web development, mobile app development, game development, or enterprise software development.

2. Systems Analyst: A systems analyst analyzes an organization's computer systems and procedures to improve efficiency and effectiveness. They work on designing and implementing new systems, conducting feasibility studies, and identifying areas for improvement in existing systems.

3. Data Scientist: With the increasing volume of data in various industries, data scientists are in high demand. They utilize their skills in data analysis, statistics, and machine learning to extract insights from large datasets, make data-driven decisions, and develop predictive models.

4. Artificial Intelligence Engineer: As AI technology continues to advance, there is a growing demand for professionals skilled in developing AI algorithms and systems. AI engineers work on creating intelligent machines, developing natural language processing systems, computer vision applications, and other AI-driven solutions.

5. Cybersecurity Analyst: In an era of heightened cybersecurity threats, organizations require experts who can protect their systems and data. Cybersecurity analysts identify vulnerabilities, implement security measures, conduct risk assessments, and respond to security incidents to safeguard computer systems and networks.

6. Network Engineer: Network engineers are responsible for designing, implementing, and maintaining computer networks within organizations. They ensure network reliability, security, and performance, and troubleshoot network issues to ensure smooth operations.

7. IT Project Manager: IT project managers oversee the planning, execution, and delivery of technology projects within organizations. They manage project teams, coordinate resources, track progress, and ensure projects are completed within budget and on time.

8. Database Administrator: Database administrators manage and maintain databases, ensuring data integrity, security, and performance. They design database structures, implement backup and recovery procedures, and optimize database systems for efficient data storage and retrieval.

9. Software Quality Assurance Engineer: QA engineers are responsible for ensuring the quality and reliability of software applications. They develop and execute test plans, identify and report bugs and issues, and work closely with development teams to improve software quality.

10. Research and Development: Graduates can pursue careers in research and development, working on innovative projects, exploring new technologies, and pushing the boundaries of computer science and engineering. This can involve academic research, industry research labs, or research and development departments within companies.

Duration

4 Years (Full-Time)

Eligibility Criteria

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

K.R. MANGALAM UNIVERSITY

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University Vision & Mission

Vision

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

Mission

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

School Vision & Mission

Vision

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

Mission

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

About School

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

School of Engineering & Technology (SOET) brings together outstanding academicians, industry professionals, and experienced researchers to impart hands-on and multi-disciplinary learning experience. The curriculum of the programs caters to the ever-changing needs and demands of 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 the 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 a 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. Our students get an opportunity to learn directly by professionals from industry.

Program Outcome (PO)

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

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

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

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

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

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

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

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

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

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

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

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

Program Educational Objectives (PEO)

PEO1 - Develop knowledge and abilities in the area of Computer Science and Engineering and create a foundation of lifelong learning to facilitate progressive careers in industry and in pursuit of higher studies.

PEO2 - To provide our students with the technical and analytical abilities they need to create creative solutions to challenging real-world issues using both current and emerging technology.

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 a comprehensive understanding of the fundamental principles, theories, and practices in Computer Science and Engineering, enabling graduates to apply their knowledge effectively in various professional settings.

PSO2 - Demonstrate proficiency in utilizing current and emerging technologies to analyze and solve complex real-world problems in the field of Computer Science and Engineering. Graduates should be capable of developing innovative solutions and adapting to technological advancements.

PSO3 - Develop strong communication and interpersonal skills, including the ability to collaborate effectively in multidisciplinary teams, present technical information clearly, and engage in professional discussions. Graduates should also demonstrate leadership qualities and be able to assume responsibilities in their chosen field.

PSO4 - Cultivate a sense of ethics, social responsibility, and awareness of current concerns in the field of Computer Science and Engineering. Graduates should understand the importance of ethical practices, sustainable development, and contribute positively to their workplace, society, and the nation.

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	ENPH101/ENCH101	Engineering Physics / Engineering Chemistry	4	-	-	4
3	Major	ENEE101	Basics of Electrical & Electronics Engineering	4	-	-	4
4	Major	ENCS101	Fundamentals of Computer programming	4	-	-	4
5	Minor	ENPH151/ENCH151	Engineering Physics Lab/ Engineering Chemistry lab	-	-	2	1
6	Major	ENEE151	Basics of Electrical & Electronics Engineering Lab	-	-	2	1
7	Major	ENCS151	Fundamentals of Computer Programming Lab	-	-	2	1
8	VAC I		Environmental Studies & Disaster Management	2	-	-	2
TOTAL				17	1	6	**21**

Semester II

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENMA102	Linear Algebra and Ordinary Differential Equations	3	1	-	4
2	Major	ENCS102	Object Oriented Programming using C++	4	-	-	4
3	Major	ENCH101/ENPH 101	Engineering Chemistry / Engineering Physics	4	-	-	4
4	SEC	SEC033	Engineering Drawing & Workshop Lab	-	-	4	2
5	Major	ENCS152	Object Oriented Programming using C++ Lab	-	-	2	1
6	Major	ENCH151/ENPH 151	Engineering Chemistry Lab / Engineering Physics lab	-	-	2	1
7	Open Elective		Open Elective-I	3	-	-	3
8	VAC		VAC II (Along with Community Service)	2	-	-	2
TOTAL				16	1	8	**21**

Semester III

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENCS201	Java Programming	4	-	-	4
2	Major	ENCS203	Discrete Mathematics	3	1	-	4
3	Major	ENCS205	Data Structures	4	-	-	4
4	VAC		VAC III	2	-	-	2
5	Major	ENCS251	Java Programming Lab	-	-	2	1
6	Major	ENCS253	Data Structures Lab	-	-	2	1
7	AEC	AEC011	Life Skills for Professionals-I	3	-	-	3
8	INT	ENSI251	Summer Internship / Project-I	-	-	-	2
9	Open Elective		Open Elective	3	-	-	3
10	SEC	**SEC034**	Fundamentals of AI & Machine Learning	2	-		2
TOTAL				21	1	4	**26**

Semester IV

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENMA202	PROBABILITY AND STATISTICS	3	1	-	4
2	SEC	**SEC035**	Web Programming with Python and JavaScript Lab	-	-	4	2
3	Major	ENCS202	Analysis and Design of Algorithms	4	-	-	4
4	Major	ENCS204	Database Management Systems	4	-	-	4
5	AEC	AEC012	Life Skills for Professionals-II	3	-	-	3
6	Major	ENCS254	Database Management Systems Lab	-	-	2	1
7	Major	ENCS256	Analysis and Design of Algorithms Lab	-	-	2	1
8	Open Elective		Open Elective	3	-	-	3
9	VAC		VAC IV	2	-	-	2
10	Project	ENSI252	Minor Project-I	-	-	-	2
TOTAL				19	1	8	**26**

Semester V

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENCS301	Theory of Computation	3	1	-	4
2	Major	ENCS303	Operating Systems	4	-	-	4
3	Major	ENCS351	Operating System Lab	-	-	2	1
4	INT	ENSI351	Summer Internship/ Project-II	-	-	-	2
5	AEC	AEC013	Life Skills for Professionals-III	3	-	-	3
6	Minor		Department Elective-I	4			4
7	Minor		Department Elective-I lab			2	1
8	Major	ENCS305	Software Engineering	4	-	-	4
TOTAL				18	1	4	**23**

Department Elective I (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

Semester VI

SN	Category	Course Code	Course Title	L	T	P	C
1	Major	ENCS302	Computer Organization & Architecture	3	1	-	4
2	Major	ENCS304	Computer Networks	4	-	-	4
3	Major	ENCS306	Introduction of Neural Network and Deep Learning	4	-	-	4
4	Major	ENCS352	Computer Networks Lab	-	-	2	1
5	SEC	SEC036	Competitive Coding Lab	-	-	4	2
6	Major	ENCS354	Introduction to Neural Networks & Deep Learning Lab	-	-	2	1
7	Minor		Department Elective -II	4	-	-	4
8	Minor		Department Elective -II Lab	-	-	2	1
9	Project	ENSI352	Minor Project-II				2
TOTAL				15	1	10	**23**

	Department Elective II (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

Semester VII

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

Department Elective - III (Cloud Computing)							
(i)	Minor	ENSP401	Computational Services in The Cloud	4	-	-	4
	Minor	ENSP451	Computational Services in The Cloud Lab	-	-	2	1
(ii)	Minor	ENSP403	Microsoft Azure Cloud Fundamentals	4	-	-	4
	Minor	ENSP453	Microsoft Azure Cloud Fundamentals Lab	-	-	2	1
(iii)	Minor	ENSP405	Storage and Databases on Cloud	4	-	-	4
	Minor	ENSP455	Storage and Databases on Cloud Lab	-	-	2	1
(iv)	Minor	ENSP407	Application Development and DevOps on Cloud	4	-	-	4
	Minor	ENSP457	Application Development and DevOps on Cloud Lab	-	-	2	1

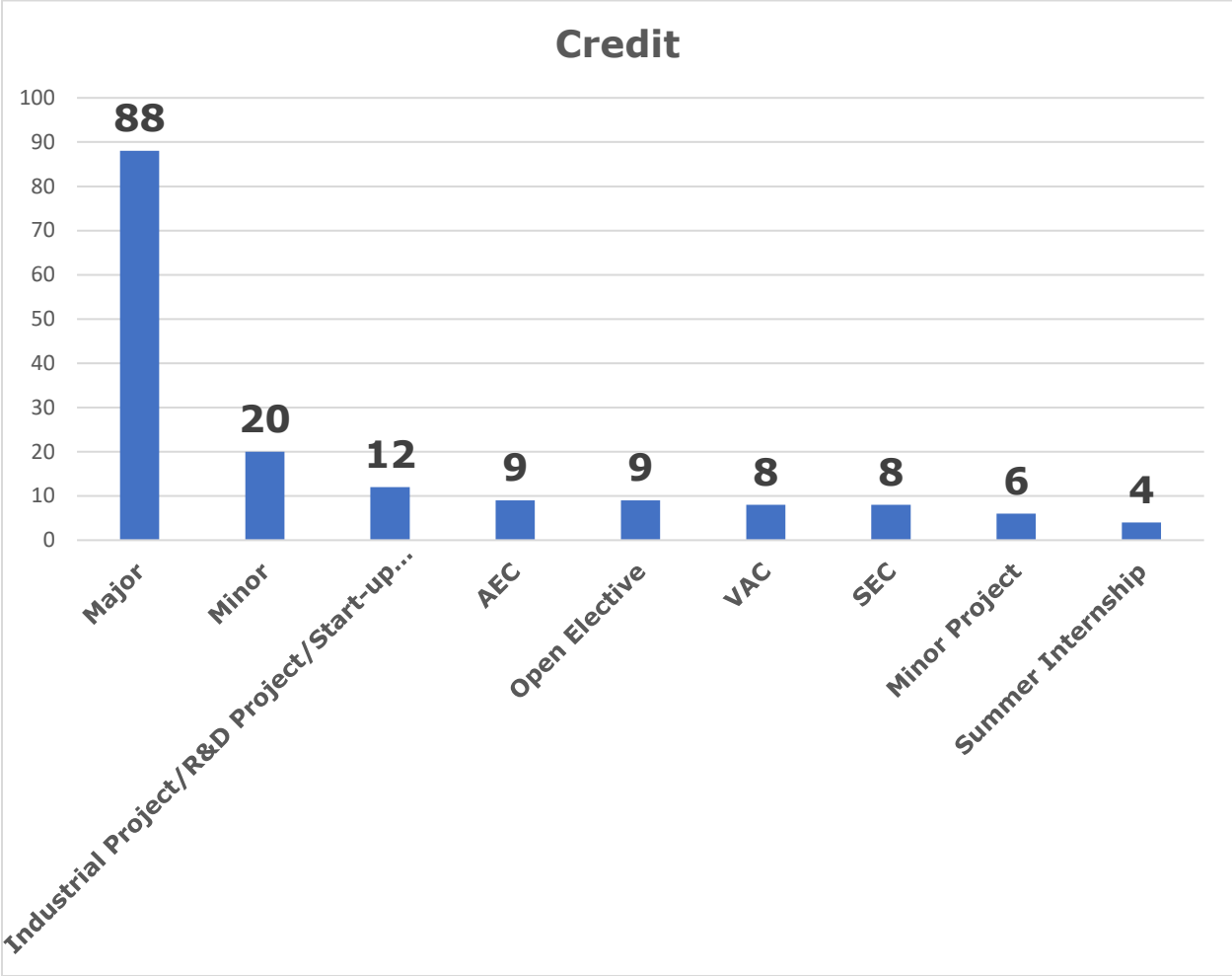
Department Elective - IV (Full Stack Development)							
(i)	Minor	ENSP409	Mobile Application Development using iOS	4	-	-	4
	Minor	ENSP459	Mobile Application Development using iOS Lab	-	-	2	1
(ii)	Minor	ENSP411	DevOps & Automation	4	-	-	4
	Minor	ENSP461	DevOps & Automation Lab	-	-	2	1
(iii)	Minor	ENSP413	.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

Semester VIII

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

Total Credits: 164

Categorization of Courses



Syllabus

Semester: 1

ENGINEERING CALCULUS

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Engineering Calculus	**ENMA101**	3-1-0	4
Type of Course:	Major		
Pre-requisite(s): Calculus knowledge at higher secondary level			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Differential Calculus- I**	**No. of hours: 10**	
Content Summary: Introduction to limits, continuity and differentiability, Rolle's Theorem, Lagrange's Mean value theorem with their Geometrical Interpretation and applications, Cauchy's Mean value Theorem, Taylor's Series. Applications of definite integrals to evaluate surface areas and volumes of revolutions of curves (Only in Cartesian coordinates), Successive Differentiation (nth order derivatives), Leibnitz theorem and its application, Curve tracing: Cartesian and Polar co-ordinates.			
Unit Number: 2	**Title: Multivariable Calculus (Partial Differentiation and applications)**	**No. of hours: 10**	

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

Define Course Outcomes (CO)

COs	Statements
CO 1	To **apply** the knowledge of differential calculus in the field of engineering.
CO 2	To **deal** with functions of several variables that are essential in optimizing the results of real life problems.
CO 3	Multiple integral tools to deal with engineering problems involving centre of gravity, volume etc.

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

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1	-	P1
CO2	C2	-	P2
CO3	C2	-	P2
CO4	C3, C4	-	P3
CO5	C5	-	P4, P5

CO-PO Mapping

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

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	**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 Ethics	Applying differential calculus with integrity ensures ethical 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 & Sustainability	Multivariable calculus can be used to model and optimize 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.

ENGINEERING PHYSICS

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Engineering Physics	**ENPH101**	4-0-0	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

BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING

Department:	**Department of Electrical & Electronics Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Basics of Electrical & Electronics Engineering	**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/

Define Course Outcomes (CO)

Course Outcomes (COs)

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

COs	Statements
CO 1	**Describe** and learn the basic Knowledge of AC and DC Circuits in making real-time projects to solve engineering difficulties of real time.

CO 2	**Understands its** utilization in day-to-day work dealing with pure AC circuits. R L and basic C circuits effect over-voltage and ac wave will be studied.
CO 3	**Compare** and **Contrast** various logic gates. Demonstrate the ability to identify series, parallel complex circuits. Utilization of the preliminary knowledge gained to obtain real existing power-related problems.
CO 4	**Differentiate** about the understanding of semiconductor devices application to existing apparatuses
CO 5	**Distinguish** the devices used in multipurpose electronics devices.

CO-PO Mapping

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

CO-PSO Mapping

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

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1	-	-
C02	C2	-	-
CO3	C3	A4	-
CO4	C6	-	P5
CO5	-	-	-

Relevance of the Syllabus to various indicators

Unit I	**Circuit Analysis:**
Local	In the local context, circuit analysis plays a role in electrical infrastructure, power distribution, and ensuring safe electrical connections within a community. It is crucial for local electricians, engineers, and technicians to understand circuit analysis principles to maintain and troubleshoot electrical systems efficiently.
Regional	In the regional context, circuit analysis is applied to larger electrical networks and power grids that serve multiple cities or areas. Engineers and policymakers use circuit analysis to design and optimize the regional power distribution, taking into account factors like load balancing, transmission losses, and system reliability.

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

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

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

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

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

Professional Ethics	• Semiconductor Physics: Professionals working in semiconductor research and development must adhere to ethical principles concerning safety, environmental protection, and responsible use of semiconductor technology.
Gender	• Semiconductor Physics: Encouraging gender diversity and inclusion in semiconductor physics and related fields is essential for creating a more balanced and diverse workforce. Efforts to promote gender equity in STEM fields help increase representation and opportunities for women. •
Human Values	• Semiconductor Physics: The advancements in semiconductor technology have improved human life through various electronic devices, communication systems, medical equipment, and energy-efficient solutions. •
Environment & Sustainability	• Semiconductor Physics: Research in semiconductor physics contributes to the development of energy-efficient electronic devices, renewable energy technologies, and environmental monitoring systems, which align with sustainability goals.
Unit IV	**Digital Electronics**
Local	• Digital Electronics: In the local context, digital electronics is used in everyday electronic devices found in homes and businesses. Local electronics retailers and repair services utilize digital electronics knowledge to provide and maintain electronic products in the community. •
Regional	• Digital Electronics: At the regional level, digital electronics plays a role in the development of regional technology hubs and manufacturing centers. Collaboration among regional industries and

	research institutions may lead to advancements in digital electronics applications. •
National	• Digital Electronics: Nationally, digital electronics is vital for the electronics industry, contributing to the design and production of integrated circuits, microprocessors, and electronic systems. National investments in research and development can lead to technological innovations and economic growth. •
Global	• Digital Electronics: Globally, digital electronics is at the heart of the information age, enabling global communication, computing, and connectivity. Global collaborations and standardizations shape the advancement and implementation of digital technologies worldwide. •
Employability	• Digital Electronics: Understanding digital electronics is essential for professionals in the electronics, computer hardware, and telecommunications industries. Skills in digital logic design, microprocessor programming, and digital system troubleshooting are highly sought after.
Entrepreneurship	• Digital Electronics: Entrepreneurs can explore opportunities in digital electronics by starting companies that develop innovative digital products, embedded systems, or IoT devices. •
Skill Development	• Digital Electronics: Skill development in digital electronics involves learning about binary systems, logic gates, digital circuit design, FPGA programming, and microcontroller applications. These skills are valuable for engineers and technologists in various industries. •
Professional Ethics	• Digital Electronics: Professionals working with digital electronics must adhere to ethical principles concerning data privacy, cybersecurity, and responsible use of digital technology. •
Gender	• Digital Electronics: Efforts to promote gender diversity and inclusion in digital electronics and related fields aim to bridge the gender gap in STEM

	professions, creating more opportunities for women in technology. •
Human Values	• Digital Electronics: Digital electronics contributes to human values by enabling efficient communication, improved healthcare through medical devices, and enhanced quality of life through various electronic innovations. •
Environment & 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:	**Course Code**	**L-T-P**	**Credits**
Basics of Electrical & Electronics Lab	**ENEE151**	0-0-2	1
Type of Course:	Major Course		

Proposed Lab Experiments

Defined Course Outcomes

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

Ex. No.	Experiment Title	Mapped CO/COs
1	To get familiar with the working knowledge of the following instruments: a) Cathode ray oscilloscope (CRO) b) Multimeter (Analog and Digital) c) Function generator d) Power supply	CO4, CO1

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

FUNDAMENTALS OF COMPUTER PROGRAMMING

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Fundamentals of Computer Programming	**ENCS101**	4-0-0	4
Type of Course:	Major Course		
Pre-requisite(s), if any: None			
Brief Syllabus: Fundamentals of Computer Science, Python Introduction, Data Types, Operators, Python data Structures, Conditional Statements, Loops in Python, Functions, OPPS Concepts, basics of Data Pre-processing, Classification and Visualization in Python			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to Computer Fundamentals**	**No. of hours: 8**	
Content Summary: Introduction to Computers and Computing, Von Neumann architecture, Central Processing Unit (CPU): ALU, control unit, registers, Memory: primary and secondary storage, cache memory, virtual memory, Input/output devices: keyboard, mouse, monitor, printer, etc., Introduction to operating systems Types of operating systems: batch processing, time-sharing, distributed, real-time, etc., Binary, decimal, and hexadecimal number systems, Bits, bytes, and data representation, Character encoding: ASCII, Unicode, Storage devices: hard disks, solid-state drives, optical storage, Introduction to algorithms and complexity analysis, Introduction to software development life cycle (SDLC) Overview of computer security, Types of threats: viruses, malware, phishing			

Ethical considerations in computer use		
Unit Number: 2	**Title: Introduction to Python programming & its Environment**	**No. of hours: 8**
Content Summary: Python Features, Local Environment Setup, Installing Python, Setting up PATH, Python Syntax, Keywords, Understanding Variables, Data Types: Scalar Types, Sequence Type, Mapping Type, Set Types, Mutable Types: List, Dictionary, Set, Immutable Types: Numbers, String, tuple, Operators: Arithmetic, Assignment, Comparison, Logical, Identity, Membership, Bitwise, Basic of String, Manipulating strings, Modify Strings, String Concatenation, Format – Strings, Escape Characters, Inbuilt method of Strings, Basic of Regular Expressions		
Unit Number: 3	**Title: Condition and Control Structures, Functions and Recursion**	**No. of hours: 8**
Content Summary: Condition: If, If. Else and nested if, Loops: For, while loops, Nested loops, Enumerate, Break, Continue Statement. Sequence and Iterable Objects, Randomization Function calls, type conversion and coercion, math functions, adding new function, parameters and argument, recursion and its use, Recursive Fibonacci, Tower of Hanoi, Lambda Functions and Anonymous Functions in Python		
Unit Number: 4	**Title: Objects and Classes**	**No. of hours: 8**
Content Summary: Basics of Object-Oriented Programming, Creating Class and Object, Constructors in Python – Parameterized and Non-parameterized, Inheritance in Python, In built class methods and attributes, Multi-Level and Multiple Inheritance, Method Overriding and Data Abstraction, Encapsulation and Polymorphism.		
Unit Number: 5	**Title: Data Pre-processing, Classification and Visualization in Python**	**No. of hours: 8**

Content Summary:

Data Preprocessing: Data cleaning - Missing Values Noisy Data, Data Cleaning as a Process, Data Integration, Data Reduction, Data transformation and Data Discretization.

Data visualization: Introduction to Matplotlib & Seaborn Libraries, basic plotting, various charts

Mini Project: Students to work on good size dataset, apply data preprocessing and cleaning, write data retrieval queries, apply various data exploration & visualization techniques.

***Self-Learning Components:**

Students are expected to gain working knowledge of various IDE like Anaconda, Pytorch, Spider etc, various components of Anaconda Navigator. Use Github, Kaggle, Google Colab etc.

**Students will demonstrate the self-learning components through classroom presentations*

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:

TEXTBOOKS:

1. John V Guttag. "Introduction to Computation and Programming Using Python", Prentice Hall of India

Reference Books

1. R. Nageswara Rao, "Core Python Programming", Dreamtech

2. Wesley J. Chun. "Core Python Programming, Second Edition", Prentice Hall

3. Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, "Data Structures and Algorithms in Python", Wiley

Web References

https://www.tutorjoes.in/python_programming_tutorial/

https://www.udemy.com/course/100-days-of-code/

https://favtutor.com/blog-details/7-Python-Projects-For-Beginners

https://github.com/NaviRocker/100-days-of-python

https://hackr.io/blog/python-projects

Define Course Outcomes (CO)

COs	Statements
CO1	Acquire an **understanding** of Computer fundamental concepts and Python programming language features, working environment
CO2	**Demonstrate** proficiency in Python syntax and effectively utilize keywords in programming.
CO3	**Analyze** and **solve** programming problems that require the use of conditional statements and looping structures
CO4	**Apply** the concepts of functions, recursion & OOPS in problem solving
CO5	Be able to **implement & demonstrate** the concepts of data Pre-processing and data visualization techniques on real datasets.
CO6	**Involve** in self-Learning & be **able to develop** mini-projects in python

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	-	P1
CO2	C1	-	P1, P2
C03	C2	-	P3
CO4	C3	-	P3
CO5	C6	-	P3
CO6	C6	-	P3

CO-PO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	Mapping
Local	All topics in the syllabus are relevant at the local level as they provide a foundational understanding of computer fundamentals & programming.
Regional	All topics in the syllabus can be applicable at the regional level, where individuals and organizations in a specific region utilize Python for various purposes.
National	All topics in the syllabus can be applicable at the national level, as Python is widely used across different industries and sectors.
Global	All topics in the syllabus can be applicable at the global level, as Python is a popular programming language used worldwide.
Employability	All topics in the syllabus, especially Python features, syntax, data types, and string manipulation, contribute to enhancing employability as Python is widely used in the job market.
Entrepreneurship	Understanding Python features, syntax, and data types can be beneficial for entrepreneurs who want to develop software solutions or build web applications.
Skill Development	All topics in the syllabus contribute to skill development in Python programming, including understanding variables, data types, operators, and string manipulation.
Professional Ethics	Professional ethics are not directly addressed in the syllabus topics but are important for ethical behaviour in any professional field.
Gender	NA
Human Values	Human values are not directly addressed in the syllabus topics but can be integrated into the teaching and learning process to emphasize the importance of ethical and responsible programming practices.

Environment & Sustainability	NA
Unit II	
Local	All topics are relevant at local level as programming problems of local nature can be solved using conditional & looping constructs in problem solving
Regional	All topics are relevant at regional level as programming problems of regional level may utilize conditional & looping constructs in problem solving
National	All topics are relevant at National level as programming problems of national level may utilize conditional & looping constructs in problem solving
Global	All topics are relevant at global level as programming problems of global level may utilize conditional & looping constructs in problem solving
Employability	Conditional & Looping structures are very useful programming tools in problem solving questions during placement drives
Entrepreneurship	Conditional & Looping structures are very useful programming tools in problem solving, any startup involving programming concepts will be useful.
Skill Development	Conditional & Looping structures are very useful programming tools in problem solving and thus skill development.
Professional Ethics	Writing programming codes/solutions will always use conditional & looping structures. There are well defined professional ethics for writing codes.
Gender	NA
Human Values	Any computational solution created with applications for humankind will always involve these programming constructs.

Environment & Sustainability	All computational solutions mapped with environment & sustainability will somehow involve these constructs at the backend.
Unit III	
Local	All topics are relevant at local level as programming solutions at local nature can always use concepts of functions & recursions in problem solving
Regional	All topics are relevant at regional level as programming solutions at regional nature can always use concepts of functions & recursions in problem solving
National	All topics are relevant at national level as programming solutions at national level can always use concepts of functions & recursions in problem solving
Global	All topics are relevant at global level as programming solutions at global nature can always use concepts of functions & recursions in problem solving
Employability	Topics are quite relevant for placements
Entrepreneurship	Working Knowledge of topics can be a advantage for entrepreneurs
Skill Development	Topics can be quite useful for skill development on Programming
Professional Ethics	Writing codes involving functions can be related to coding ethics
Gender	NA
Human Values	NA
Environment & Sustainability	Related applications may be mapped with environment and sustainability
Unit IV	
Local	Solutions involving Descriptive analytics using data visualization techniques can have a local reference.

Regional	Regional reference is possible
National	National reference is possible
Global	Global aspect is also possible
Employability	Skills attained for developing applications using pandas, data visualizations have direct mapping with employability
Entrepreneurship	Mapping of this aspect is also possible. Startup problems can be using these learning aspects
Skill Development	Topics can be quite useful for skill development on descriptive analytics
Professional Ethics	descriptive analytics is related to presenting thoughts & values in ethical manner
Gender	NA
Human Values	NA
Environment & Sustainability	Applications/problem handling based on environment & sustainability issues
SDG	All SDG goals can be touched upon through development /problem solving of related issues
NEP 2020	All indicators of NEP 2020 can be touched upon through development /problem solving of related issues
POE/4th IR	All indicators of POE & 4th IR can be touched upon through development /problem solving of related issues
UNIT V	
Local	Data Cleaning (Missing Values, Noisy Data): These techniques are applicable at the local level to improve the quality of data for local applications and analysis. Data Integration: This process can be used to combine and integrate locally collected data from multiple sources for analysis and decision-making.

Regional	Data Reduction: By reducing the dimensionality or size of the data, regional organizations can efficiently process and analyze data within their specific context.
National	Data Transformation and Data Discretization: These techniques can be applied to national datasets to transform and discretize the data for further analysis and decision-making. Mini Project: The mini project, which involves data preprocessing, exploration, and visualization, can be conducted using national datasets to address relevant national-level issues or challenges.
Global	Data Cleaning as a Process: Data cleaning is a crucial step in ensuring the quality and reliability of global datasets that are used for international research, collaborations, and decision-making
Employability	Data preprocessing, cleaning, and visualization skills are highly valuable in various industries and sectors, enhancing employability prospects.
Entrepreneurship	Data preprocessing and visualization skills are essential for entrepreneurs to gain insights from data, make data-driven decisions, and develop innovative solutions.
Skill Development	The syllabus provides an opportunity for students to develop skills in data preprocessing, data cleaning, data integration, and data visualization, which are in high demand in the current job market.
Professional Ethics	The syllabus includes aspects of data cleaning and integration, which contribute to maintaining data integrity and upholding professional ethics in data analysis and decision-making processes.
Gender	The syllabus does not specifically address gender-related aspects.
Human Values	The syllabus indirectly promotes human values by emphasizing the importance of data quality, integrity, and accuracy in decision-making processes.

Environment & Sustainability	The syllabus does not directly address environmental or sustainability aspects.
SDG	The syllabus can indirectly contribute to various SDGs, such as SDG 4 (Quality Education) by providing students with essential data processing and analysis skills.
NEP 2020	The syllabus aligns with the objectives of NEP 2020 by focusing on the development of practical skills, project-based learning, and application of data analysis techniques.
POE/4th IR	The syllabus aligns with the demands of the fourth industrial revolution by equipping students with data preprocessing, cleaning, and visualization skills that are essential for data-driven decision-making and automation.

FUNDAMENTALS OF COMPUTER PROGRAMMING LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Fundamentals of Computer Programming lab	**ENCS151**	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

CO1	**Demonstrate** the problem-solving skills using variables, basic data types, python data structures, operators, conditional statements, looping structures, functions etc.
CO 2	**Solve** real world problems involving the concepts based on OOPS
CO 3	**Solve** Real world problems using pandas, data visualization libraries in python
CO 4	**Work** on real world data sets and develop mini projects in python

Proposed Lab Experiments

S. N	Experiment	Mapped COs
1	Working with variables, operators in Python to manage inputs	CO1
2	understanding datatypes & formatting commands	CO1
3	Control Flow & Loops in Python	CO1
4	Python Data Types- List & Tuples	CO1
5	Python Data Types- Dictionary, Sets	CO1
6	Python Functions and Recursion	CO1
7	Python Object Oriented Programming: Class and Constructor	CO2
8	Python Object Oriented Programming: Inheritance, Methods Method Overriding and Data Abstraction, Encapsulation and Polymorphism	CO2
9	Handling data in Python	CO3
10	Data Visualization with various python packages	CO3
11	Mini Projects (Suggested): Project 1: Interactive Basic Calculator: Create a calculator that accepts two numbers and an operator (+,-,/,*,&,<,>,// etc) using keyboard. Depending on operator, calculator must calculate the appropriate answer. Project 2: Create a formatted student marksheet. Refer to your marksheet format. Project 3: Guess the Number game. Project 4: Dice Rolling Simulator Project 5: **Rock, Paper, Scissors Game**	CO4

	Project 6: Contact Management System: Project 7: Sudoku Solver Project 8: Bank Account Management System: Project 9: Student Management System Project 10: Library Management System: Project 11: Employee Payroll System: Projects 12: Contact Management System with Inheritance: Project 13: Banking System with Multiple Inheritance: Project 14: School Management System with Multi-Level Inheritance:	

Session 1: Working with variables, operators in Python to manage inputs

- Rules for creating variables in Python
- Comments
- Handling user inputs from keyboard using 'input' command and printing on console
- Multiple assignment
- Basics of how memory is allocated to variables in python.
- Mathematical Operators in Python: Arithmetic, Logical, shift, identity, membership, bitwise

Exercises:

1. Your first program: Say Hello
2. Calculate the multiplication and sum of tw[=o numbers
3. Print the sum of the current number and the previous number
4. Exercise on python operators & input command
5. Create a BMI calculator with Python

Project 1: Interactive Basic Calculator: Create a calculator that accepts two numbers and an operator (+,-,/,*,&,<,>,// etc) using keyboard. Depending on operator, calculator must calculate the appropriate answer

Session 2: understanding datatypes & formatting commands

- Python Primitive Data Types
- Type Error, Type Checking and Type Conversion
- Number Manipulation and Strings in Python
- Formatting numbers & strings
- Random number generation in python
-

Exercises:

1. Exercise on primitive data types
2. Exercise on number & string manipulation
3. Exercise on Type Error, Type Checking and Type Conversion
4. Exercise on random number generation in python
5. Convert Decimal number to octal using print() output formatting
6. Display float number with 2 decimal places using print()
7. Accept any three string from one input() call
8. Format variables using a string.format() method.

Project 2: Create a formatted student marksheet. Refer to your marksheet format

Session 3 & 4 : Control Flow & Loops in Python

- Control Flow with if / else and Conditional Operators
- Nested if statements and elif statements
- Multiple If Statements in Succession
- Loops in python,
- Concept of break, continue, pass statement

Exercises:

1. program which asks the user for a number. If number is even print 'Even', else print 'Odd'.
2. Program to print the largest of the three numbers
3. Program that accepts marks of a student & calculates his percentage & grade. Make suitable assumptions
4. program to print counting from 1 to 10
5. program which prints all the divisors of a number.
6. program to check if input number is a prime number
7. Write a program to print all the numbers between 1000 and 2000 which are divisible by 7 but are not a multiple of 5.
8. program to find greatest common divisor (GCD) or highest common factor (HCF) of given two numbers.
9. Write a program to calculate factorial of a number.
10. program to print multiplication table of a given number
11. Count the total number of digits in a number
12. Display numbers from -10 to -1 using for loop
13. Use else block to display a message "Done" after successful execution of for loop
14. Program to display all prime numbers within a range
15. Display all Armstrong numbers in a given range
16. Display Fibonacci series up to 10 terms
17. Calculate the cube of all numbers from 1 to a given number
18. Find the sum of the series upto n terms

19. Print the following pattern

1

1 2

1 2 3

1 2 3 4

1 2 3 4 5

20. program to use for loop to print the following reverse number pattern

5 4 3 2 1

4 3 2 1

3 2 1

2 1

1

21. Write a program to print the following start pattern using the for loop

*

* *

* * *

* * * *

* * * * *

* * * *

* * *

* *

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22. [Interactive Coding Exercise] Leap Year

23. [Interactive Coding Exercise] Pizza Order Practice

Project 3: Guess the Number game

Create a program in which the system will choose a random number between any ranges defined, and then the user is given a hint to guess the number. Every time the user guesses the number wrongly, he is given another clue leading him toward the answer. The clue can be of any type like smaller, greater, multiples, dividers, etc.

Project 4: Dice Rolling Simulator

- As the name of the program suggests, this project will be imitating a rolling dice. This python project will generate a random number each time the dice is rolled and also the user can repeat this program as long as he wants. The program is projected in such a way that when the user rolls a die, the program will generate a random number between 1 and 6.
- The program will use the in-build function to generate the random number for rolling dice. It will also ask the user if they wish to roll the dice again.

Session 5: Python Data Types- List & Tuples

- list operations and manipulations
- list & tuple functions
- list slicing
- list comprehension
- Tuples
- List VS Tuples
- List & Tuple methods
- Uses of List & Tuples

Exercises:

1. Reverse a list in Python
2. Concatenate two lists index-wise
3. Turn every item of a list into its square
4. Concatenate two lists in the following order
5. Iterate both lists simultaneously
6. Remove empty strings from the list of strings
7. Add new item to list after a specified item
8. Extend nested list by adding the sublist
9. Replace list's item with new value if found
10. Remove all occurrences of a specific item from a list.
11. Python program to get the smallest number from a list

12. Python program to count the number of strings where the string length is 2 or more and the first and last character are same from a given list of strings
13. Implement the concept of stacks & queues with lists
14. Write a Python program to remove duplicates from a list
15. Write a Python program to clone or copy a list
16. program to find the list of words that are longer than n from a given list of words
17. Program that get two lists as input and check if they have at least one common member
18. program to print a specified list after removing the 0th, 4th and 5th elements. (enumerate)
19. program to print the numbers of a specified list after removing even numbers from it
20. program to shuffle and print a specified list (shuffle)
21. program to generate all permutations of a list in Python. (itertools)
22. program to convert a list of characters into a string
23. program to find the index of an item in a specified list
24. Python program to add a list to the second list
25. program to check whether two lists are circularly identical
26. program to find the second smallest number in a list
27. program to get unique values from a list
28. program to get the frequency of the elements in a list.
29. Create a list by concatenating a given list which range goes from 1 to n
30. Program to find common items from two lists
31. Program to Extract elements with Frequency greater than K
32. program to check if the list contains three consecutive common numbers in Python
33. program to Replace all Characters of a List Except the given character
34. Program to Prefix frequency in string List
35. program to reverse All Strings in String List
36. Program to Swap elements in String list
37. Program to Retain records with N occurrences of K
38. Program to Remove Consecutive K element records
39. Copy specific elements from one tuple to a new tuple
40. Check if all items in the tuple are the same
41. Create acronyms using Python
42. Python program to find tuples which have all elements divisible by K from a list of tuples
43. Python program to find Tuples with positive elements in List of tuples
44. Python – Count tuples occurrence in list of tuples
45. Python – Removing duplicates from tuple
46. Python – Remove duplicate lists in tuples (Preserving Order)

47. Python – Cross Pairing in Tuple List
48. Python – Consecutive Kth column Difference in Tuple List
49. Python – Kth Column Product in Tuple List
50. Python – Flatten tuple of List to tuple

Project 5: Rock, Paper, Scissors Game

- We have always played rock, and paper scissors game with our playmates. But what if your playmate is not available? Then you can play rock, paper, scissors along with your computer that is designed by you. It is one of the most fun python project ideas for beginners to build their skills.

- **In this program, we will use a random function for generating the random output by the computer side. The user will make the first move and then the program makes one.** Then a function will check the validity of the move. At last, we will display the result and ask the user to play again or not.

Session 6: Python Data Types- Dictionary, Sets

- Create a dictionary
- Add Elements to a Python Dictionary
- Accessing Elements from Dictionary
- Removing elements from Dictionary
- Python Dictionary Methods
- Create a Set in Python
- Duplicate Items in a Set
- Add and Update Set Items in Python
- Add, update items
- Remove an Element from a Set
- Built-in Functions with Set

Exercises

- program to check whether a given key exists in a dictionary or not.
- program to iterate over dictionary items using for loop.
- program to print only keys & values of a dictionary.
- program in python to map 2 lists into a dictionary.
- program to remove a set of keys.
- program to sort dictionary by values (Ascending/ Descending).
- program to concatenate two dictionaries to create one.

- program to sum all the values of a dictionary.
- program to get the maximum and minimum value of dictionary.
- program to check if a dictionary is empty or not.
- program to sort dictionary values in python.
- program to check whether a key exists in the dictionary or not.
- program in python to map keys to dictionary.
- program in Python to remove repetitive items from a list.

Session 7: Python Functions and Recursion

- Learn Syntax for function calls in Python.
- Call built-in functions and user-defined functions.
- Understand the return value of a function call.
- Explicit type conversion using functions like int (), float (), str ().
- Implicit type coercion in Python operations.
- Exploring the math module in Python.
- Commonly used math functions like sqrt (), sin (), cos (), etc.
- Defining and implementing user-defined functions in Python.
- Syntax for function definition, including the function name, parameters, and return statement.
- Understanding the concept of recursion.
- Recursive function calls and their relationship with the call stack.
- Identifying base cases and recursive cases in recursive functions.
- Implementing a recursive function to calculate the Fibonacci sequence.
- Understanding the mathematical definition of the Fibonacci sequence.
- Analyzing the efficiency and limitations of the recursive solution.
- Implementing a recursive function to solve the Tower of Hanoi puzzle.
- Understanding lambda functions as anonymous functions in Python.
- Using lambda functions in conjunction with built-in functions like map (), filter (), and reduce ().

Exercises

Exercise 1: Function Calls and Type Conversion:

- Write a program that takes user input of two numbers, performs addition, and displays the result.
- Implement error handling to handle cases where non-numeric input is provided.

Exercise 2: Math Functions:

- Create a program that calculates the area of a circle using the math module's functions.

- Prompt the user for the radius and display the calculated area.

Exercise 3: Adding New Function:

- Write a program that converts temperature from Celsius to Fahrenheit and vice versa.
- Implement two separate functions for the conversion formulas and test them.

Exercise 4: Parameters and Arguments:

- Create a program that calculates the total cost of a meal, including tax and tip.
- Define a function that takes the cost of the meal, tax percentage, and tip percentage as arguments.

Exercise 5: Recursion and Fibonacci:

- Write a program that calculates the Fibonacci sequence up to a given term using recursion.
- Prompt the user for the desired term and display the Fibonacci sequence.

Exercise 6: Tower of Hanoi:

- Implement a program that solves the Tower of Hanoi puzzle using recursion.
- Prompt the user for the number of disks and display the steps required to solve the puzzle.

Exercise 7: Lambda Functions and Anonymous Functions:

- Write a program that uses lambda functions to perform basic arithmetic operations.
- Prompt the user for two numbers and allow them to choose the operation to perform.

Project 6: Contact Management System:

- Create a contact management system that allows users to add, search, update, and delete contacts.
- Implement the functionalities using functions for each operation.
- Provide options for sorting and displaying contacts using different criteria, such as name or date added.

Project 7: Sudoku Solver:

- Develop a program that can solve Sudoku puzzles using recursion.
- Write a recursive function to fill in the empty cells of the puzzle one by one, checking for valid entries at each step.
- Allow users to input the unsolved puzzle and display the solved result.

Session 8: Python Object Oriented Programming: Class and Constructor

- Understanding the fundamental concepts of OOP, such as objects, classes, encapsulation, inheritance, and polymorphism.
- Differentiating between procedural programming and OOP.
- Defining classes in Python to create blueprints for objects.
- Introducing constructors as special methods in classes.
- Implementing a non-parameterized constructor using the __init__ method.
- Implementing a parameterized constructor to initialize attributes with user-provided values.
- Defining class attributes that are shared among all instances of a class.
- Understand and implement Class Methods and Static Methods
- Implementing inheritance by defining a subclass that inherits attributes and methods from a superclass.
- Defining method overriding to provide a different implementation of a method in a subclass.
- Understanding polymorphism as the ability of objects to take on multiple forms.

Exercises

Exercise 1: Class and Object Creation

- Create a class called **Student** that represents a student's information.
- Define attributes such as name, age, and grade for the **Student** class.
- Instantiate multiple objects of the **Student** class and set their attributes.
- Display the information of each student object.

Exercise 2: Non-parameterized Constructor

- Create a class called **Rectangle** that represents a rectangle.
- Define attributes for the length and width of the rectangle.
- Implement a non-parameterized constructor in the **Rectangle** class to initialize the attributes with default values.
- Instantiate a **Rectangle** object and display its dimensions.

Exercise 3: Parameterized Constructor

- Extend the **Rectangle** class with a parameterized constructor.
- Modify the parameterized constructor to accept length and width values as parameters and initialize the attributes accordingly.
- Instantiate a **Rectangle** object by providing length and width values through the constructor.
- Display the dimensions of the rectangle object.

Exercise 4: Bank Account Class

- Create a class called **BankAccount** that represents a bank account.

- Define attributes such as account number, account holder name, and balance.
- Implement a parameterized constructor to initialize the attributes.
- Include methods to deposit and withdraw funds from the bank account.
- Instantiate a **BankAccount** object and perform deposit and withdrawal operations.
- Display the updated balance after each transaction.

Exercise 5: Employee Class

- Create a class called **Employee** to represent an employee's information.
- Define attributes such as employee ID, name, and salary.
- Implement a parameterized constructor to initialize the attributes.
- Include a method to display the employee's details.
- Instantiate multiple **Employee** objects and display their information.

Exercise 6: Vehicle Class Hierarchy

- Create a base class called **Vehicle** with attributes such as make, model, and year.
- Define a parameterized constructor in the **Vehicle** class to initialize the attributes.
- Create derived classes like **Car**, **Motorcycle**, and **Truck** that inherit from the **Vehicle** class.
- Implement constructors in the derived classes to initialize additional attributes specific to each type of vehicle.
- Instantiate objects of each derived class and display their details.

Students to do any of the following mini project

Project 8: Bank Account Management System:

- Create a bank account class with attributes such as account number, account holder name, and balance.
- Implement methods to deposit, withdraw, and display the account details.
- Use constructors to initialize the account attributes and handle different types of accounts (e.g., savings, checking).

Project 9: Student Management System:

- Develop a student class with attributes like student ID, name, and grades.
- Implement methods to calculate the average grade, display student information, and add new grades.
- Use constructors to initialize student attributes and handle student objects with different sets of grades.

Project 10: Library Management System:

- Create classes for books, authors, and library members.

- Implement methods to add books, search for books by author or title, and manage library member details.
- Use constructors to initialize book and member attributes and handle multiple book copies.

Project 11: Employee Payroll System:

- Develop an employee class with attributes like employee ID, name, salary, and designation.
- Implement methods to calculate monthly salary, display employee details, and handle promotions.
- Use constructors to initialize employee attributes and handle different employee designations.

Session 9: Python Object Oriented Programming: Inheritance, Methods Method Overriding and Data Abstraction, Encapsulation and Polymorphism.

- Understanding the fundamental concepts of OOP, such as objects, classes, encapsulation, inheritance, and polymorphism.
- Differentiating between procedural programming and OOP.
- Defining classes in Python to create blueprints for objects.
- Introducing constructors as special methods in classes.
- Implementing a non-parameterized constructor using the __init__ method.
- Implementing a parameterized constructor to initialize attributes with user-provided values.
- Defining class attributes that are shared among all instances of a class.
- Understand and implement Class Methods and Static Methods
- Implementing inheritance by defining a subclass that inherits attributes and methods from a superclass.
- Defining method overriding to provide a different implementation of a method in a subclass.
- Understanding polymorphism as the ability of objects to take on multiple forms.

Exercises

Exercise 5: Class Attributes and Methods:

- Create a class that represents a car. Include class attributes such as the number of wheels and class methods to calculate the average speed of all cars created.
- Write a program to instantiate multiple car objects and access their class attributes and methods.

Exercise 5: Parameterized Constructors:

- Build a class called "Rectangle" that has attributes for length and width.

- Implement a parameterized constructor that takes the length and width as arguments and initializes the attributes.
- Write a program to create multiple rectangle objects with different dimensions and display their properties.

Exercise 5: Multi-Level Inheritance:

- Create a base class called "Animal" with attributes and methods common to all animals.
- Derive a subclass called "Mammal" from the "Animal" class with additional attributes and methods specific to mammals.
- Further derive a subclass called "Dog" from the "Mammal" class with specific attributes and methods for dogs.
- Write a program to instantiate a dog object, access its inherited attributes and methods, and invoke the dog-specific ones.

Exercise 5: Multiple Inheritance:

- Define a base class called "Shape" with attributes and methods related to shapes.
- Create two subclasses, "Circle" and "Rectangle," that inherit from the "Shape" class.
- Implement another class called "Shape3D" that represents 3D shapes and inherits from both the "Circle" and "Rectangle" classes.
- Write a program to instantiate a 3D shape object, access attributes and methods from the multiple inherited classes, and display their properties.

Exercise 5: Method Overriding:

- Create a base class called "Vehicle" with a method called "start" that prints "Vehicle started."
- Derive a subclass called "Car" from the "Vehicle" class and override the "start" method to print "Car started."
- Derive another subclass called "Motorcycle" from the "Vehicle" class and override the "start" method to print "Motorcycle started."
- Write a program to instantiate a car and a motorcycle object and invoke their respective "start" methods.

Exercise 5: Polymorphism:

- Define a base class called "Shape" with a method called "area" that returns the area of a shape.
- Create subclasses, such as "Rectangle," "Circle," and "Triangle," that inherit from the "Shape" class and implement their own "area" methods.
- Write a program to instantiate objects of different shapes, invoke their "area" methods, and display the calculated areas.

Projects 12: Contact Management System with Inheritance:

- Build a contact management system that allows users to add, search, update, and delete contacts.
- Create a base class called "Contact" with common attributes and methods.
- Implement subclasses like "PersonContact" and "OrganizationContact" that inherit from the base class and add specific attributes and methods.
- Employee Management System with Class Methods:

- Develop an employee management system that stores and manages employee information.
- Use class methods to implement functionalities such as calculating average salary, finding the highest-paid employee, and displaying employee statistics.

Project 13: Banking System with Multiple Inheritance:

- Create a banking system that models different types of bank accounts, including savings accounts, checking accounts, and credit card accounts.
- Implement multiple inheritance by creating a base class called "BankAccount" and subclasses for each specific account type.
- Use the appropriate attributes and methods from both the base class and the subclasses to handle account transactions and balance management.

Project 14: School Management System with Multi-Level Inheritance:

- Develop a school management system that handles student, teacher, and administrative tasks.
- Implement multi-level inheritance with a base class called "Person" and subclasses like "Student," "Teacher," and "Administrator" inheriting from it.
- Define specific attributes and methods for each subclass, such as calculating student grades, managing teacher schedules, and handling administrative tasks.

Session 10: Handling data in Python

- Text file handling
- What is Python Pandas?
- Pandas Series
- Basic Operations on Series
- Pandas DataFrame
- Basic Operations on DataFrames
- Extracting data from RDBMS using SQLite

Exercises:

- Read the data in different formats like csv,excel,text file etc
- Apply data cleaning activities
- Apply queries on data to fetch relevant data using various sample data sources

- Apply join operations on multiple data sources to extract data
- Extracting data from data in RDBMS using SQLite library

Project: https://github.com/jvns/pandas-cookbook

Session 11: Data Visualization with various python packages

Learn to create various types of visualization charts with following libraries

- Matplotlib
- Seaborn
- Bokeh
- Plotly

Exercises:

1.draw a line using given axis values with suitable label in the x axis , y axis and a title.

2.draw line charts of the financial data of Alphabet Inc. between October 3, 2016 to October 7, 2016.
Sample Financial data (fdata.csv):

Date, Open, High, Low, Close
10-03-16,774.25,776.065002,769.5,772.559998
10-04-16,776.030029,778.710022,772.890015,776.429993
10-05-16,779.309998,782.070007,775.650024,776.469971
10-06-16,779,780.47998,775.539978,776.859985
10-07-16,779.659973,779.659973,770.75,775.080017

3. display the grid and draw line charts of the closing value of Alphabet Inc. between October 3, 2016 to October 7, 2016. Customized the grid lines with linestyle -, width .5. and color blue.
Date, Close
03-10-16,772.559998
04-10-16,776.429993
05-10-16,776.469971
06-10-16,776.859985
07-10-16,775.080017

4. display the grid and draw line charts of the closing value of Alphabet Inc. between October 3, 2016, to October 7, 2016. Customized the grid lines with rendering with a larger grid (major grid) and a smaller grid (minor grid).Turn on the grid but turn off ticks

5. Write a Python program to create multiple plots.

Consider following data in csv format:

Exercise 1: Read Total profit of all months and show it using a line plot

Exercise 2: Get total profit of all months and show line plot with the following Style properties

Exercise 3: Read all product sales data and show it using a multiline plot

Exercise 4: Read toothpaste sales data of each month and show it using a scatter plot

Exercise 5: Read face cream and facewash product sales data and show it using the bar chart

Exercise 6: Read sales data of bathing soap of all months and show it using a bar chart. Save this plot to your hard disk

Exercise 7: Read the total profit of each month and show it using the histogram to see the most common profit ranges

Exercise 8: Calculate total sale data for last year for each product and show it using a Pie chart

Exercise 9: Read Bathing soap facewash of all months and display it using the Subplot

Exercise 10: Read all product sales data and show it using the stack plot

Project: https://github.com/CICIFLY/Data-Analytics-Projects

Self-Learning Components
• Students are required to demonstrate their self • learning components by developing a mini project

List of Suggested projects for students

Project: Random password generator
Create a program that takes a number and generate a random password length of that number. Topics: random module, joining strings, taking input Hint: *Create a string with all characters, then take random characters from it and concatenate each char to make a big string.*
Project: Tic-Tac-Toe
• We all have interesting memories of playing tic-tac-toe with our friends, don't we? This is the most fun and interesting game to play anywhere, all you need is a pen and paper. • create a 3x3 grid just like the traditional method. Then we will ask the user to put 'X' at any of the grid and respond accordingly by placing 'O' in the remaining places. Also, we will try to put 'O' in the program to create the vertical, horizontal, or diagonal lines as because whoever does that first will win the game and the message will be displayed.
Project: Number Guessing
The number-guessing game is a simple game where one player thinks of a number and the other player tries to guess the number. The player who is thinking of the number will provide hints to the other player, such as whether the guess is too high or too low, to help them narrow down the possibilities and eventually guess the correct number.
Project: Password Strength Checker
A password strength generator is a program that helps users create strong and secure passwords. **This type of program typically uses algorithms to evaluate the strength of a given password and provide feedback to the**

user on how to improve it. The program may also be able to generate a strong password for the user automatically.

Strong passwords are important for protecting online accounts from hackers and other malicious actors. A good password should be at least 8 characters long and include a mix of uppercase and lowercase letters, numbers, and special characters. Using a password strength generator can help ensure that your password is strong and secure.

Project: Hangman Game

- It is always fun to build a game using python programming. This project involves the same. Hangman Game or more like a "guess the word" game is the best program for good interactive learning.
- Here, the user will have to guess an alphabet to complete a word, and also each user will have a limited number of chances to guess a letter. The programmer can create the preorganized list of words to be finished and then include a specific function to check whether the user has guessed the correct letter if yes then include that letter to word for finishing the default word and if the guesswork is not true then reducing the count of chances to guess further.
- While developing this python project you will learn the core concepts like variables, characters, strings, lists, conditional statements, loops, and functions. Also, the concept of the counter variable is used to limit the number of guesses.

Project: Password Strength Checker

- A password strength generator is a program that helps users create strong and secure passwords. **This type of program typically uses algorithms to evaluate the strength of a given password and provide feedback to the user on how to improve it.** The program may also be able to generate a strong password for the user automatically.
- Strong passwords are important for protecting online accounts from hackers and other malicious actors. A good password should be at least 8 characters long and include a mix of uppercase and lowercase letters, numbers, and special characters. Using a password strength generator can help ensure that your password is strong and secure.

Project: Mad Libs Generator
Mad Libs is a word game where players supply words to fill in blanks in a story or sentence, typically with funny or amusing results. A Mad Libs generator is a tool that can be used to automatically create Mad Libs stories. To use a Mad Libs generator, the user typically inputs various types of words, such as nouns, verbs, and adjectives, and the generator will use these words to fill in the blanks in a pre-written story or sentence. The resulting Mad Libs story will often be humorous and nonsensical.
Project: Snake Game
The snake game is a classic arcade game where the player controls a snake that moves around the screen, trying to eat food while avoiding obstacles and its own tail. The snake grows in length each time it eats food, making it more difficult to navigate and maneuver. The objective of the game is to score as many points as possible by eating as much food as possible without crashing into an obstacle or the snake's own tail.
Project: Calculator Application:
• Build a calculator application that supports basic mathematical operations using functions. • Implement error handling for invalid input and division by zero. • Enhance the calculator by adding more advanced operations such as exponentiation and square root using math functions.
Project: Recursive File Search:
• Write a program that recursively searches a directory and its subdirectories for files with a specific extension. • Implement the recursive file search using a function that calls itself. • Allow the user to input the directory path and extension to search for.
Project: Recursive Drawing:
• Create a program that uses recursion to draw geometric patterns. • Write functions to draw shapes such as squares, circles, and triangles, with varying sizes and positions. • Implement recursion to generate more complex patterns by recursively calling the drawing functions.
Project: Text Adventure Game:
• Design and build a text-based adventure game using functions for different game actions and interactions. • Implement recursion to allow for nested scenarios or choices within the game. • Include multiple storylines, character interactions, and branching paths based on user decisions.

Project: Recursive Image Processing:
• Develop a program that applies recursive algorithms for image processing tasks, such as blurring or edge detection. • Implement recursive functions to traverse the image pixels and modify their values based on neighboring pixels. • Allow users to input an image file and display the processed result.
Project: Maze Solver:
• Build a program that solves a maze using recursion. • Create a function that recursively explores the possible paths in the maze until the exit is found. • Visualize the maze solving process by displaying the steps taken to navigate through the maze.

References

https://www.tutorjoes.in/python_programming_tutorial/

https://www.udemy.com/course/100-days-of-code/

https://favtutor.com/blog-details/7-Python-Projects-For-Beginners

https://github.com/NaviRocker/100-days-of-python

https://hackr.io/blog/python-projects

Semester: 2

LINEAR ALGEBRA AND ORDINARY DIFFERENTIAL EQUATIONS

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Linear Algebra and Ordinary Differential Equations	**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.

Define 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

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	-	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	-

OBJECT ORIENTED PROGRAMMING USING C++

Department:	**Department of Computer Science and Engineering**		
Course Name: **Object Oriented Programming using C++**	**Course Code**	**L-T-P**	**Credits**
	ENCS102	4-0-0	4
Type of Course:	Major		
Pre-requisite(s), if any: Basics of C programming			
Brief Syllabus: The objective of this course is to introduce object-oriented programming. To explore and implement the various features of OOP such as inheritance, polymorphism, Exceptional handling using programming language C++. After completing this course student can easily identify the basic difference between the programming approaches like procedural and object oriented.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction**		**No. of hours: 10**
Content Summary: Procedure Oriented and Object-Oriented Approach. Basic Concepts: Objects, classes, Principals like Abstraction, Encapsulation, Inheritance and Polymorphism. Dynamic Binding, Message Passing. Characteristics of Object-Oriented Languages, Functions, Returning values from functions. Reference arguments, Data Types			
Unit Number: 2	**Title: CLASSES AND OBJECTS**		**No. of hours: 10**

Content Summary:

Abstract data types, Object & classes, attributes, methods, C++ class declaration, Local Class and Global Class, State identity and behaviour of an object, Local Object and Global Object, Scope resolution operator, Friend Functions, Inline functions, Constructors and destructors, instantiation of objects, Types of Constructors, Static Class Data, Array of Objects, Constant member functions and Objects, Memory management Operators.

Unit Number: 3	**Title: INHERITANCE & POLYMORPHISM**	**No. of hours: 10**

Content Summary:

Inheritance, Types of Inheritance, access modes – public, private & protected, Abstract Classes, Ambiguity resolution using scope resolution operator and Virtual base class, Aggregation, composition vs classification hierarchies, Overriding inheritance methods, Constructors in derived classes, Nesting of Classes

Polymorphism, Type of Polymorphism – Compile time and runtime, Function Overloading, Operator Overloading (Unary and Binary) Polymorphism by parameter, Pointer to objects, this pointer, Virtual Functions, pure virtual functions.

Unit Number: 4	**Title: STRINGS, FILES AND EXCEPTION HANDLING**	**No. of hours: 10**

Content Summary:

Manipulating strings, Streams and files handling, formatted and Unformatted Input output. Exception handling, Generic Programming – function template, class Template Standard Template Library: Standard Template Library.

***Self-Learning Components:**

Students should explore Platforms like LeetCode, HackerRank for C++.

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

1. Introduction to C++" and "C++ Programming for C Programmers" offered by edX
2. "C++ Programming for Beginners," and "Learn Advanced C++ Programming." offered by Udemy

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. Balagurusamy ,"Object Oriented Programming with C++", Mc Graw Hill,6th Edition,2013.
2. Schildt Herbert, "C++: The Complete Reference", Wiley DreamTech, 2005.Parasons, "Object Oriented Programming with C++", BPB Publication, 1999.
3. Steven C. Lawlor, "The Art of Programming Computer Science with C++", Vikas Publication, 2002.
4. Yashwant Kanethkar, "Object Oriented Programming using C++", BPB, 2004

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** object-oriented programming concepts.
CO2	**Applying t**he concepts of object-oriented paradigm (Classes, Objects, inheritance, polymorphism etc.) for designing solution of a given programming problem
CO3	**Developing** applications that can manipulate data stored in files
CO4	**Developing** applications by considering all possible scenarios thereby employing appropriate exception handling.

COs Mapping with Levels of Bloom's taxonomy

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

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	3	-	3	-	-	-	2	2	1	2
CO2	1	-	3	-	3	-	-	-	2	2	1	2
CO3	1	-	3	2	3	-	2	-	2	3	1	2
CO4	1	-	3	2	3	-	2	-	2	3	1	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
Local	-
Regional	-
National	-
Global	Aligns with global trends in programming languages
Employability	Proficiency in procedure-oriented and object-oriented approaches is highly valued by employers in the software development industry.
Entrepreneurship	Entrepreneurs in the software industry can benefit greatly from understanding procedure-oriented and object-oriented approaches
Skill Development	Develops skills in Visual Code using C++
Professional Ethics	-
Gender	These concepts are equally applicable and accessible to individuals of all genders pursuing careers in software development.
Human Values	-
Environment & Sustainability	-
Unit II	CLASSES AND OBJECTS
Local	Understanding abstract data types, object and classes, and other concepts covered in the course can be valuable at the local level for developing software solutions tailored to meet the specific needs of local communities or organizations.
Regional	The concepts covered, such as abstract data types and classes, can have regional relevance by enabling the development of software systems that address the

	requirements and preferences of a specific region or geographic area.
National	It contributes to the development of software infrastructure, applications, and systems that support national industries, governance, and public services.
Global	These concepts are widely used across countries and industries, facilitating collaboration and interoperability on a global scale.
Employability	These skills are highly sought after by employers, as they form the foundation for building robust and scalable software solutions.
Entrepreneurship	These concepts enable them to design innovative and scalable software products, laying the groundwork for successful ventures.
Skill Development	These skills include critical thinking, problem-solving, and designing modular and reusable software components.
Professional Ethics	promotes ethical practices by emphasizing proper design and encapsulation principles, which lead to well-structured and maintainable code.
Gender	Both men and women can equally benefit from and contribute to the field of software development, utilizing these concepts.
Human Values	promotes human values by fostering efficient and user-friendly software development practices, which can contribute to providing value to users and stakeholders.
Environment & Sustainability	promoting efficient and optimized software design, it indirectly contributes to reducing energy consumption and supporting environmental sustainability efforts.
Unit III	**INHERITANCE & POLYMORPHISM**
Local	Understanding abstract data types, object and classes, and other concepts covered in the course can be valuable at the local level for developing software solutions tailored to meet the specific needs of local communities or organizations.

Regional	The concepts covered, such as abstract data types and classes, can have regional relevance by enabling the development of software systems that address the requirements and preferences of a specific region or geographic area.
National	It contributes to the development of software infrastructure, applications, and systems that support national industries, governance, and public services.
Global	These concepts are widely used across countries and industries, facilitating collaboration and interoperability on a global scale.
Employability	These skills are highly sought after by employers, as they form the foundation for building robust and scalable software solutions.
Entrepreneurship	
Skill Development	These skills include critical thinking, problem-solving, and designing modular and reusable software components.
Professional Ethics	promotes ethical practices by emphasizing proper design and encapsulation principles, which lead to well-structured and maintainable code.
Gender	Both men and women can equally benefit from and contribute to the field of software development, utilizing these concepts.
Human Values	promotes human values by fostering efficient and user-friendly software development practices, which can contribute to providing value to users and stakeholders.
Environment & Sustainability	promoting efficient and optimized software design, it indirectly contributes to reducing energy consumption and supporting environmental sustainability efforts.
Unit IV	**STRINGS, FILES AND EXCEPTION HANDLING**
Local	
Regional	
National	

Global	
Employability	These skills are highly sought after by employers, as they form the foundation for building robust and scalable software solutions.
Entrepreneurship	
Skill Development	These skills include critical thinking, problem-solving, and designing modular and reusable software components.
Professional Ethics	promotes ethical practices by emphasizing proper design and encapsulation principles, which lead to well-structured and maintainable code.
Gender	Both men and women can equally benefit from and contribute to the field of software development, utilizing these concepts.
Human Values	promotes human values by fostering efficient and user-friendly software development practices, which can contribute to providing value to users and stakeholders.
Environment & Sustainability	promoting efficient and optimized software design, it indirectly contributes to reducing energy consumption and supporting environmental sustainability efforts.
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of Design, Efficiency ,Problem Solving, Abstraction and System Analysis

OBJECT ORIENTED PROGRAMMING USING C++ LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Object Oriented Programming using C++ Lab	**ENCS152**	0-0-2	1
Type of Course:	Major		
Pre-requisite(s), if any: Basics of C programming			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Demonstrate** class object concepts by using C++.
CO 2	**Develop** programs using inheritance and polymorphism.
CO 3	**Demonstrate** the significance of constructors and destructor.
CO 4	**Construct** generic classes using template concepts.
CO5	**Implement** the concept of file handling.

Ex. No	Experiment Title	Mapped CO/COs
1	Write a program for Functions with default arguments	CO 1
2	Simple Classes for understanding objects, member functions and Constructors. i. Classes with primitive data members	CO 1
3	Write a program for Classes with constant data members, Classes with static member functions	CO 1
4	Write a program for Classes with pointers as data members – String Class	CO 1
5	Write a program for Classes with arrays as data members	CO 1
6	Implementation of Call by Value, Call by Address and Call by Reference	CO 1
7	Write a Program to illustrate New and Delete Keywords for dynamic memory allocation	CO 1
8	Write a Program Containing a Possible Exception. Use a Try Block to Throw it and a Catch Block to Handle it Properly.	CO 1
9	Project 1: interactive Basic Calculator: Create a calculator that accepts two numbers and an operator (+,-,/,*,&,<,>,// etc) using keyboard. Depending on operator, calculator must calculate the appropriate answer	CO 1
10	Write a Program to Demonstrate the Catching of All Exceptions.	CO 1, CO 2, CO 3, CO 4, CO 5
11	Write a program fir passing object as argument to a function with help of a program to add marks of two students in two different subjects respectively. Marks of first student in "sub1" should be added with marks of	CO 1

	second student in "sub1" and respectively for marks of "sub2" added for both students and then displayed.	
12	Write a program to illustrate the concept of one class with two objects by taking student data.	CO 1, CO 3
13	Write a program to show the relationship of class and object to display roll no., grade and fee paid by student.	CO 1, CO 3
14	Write a program to define the member function outside and inside the class.	CO 1, CO 3
15	Write a program to read and display the information of N persons to illustrate the concept of array of objects.	CO 1, CO 3
16	Write a program to add two numbers to illustrate the use of friend function.	CO 1, CO 3
17	Write a program to assign and copy values to illustrate the concept of parametrized and copy constructor.	CO 1, CO 3
18	Write a program to show the order of constructor and destructor.	CO 1, CO 3
19	Write a program to add two numbers using binary operator overloading.	CO 1, CO 3
20	Write a program to illustrate the assignment operator overloading.	CO 1, CO 3, CO 4
21	Sample Programs using inheritance in and accessing objects of different derived classes. (a) Write a program to compute the marks explaining the concept of multiple inheritance.	CO 1, CO 3, CO 4
22	Write a program to find the factorial of a number using inheritance	CO 2
23	Sample Programs using polymorphism and virtual functions (using pointers) (a) Write a program to find the volume of cylinder and cuboid using function overloading.	CO 2

	(b) Write a program to reverse a string using pointers.	
24	Write a program to explain the relationship of inheritance and virtual function.	CO 2
25	Write a program to read the student's name and fee paid using read () function from the file.	CO 2, CO 5
26	Write a Program to read and write data to and from a file.	CO 2, CO 5
27	Write a C++ program that uses function templates to find the largest and smallest number in a list of integers and to sort a list of numbers in ascending order.	CO 4
28	Project2: Create Tic Tac Toe game using C++ concepts	CO 1, CO 2, CO 3, CO 4, CO 5
29	Project 3: Quiz Game: Design a quiz game program where users can answer multiple-choice questions from various topics. The program should keep track of the score and provide feedback on the user's performance.	CO 1, CO 2, CO 3, CO 5

ENGINEERING CHEMISTRY

Department:	**Department of Computer Science and Engineering**		
Course Name: **ENGINEERING CHEMISTRY**	**Course Code**	**L-T-P**	**Credits**
	ENCH101	4-0-0	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

ENGINEERING DRAWING & WORKSHOP LAB

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

Proposed Lab Experiments

Defined Course Outcomes

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

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

15	To make saw - cut filling V-cut taper at the corners, circular cut in fitting shop.	CO4

Semester: 3

JAVA PROGRAMMING

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

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.

DEFINE COURSE OUTCOMES (CO)

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

COs MAPPING WITH LEVELS OF BLOOM'S TAXONOMY

CO	COGNITIVE LEVELS© 1. KNOWLEDGE 2. UNDERSTAND 3. APPLY 4. ANALYZE 5. EVALUATE 6. CREATE	AFFECTIVE LEVELS(A) 1. RECEIVING 2. RESPONDING 3. VALUING 4. ORGANIZING 5. CHARACTERIZING	PSYCHOMOTOR LEVELS(P) 1. IMITATION 2. MANIPULATION 3. PRECISION 4. ARTICULATION 5. IMPROVING
CO1	C2	A1	P1
C02	C3	A2	P2
CO3	C3	A5	P5
CO4	C6	A5	P5

CO-PO MAPPING

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

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

CO-PSO MAPPING

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

RELEVANCE OF THE SYLLABUS TO VARIOUS INDICATORS

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

REGIONAL	-
NATIONAL	It contributes to the development of software infrastructure, applications, and systems that support national industries, governance, and public services.
GLOBAL	Java is widely used worldwide, and the skills gained from the course have global relevance in software development.
EMPLOYABILITY	Understanding object-oriented programming and java is valuable in the job market, as many industries and organizations rely on java for software development.
ENTREPRENEURSHIP	Contribute to entrepreneurship by providing individuals with the skills and knowledge needed to develop software applications or start a technology-related business
SKILL DEVELOPMENT	Contributes to skill development, particularly in programming, object-oriented design, and java development
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 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

JAVA PROGRAMMING LAB

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

PROPOSED LAB EXPERIMENTS

DEFINED COURSE OUTCOMES

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

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

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

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

DISCRETE MATHEMATICS

Department:	**Department of Computer Science and Engineering**		
Course Name: **Discrete Mathematics**	**Course Code**	**L-T-P**	**Credits**
	ENCS203	3-1-0	4
Type of Course:	Major		
Pre-requisite(s), if any: Basic of Mathematics			
Brief Syllabus: This course will discuss fundamental concepts and tools in discrete mathematics with emphasis on their applications to computer science. Topics include logic and Boolean circuits, sets, functions, relations, deterministic algorithms and randomized algorithms, analysis techniques based on counting methods and recurrence relations, trees and graphs etc.			
UNIT WISE DETAILS			
Unit Number: 1	**Propositional Logics & Relations**	**No. of hours: 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

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** foundational concepts: Gain a solid understanding of fundamental concepts in discrete mathematics, including logic, sets, relations, and functions
CO2	**Express** proficiency in logical reasoning and constructing mathematical proofs using various proof techniques such as direct proofs, proof by contradiction, and mathematical induction.
CO3	**Determine** methods to Explore various discrete structures, such as sets, sequences, functions, relations, and formal languages. Understand the properties and applications of these structures.

CO4	**Identify** and develop problem-solving skills by applying discrete mathematics concepts to solve mathematical problems and real-world scenarios. Enhance logical thinking and analytical reasoning abilities.
CO5	**Articulate** real-world applications of discrete mathematics in computer science, cryptography, network analysis, optimization problems, scheduling, and decision-making.

COs Mapping with Levels of Bloom's taxonomy

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

CO-PO Mapping

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

1=weakly mapped
2= moderately mapped

3=strongly mapped

CO-PSO Mapping

PO	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: **Data Structure**	**Course Code**	**L-T-P**	**Credits**
	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.

Define Course Outcomes (CO)

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

COs Mapping with Levels of Bloom's taxonomy

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

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

Justification for mapping must be relevant

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

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

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

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

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

DATA STRUCTURES LAB

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

Proposed Lab Experiments

Defined Course Outcomes

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

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

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

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

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

LIFE SKILLS FOR PROFESSIONALS-I

Department:	**Department of Computer Science and Engineering**		
Course Name: **Life Skills for Professionals - I**	**Course Code** **AEC011**	**L-T-P** 3-0-0	**Credits** 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:

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

Define Course Outcomes (CO)

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

COs Mapping with Levels of Bloom's taxonomy

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

CO5	C6	-	P5

CO-PO Mapping

CO	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

Justification for mapping must be relevant.

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

CO-PSO Mapping

CO	PSO1	PSO2	PSO3	PSO4
CO 1	3	-	1	-
CO 2	3	1	-	-
CO 3	1	1	-	-
CO 4	2	2	3	-
CO 5	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 Development	Develops Skills in public speaking, interpersonal communication, professional writing, and persuasive communication.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Non-Verbal Communication**
Local	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Regional	Practice attentive listening techniques, such as paraphrasing and asking clarifying questions.
National	Attentively listen to others, understand their perspectives, and respond appropriately while exhibiting techniques such as maintaining eye contact, asking clarifying questions, and paraphrasing.

Global	Aligns with global trends in employment
Employability	Develop skills in participating and contributing to group discussions, meetings, or presentations.
Entrepreneurship	Learn to share ideas, listen to others, build consensus, and manage conflicts to achieve common goals in collaborative settings.
Skill Development	Apply skills in real-life situations, such as academic exams, job interviews, and problem-solving scenarios.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Number system
Local	Improve number sense, enhance basic arithmetic skills and strengthen mental math abilities and speed.
Regional	-
National	Learn about number systems, ratios, proportions, and percentages
Global	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Employability	Develop skills in participating and contributing to group discussions, meetings, or presentations.
Entrepreneurship	-
Skill Development	Recognize the importance of continuous learning and practice to maintain and further develop mental ability.
Professional Ethics	-

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

Summer Internship / Project-I

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

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

The following options can be opted by the students:

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

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

Report Submission and Evaluation Guidelines:

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

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

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

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

Course Outcomes:

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

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

FUNDAMENTALS OF AI & MACHINE LEARNING

Department:	**Department of Computer Science and Engineering**		
Course Name: Fundamentals of AI & Machine Learning	**Course Code**	**L-T-P**	**Credits**
	SEC034	2-0-0	2
Type of Course:	SEC		
Pre-requisite(s), if any:			
Brief Syllabus: The objective of this course is to provide rigorous training on the fundamental concepts, algorithms, and theories in artificial intelligence and machine learning. The lectures will cover various supervised and unsupervised learning algorithms that will help students to design and develop AI systems to solve real-world problems.			
Unit Number: 1	**Title: Introduction to Artificial Intelligence and Performance Metrics**		**No. of hours: 05**
Content Summary: **Designing a learning system**, Types of machine learning: Problem based learning, Supervised learning, Unsupervised learning, Reinforcement learning. **Linear Regression**: Weights and Features, Applications, Cost Functions, finding best fit line, Gradient Descent Algorithm: Learning Algorithm, First order derivatives, Linear regression using gradient descent, Learning rate, Logistic Regression, Sigmoid Function, Cost Function for Logistic Regression, Multi-class classification, Probability Distribution, SoftMax Function, Polynomial Regression. **Performance Metrics**: Classification (Confusion Matrix, Accuracy, Precision, Recall, F1-score, ROC-AUC), Regression (MSE, MAE, RMSE, R2 Score).			
Unit Number: 2	**Title: Supervised Learning**		**No. of hours: 05**

Content Summary:

Decision Tree, Selecting Best Splitting Attribute, CART (Gini Index). ID3 (Entropy, Information Gain), Hyperparameters in Decision tree, Issues in Decision tree learning. Overfitting and Underfitting, Bias and Variance, Cross Validation. Ensemble Learning (Concord's Theorem), Bagging, Bootstrap and Aggregation, Random Forest. Boosting, AdaBoost, Gradient Boost. Feature Engineering, Feature Selection, Feature Extraction.

Artificial Neural Network, Neural network representation, Perceptron model, Stepwise v/s Sigmoid function, Multilayer perceptron model, Matrix Calculus (Jacobian, Hessian Matrix), Computation Graph, Backpropagation Algorithm, Activation Functions, Stochastic Gradient Descent, Batch Gradient Descent, Mini-Batch Gradient Descent, Vanishing and Exploding Gradients, Overfitting Problem, Regularization (Ridge, Lasso, Elastic), Dropout and Early Stopping, Bayesian Learning: Bayes theorem and concept learning, Naïve Bayes classifier, Gibbs Algorithm, Bayesian belief networks, The EM algorithm, Support Vector Machines, Hyperplane, Support Vectors, Kernels, Non-Parametric Regression, Locally weighted regression, K-nearest neighbour.

Unit Number: 3	**Title: Unsupervised Learning**	**No. of hours: 05**

Content Summary:

Unsupervised learning (clustering, Association rule learning, Dimensionality reduction), Common distance Measures, k-means clustering, Elbow method, Hierarchical Clustering – agglomerative and divisive, Dendogram, Similarity measures for hierarchical clustering, DBSCAN, Cluster Quality (R index, Silhouette Coefficient), Dimensionality Reduction, Principal Component Analysis, Singular Vector Decomposition, T-distributed Stochastic Neighbour Embedding.

Unit Number: 4	**Title: Evolutionary Algorithms and Deep Learning**	**No. of hours: 05**

Content Summary:

Population Based Algorithms: Genetic Algorithm, Fitness Function, Selection, Crossover, Mutation, Swarm Optimization, Particle Swarm Optimization, Ant-Colony Optimization, Reinforcement Learning, Actors, State, Reward Policy, Actions, Computer Vision, Convolutional Neural Networks, Deep Learning for Sequential Data, Recurrent Neural Network, LSTM, GRU, Natural Language Processing, Word

Embeddings, Transformers (BERT and GPT), Building and Deploying ML models (MLFlow), MLOps, Need of MLOps, ML Production Infrastructure.
***SELF-LEARNING COMPONENTS:** https://onlinecourses.nptel.ac.in/noc23_cs18/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. T. M. Mitchell, Machine Learning (1 ed.), McGraw Hill, 2017. ISBN 978-1259096952. **2.** E. Alpaydin, Introduction to Machine Learning (4 ed.), Phi, 2020. ISBN 978-8120350786

Define Course Outcomes (CO)

COs	**Statements**
CO1	**Define** the fundamental concepts and principles of artificial intelligence (AI) and machine learning (ML).
CO2	**Apply** supervised learning algorithms such as linear regression, logistic regression, decision trees, and support vector machines.
CO3	**Analyze** the strengths and limitations of different ML algorithms and approaches.
CO4	**Design** and **develop** ML pipelines for solving real-world problems.

COs Mapping with Levels of Bloom's taxonomy

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

CO-PO Mapping

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

Justification for mapping must be relevant.

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	**Designing a learning system, Regression and Performance Metrics**
Local	-
Regional	-
National	-
Global	Machine learning has a global impact as it underpins advancements in various domains, including healthcare, climate modeling, financial markets, and social media. The ability to design learning systems and apply machine learning algorithms contributes to global innovation, collaboration, and the development of intelligent systems that benefit people worldwide.
Employability	Acquiring knowledge and skills in machine learning enhances employability prospects in the rapidly growing field of data science. Proficiency in designing learning systems, implementing machine learning algorithms, and understanding performance metrics makes individuals valuable assets to organizations seeking data-driven solutions, leading to increased employability opportunities.
Entrepreneurship	Machine learning offers opportunities for entrepreneurship by enabling the development of innovative products and services.
Skill Development	Studying machine learning develops essential skills such as problem-solving, data analysis, programming, and critical thinking. These skills are valuable in various professional domains beyond machine learning itself and contribute to

	overall skill development in areas such as data science, artificial intelligence, and decision-making.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Decision Tree and Artificial Neural Network**
Local	-
Regional	-
National	-
Global	Decision trees and machine learning algorithms are extensively used in diverse fields such as finance, marketing, climate modeling, and social sciences.
Employability	Acquiring knowledge and skills in decision trees, machine learning, and related algorithms enhances employability prospects in fields such as data analysis, artificial intelligence, and data science.
Entrepreneurship	Entrepreneurs can leverage their understanding of decision trees and machine learning algorithms to develop innovative products and services.
Skill Development	Studying decision trees, ensemble learning, neural networks, and other machine learning techniques develops critical thinking, problem-solving, and data analysis skills.
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit III	**Unsupervised learning**
Local	-
Regional	-
National	-
Global	In the global context, unsupervised learning techniques contribute to the analysis and understanding of large-scale global datasets. Global industries, research organizations, and international collaborations can leverage clustering and dimensionality reduction to identify global trends, patterns, and similarities.
Employability	Proficiency in unsupervised learning, clustering, and dimensionality reduction enhances employability prospects in data analysis, machine learning, and data science roles.
Entrepreneurship	Entrepreneurs can leverage unsupervised learning techniques to identify market segments, customer preferences, and emerging trends.
Skill Development	The study of unsupervised learning, clustering, and dimensionality reduction develops critical thinking, problem-solving, and data analysis skills.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Population Based Algorithms**
Local	-
Regional	-
National	-

Global	The application of population-based algorithms extends to global challenges, such as climate modeling, disaster management, and global supply chain optimization.
Employability	Proficiency in population-based algorithms enhances employability prospects, particularly in fields related to optimization, data science, and artificial intelligence.
Entrepreneurship	Entrepreneurs can leverage population-based algorithms to develop innovative solutions and optimization-driven businesses. By understanding these algorithms, entrepreneurs can identify opportunities for optimization in various domains, create products or services based on population-based algorithms, and contribute to entrepreneurship in the digital era.
Skill Development	Studying population-based algorithms develops critical thinking, problem-solving, and algorithmic design skills.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 9, 11
NEP 2020	Integration of Emerging Technologies, Skill Development and Multidisciplinary Approach
POE/4th IR	Advanced Optimization, Data-driven Systems and Technological Disruption

Semester: 4

PROBABILITY AND STATISTICS

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Probability and Statistics	**ENMA202**	3-1-0	4
Type of Course:	Major		

Pre-requisite(s), if any: Basics of Probability and Statistics

Brief Syllabus:

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

UNIT WISE DETAILS

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

Content Summary:

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

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

Content Summary:

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

Unit Number: 3	Title: Basic Statistics	No. of hours: 8

Content Summary:

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

Unit Number: 4	Title: Applied Statistics	No. of hours: 8

Content Summary:

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

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

Content Summary:

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

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

***Self-Learning Components:**

- **Probability Simulation**: Students can explore and practice probability concepts through simulations using tools like Python's NumPy library or R programming language. https://pll.harvard.edu/course/data-science-probability

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

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

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

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

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

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

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

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

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

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

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

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

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. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall.
2. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India.
3. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, Wiley.
4. D. C. Montgomery and G. C. Runger, Applied Statistics and Probability for Engineers, Wiley.
5. J. L. Devore, Probability and Statistics for Engineering and the Sciences, Cengage Learning.

Define Course Outcomes (CO)

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

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 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	-	-	-
C02	-	-	-
CO3	-	A4	-
CO4	C4	A4	P4
CO5	C5	A5	P5

CO-PO Mapping

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

Justification for mapping must be relevant.

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	Basic Probability
Local	Addresses local understanding probability of events in online activities
Regional	-
National	Contributes to national digital literacy (probability concepts are fundamental to understanding data and making informed decisions in the digital realm).
Global	Aligned with global trends in probability concepts apply universally in analyzing and predicting outcomes.
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Some special Probability Distributions

Local	Addresses local understanding probability distributions can be applied to analyze and model various online phenomena.
Regional	
National	Contributes to national digital literacy probability distributions that play a role in understanding and analyzing data in the digital landscape.
Global	Aligns with global trends probability distributions which are applicable in analyzing data worldwide.
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Basic Statistics
Local	-
Regional	-
National	Contributes to national network security strategies and protocols (understanding statistical measures helps in analyzing and evaluating network security).
Global	Aligns with global trends in network security techniques and protocols (statistical analysis is essential in assessing and improving network security worldwide).
Employability	-
Entrepreneurship	-

Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Applied Statistics
Local	Addresses local understanding and implementation of statistics applied in analyzing and optimizing internet-based services.
Regional	-
National	Contributes to national statistics aids in analyzing and enhancing digital communication.
Global	Aligns with global trends in applied statistics which is relevant in analyzing and improving global digital services).
Employability	Develops skills in knowledge of applied statistics supports data analysis and optimization in these areas.
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4 (Quality Education)

NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO (the syllabus content covers relevant topics in these areas).

WEB PROGRAMMING WITH PYTHON AND JAVASCRIPT LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **Web programming with Python and JavaScript lab**	**Course Code**	**L-T-P**	**Credits**
	SEC035	0-0-4	2
Type of Course:	SEC		
Pre-requisite(s), if any: - Python, Java			

Proposed Lab Experiments

Defined Course Outcomes

CO 1	To design simple webpages using HTML and CSS.
CO 2	To use GIT and GIT HUB for project management.
CO 3	To apply Django web framework to create websites.
CO 4	To create interactive and responsive website using JavaScript.
CO 5	To test and deploy application web applications.

Ex. No	Experiment Title	Mapped CO/COs
1	Implement User Registration and Login form using JavaScript.	CO1
2	Designing a Responsive Navigation Bar with CSS	CO1
3	CSS: Inline Style, Internal Style ,and External Style Sheets	CO1
4	Developing a Real-time Chat Application with Flask and WebSocket	CO1
5	Building an Interactive To-Do List Using JavaScript and Flask.	CO1
6	Validating User Inputs in HTML Forms.	CO1
7	Dynamically Modifying HTML Elements and Content.	CO2

8	Designing an e-commerce website with product listings, shopping cart, and secure payments.	CO2
9	Integrate charting libraries (e.g., Chart.js) to visualize data from your Flask app.	CO3
10	Build a simple video streaming application where users can upload and view videos.	C03
11	Design a responsive navigation bar using HTML and CSS.	CO2
12	Implement a JavaScript function to change the background color of a button on hover.	Co3
13	Build a form with validation using HTML5 attributes.	CO1
14	Create a JavaScript countdown timer that triggers an event when the timer reaches zero.	CO2
15	Use JavaScript to dynamically add elements to the DOM.	CO3
16	Implement a feature to hide and show content on button click using JavaScript.	CO4
17	Develop a simple image gallery with clickable thumbnails and larger image display.	CO3
18	Set up a Flask application and create a route that displays a welcome message.	CO4
19	Build a user registration form using Flask-WTF for form handling.	CO5
20	Implement user login functionality with session management using Flask.	CO3
21	Develop a basic to-do list application using Flask for backend and JavaScript for frontend interaction.	CO2
22	Add functionality to mark tasks as completed and delete tasks from the list.	CO2
23	Make an AJAX request to an external API and display the data on your webpage.	CO3
24	Set up Flask-Socket IO for real-time chat functionality between users.	CO4

25	Create a database model for blog posts and implement CRUD operations (Create, Read, Update, and Delete).	CO3
26	Allow users to submit comments on blog posts and display them dynamically.	CO4
27	Design and build a personal portfolio website showcasing your projects and skills.	CO3

ANALYSIS AND DESIGN OF ALGORITHMS

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Analysis and Design of Algorithms	**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.

Define Course Outcomes (CO)

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

COs Mapping with Levels of Bloom's taxonomy

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

CO-PO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	Introduction to algorithm
Local	Addresses local understanding of the problems and how to find its solutions
Regional	Addresses regional understanding of the problems and how to find its solutions
National	Addresses national understanding of the problems and how to find its solutions
Global	Addresses global understanding of the problems and how to find its solutions
Employability	After having knowledge about how to solve real world problems, new problems can be addressed to develop their algorithms.
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills to develop analytical skills
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	
Local	Understanding and applying algorithm design methodologies enhances programming and problem-solving skills at the local level.
Regional	Knowledge of algorithm design methodologies allows individuals to develop innovative solutions and potentially start their own businesses in the region

National	Adhering to ethical principles in algorithm design ensures professionalism and ethical practices at the national level.
Global	Employability: Proficiency in algorithm design techniques enhances employability opportunities globally.
Employability	Employability: Proficiency in algorithm design techniques enhances employability opportunities globally.
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills to develop analytical skills
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	
Local	Addresses local understanding of the problems and how to find its solutions
Regional	Addresses regional understanding of the problems and how to find its solutions
National	Addresses national understanding of the problems and how to find its solutions
Global	Addresses global understanding of the problems and how to find its solutions
Employability	After having knowledge about how to solve real world problems, new problems can be addressed to develop their algorithms.
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills to develop analytical skills

Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	
Local	Addresses local understanding of the problems and how to find its solutions
Regional	Addresses regional understanding of the problems and how to find its solutions
National	Addresses national understanding of the problems and how to find its solutions
Global	Addresses global understanding of the problems and how to find its solutions
Employability	After having knowledge about how to solve real world problems, new problems can be addressed to develop their algorithms.
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills to develop analytical skills
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4, 8, 9
NEP 2020	-
POE/4th IR	-

ANALYSIS AND DESIGN OF ALGORITHMS LAB

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

Proposed Lab Experiments

Defined Course Outcomes

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

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

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

DATABASE MANAGEMENT SYSTEMS

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**

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

***SELF-LEARNING COMPONENTS:**

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

Please Note:

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

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

Reference Books:

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

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

Define Course Outcomes (CO)

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

CO-PO Mapping

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

CO-PSO Mapping

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

COs Mapping with Levels of Bloom's taxonomy

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

Relevance of the Syllabus to various indicators

Unit I	**Introduction**
Local	Understanding the fundamentals of DBMS can aid in solving local data management challenges.
Regional	Understanding DBMS architecture can be applied to regional projects or research in data management fields.
National	DBMS plays a significant role in various national data management systems and applications.
Global	DBMS is fundamental to global data management practices and technologies.

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

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

Local	Understanding database security aids in protecting local data from unauthorized access and attacks.
Regional	Understanding database security can be applied to regional data management systems and applications.
National	Database security is essential for safeguarding national data and information systems.
Global	Database security is fundamental to global data protection and privacy practices.
Employability	Knowledge of database security enhances employability in IT security and data protection professions.
Entrepreneurship	Knowledge of database security can inspire entrepreneurial opportunities in cybersecurity ventures.
Skill Development	Learning database security develops skills in access control and intrusion detection.
Professional Ethics	Applying database security with integrity ensures ethical data protection and privacy.
Gender	Database security education is equally important for individuals of all genders pursuing IT security careers.
Human Values	Applying database security with ethical considerations promotes data confidentiality and integrity.
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	-

DATABASE MANAGEMENT SYSTEMS LAB

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

Proposed Lab Experiments

Defined Course Outcomes

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

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

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

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

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

LIFE SKILLS FOR PROFESSIONALS-II

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Life Skills for Professionals - II	**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:

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

Define Course Outcomes (CO)

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

COs Mapping with Levels of Bloom's taxonomy

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

CO5	C5	-	P5

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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

Justification for mapping must be relevant.

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

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. File needs to be submitted in spiral bind.
- Project will be evaluated on the scale of 100 with following evaluation criteria.
    - Project idea & features (10)
    - Literature review (10)
    - Tools & Techniques employed (10)
    - Methodology (10)
    - Presentation of Results and its usefulness (20)
    - Implementation and its understandability (10)
    - Meetings & comments by guide (20)
    - Research paper (10)

File format for Minor project

1.	Abstract	Page No.
2.	Introduction (description of broad topic)	
3.	Motivation	
4.	Literature Review	
5.	Gap Analysis	
6.	Problem Statement	
7.	Objectives	
8.	Tools/platform used	
9.	Methodology	
10.	Experimental Setup	
11.	Evaluation Metrics	
12.	Results And Discussion	
13.	Conclusion & Future Work	
14.	References	
15.	Annexure I: Responsibility Chart	
16.	Annexure II: Screenshots of all the MS-Team Meetings with links (online)/ handwritten comments(offline) from guide	
17.	Annexure III Complete implementation code	
18.	Annexure IV Research Paper (Published/Submitted)	

Semester: 5

THEORY OF COMPUTATION

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. J. Martin, "Introduction to Languages and the Theory of computation" Third Edition, Tata Mc Graw Hill.

Define Course Outcomes (CO)

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

COs Mapping with Levels of Bloom's taxonomy

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

CO3	C4	A2	P3
CO4	C4	A4	P4
CO5	C5	A3	P2
CO6	C6	A5	P5

CO-PO Mapping

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

1. Case study on UNIX and WINDOWS Operating System.

2. Practice of System calls

3. Students can refer the following book as well:

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

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

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

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

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:

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

5. William Stallings, "Operating Systems Internals and Design Principles", PHI

Define Course Outcomes (CO)

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

COs Mapping with Levels of Bloom's taxonomy

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

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	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

Defined Course Outcomes

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

List of Experiments

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: Priority	CO1
5	Given the list of processes, their CPU burst times, and arrival times, write a Python program to display/print the Gantt chart for Priority and Round Robin scheduling algorithms. Compute and print the average waiting time and average turnaround time for each scheduling policy.	CO4
6	Write a Python program to simulate the following file allocation strategies like Sequential	CO5
7	Write a Python program to simulate the following file allocation strategies like Indexed	CO5
8	Write a Python program to simulate the following file allocation strategies like linked.	CO5
9	Write Python programs to simulate the following contiguous memory allocation techniques: a) Worst-fit b) Best-fit c) First-fit	CO5
10	Write programs using the I/O system calls of UNIX/Linux operating system (open, read, write, close, fcntl, seek, stat, opendir, readdir).	CO1
11	Write program to simulate the MVT (Multiple Variable Tasks) memory management technique.	CO5
12	Write program to simulate the MFT (Multiple Fixed Tasks) memory management technique.	CO5

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

30	Write a Python program to simulate the following file organization technique: Single level directory	CO5

(DEPARTMENT ELECTIVE-I)

SECURE CODING AND VULNERABILITIES

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Secure Coding & Vulnerabilities	**ENSP301**	4-0-0	4
Type of Course:	Minor (DEPARTMENT ELECTIVE-I)		
Pre-requisite(s), if any:			

Brief Syllabus:

Secure Coding and Vulnerabilities is a comprehensive course that focuses on understanding and mitigating application security threats and attacks. The course covers various aspects such as security requirements gathering, secure application design and architecture, and secure coding practices for input validation, authentication, cryptography, session management, and error handling. Students will learn about common application vulnerabilities and the potential consequences of security breaches. They will also gain knowledge and skills in static and dynamic application security testing methods, as well as secure deployment and maintenance practices. The course aims to equip students with the necessary tools and techniques to develop robust and secure applications while adhering to best practices in the field of application security.

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to coding and Security**	**No. of hours: 10**

Content Summary:

Introduction-security concepts-CIA Triad, Viruses, Trojans, and Worms, threat, vulnerability, risk, attack. Coding Standards: Dirty Code and Dirty Compiler, Dynamic Memory Management functions, Common memory management Errors (Initialization Errors, Forget to Check Return Values, accessing already freed memory, Freeing the same memory multiple times, Forget to free the allocated

memory), Integer Security –Introduction to integer types: Integer Data Types, data type conversions, Integer vulnerabilities and mitigation strategies

Unit Number: 2	Title: Secure Application Design and Architecture	No. of hours: 10

Content Summary:

Security requirements gathering and analysis, Secure software development life cycle (SSDLC), Security issues while writing SRS, Design phase security, Development Phase, Test Phase, Maintenance Phase, Writing Secure Code – Best Practices SD3 (Secure by design, default and deployment), Security principles and Secure Product Development Timeline.

Unit Number: 3	Title: Secure Coding Practices and Vulnerabilities	No. of hours: 10

Content Summary:

Input validation Techniques-whitelist validation, regular expressions, authentication and authorization, Cryptography, buffer overflows, Session management and protection against session-related attacks, Secure error handling and logging practices, SQL Injection Techniques and Remedies, Race conditions

Unit Number: 4	Title: Application Security Testing and Deployment	No. of hours: 10

Content Summary:

Security code overview, Secure software installation. The Role of the Security Tester, Building the Security Test Plan. Testing HTTP-Based Applications, Testing File-Based Applications, Testing Clients with Rogue Servers, Static and Dynamic Application Security Testing (SAST & DAST), Secure Deployment and Maintenance, Patch management and software updates, Vulnerability scanning and penetration testing.

***Self-Learning Components**: **mention 4-5 topics for students in bullet points**

Please Note:

1) Code Review Tools: Students can explore open-source code review tools such as SonarQube, ESLint, or FindBugs to understand how these tools can help identify security vulnerabilities in code.
2) Security Frameworks such as OWASP (Open Web Application Security Project) and their associated resources.

3) Secure Development Tools: Students can explore tools like Burp Suite, ZAP (Zed Attack Proxy), or WebInspect to understand how these tools can be used for dynamic application security testing (DAST) and penetration testing.
4) Secure Coding in Web Applications: Students can dive deeper into web application security topics, such as Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), or security measures like Content Security Policy (CSP) and HTTP security headers.

Please Note:

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

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

Reference Books:

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

Reference Links:

- **"Secure Coding Practices" on Udemy - Offered by The App Brewery. Link: https://www.udemy.com/course/secure-coding-practices/**
- "**Secure Coding: Preventing Software Vulnerabilities" on Pluralsight - Offered by Pluralsight**. Link: Secure Coding: Preventing Software Vulnerabilities
- "**Software Security" on edX - Offered by University of Maryland, College Park**. Link: Software Security
- Identifying Security Vulnerabilities in C/C++Programming | Coursera
- Principles of Secure Coding | Coursera
- Identifying Security Vulnerabilities | Coursera

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** different types of application security threats and their potential impact.
CO2	**Apply** secure design principles and architectures to develop robust and secure applications.
CO3	**Implement** secure coding practices for input validation, authentication, cryptography, session management, and error handling.
CO4	**Conduct** static and dynamic application security testing to identify vulnerabilities and implement secure deployment and maintenance practices.

COs Mapping with Levels of Bloom's taxonomy

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

CO-PO Mapping

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

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	**Introduction to coding and Security**
Local	-
Regional	-
National	-
Global	Enhancing cybersecurity capabilities and promoting secure software development.
Employability	-
Entrepreneurship	-
Skill Development	Developing coding skills with a focus on security.

Professional 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.

SECURE CODING AND VULNERABILITIES LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Secure Coding & Vulnerabilities Lab	**ENSP351**	0-0-2	1
Type of Course:	Minor (DEPARTMENT ELECTIVE-I)		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Apply** Secure Coding Techniques for enhancing application security.
CO 2	**Analyze** and Evaluate Security Vulnerabilities
CO 3	**Evaluate** and Communicate Importance of Secure Coding by analyzing potential vulnerabilities
CO 4	**Design** and Implement Secure Applications using secure cryptographic libraries.

Ex. No	Experiment Title	Mapped CO/COs
1	Write code to convert between different data types	CO1

2	Implement dynamic memory allocation and deallocation operations and analyze potential errors and 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:	**Course Code**	**L-T-P**	**Credits**
Cyber Crime Investigation & Digital Forensics	**ENSP303**	4-0-0	4
Type of Course:	Minor (DEPARTMENT ELECTIVE-I)		
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:

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

Web references:

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

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the nature and classification of conventional and cyber-crimes.
CO2	**Analyze** and **identify** various types of cyber-crimes and their modes of operation.
CO3	**Evaluate** the impact of cyber-crimes on individuals, organizations, and society**.**

CO4	**Develop** an understanding of digital forensics and the investigative procedures used in cyber-crime cases.
CO5	**Apply** forensic tools and techniques to retrieve and analyze digital evidence.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A1	-
C02	C3	-	-
CO3	C4	A2	-
CO4	C5	-	P5
CO5	C6	-	P2

CO-PO Mapping

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

Justification for mapping must be relevant.

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	Introduction
Local	The knowledge and understanding of cybercrime and computer crime can help local communities and law enforcement agencies address and prevent such crimes in their area.
Regional	Cybercrime is a regional concern, and understanding its types and emerging trends can help in regional collaboration for combating cyber threats.
National	Cybercrime is a significant concern at the national level. Developing expertise in digital forensics and cybercrime investigation can enhance national security and protect critical infrastructure.
Global	Cybercrime has a global impact, and knowledge in this area can contribute to international efforts in combating cyber threats and promoting cybersecurity.

Employability	The skills and knowledge gained in this unit can enhance employability in the field of cybersecurity, law enforcement, digital forensics, and related industries.
Entrepreneurship	-
Skill Development	Developing skills in digital forensics, evidence handling, and understanding emerging digital crimes, contributing to skill development in the field.
Professional 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:	**Course Code**	**L-T-P**	**Credits**
Cyber Crime Investigation & Digital Forensics Lab	**ENSP353**	0-0-2	1
Type of Course:	Minor (DEPARTMENT ELECTIVE-I)		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Understand** the fundamental concepts and principles of digital forensics and cybercrimes.
CO 2	**Apply** the knowledge of digital forensics techniques and procedures to collect, analyse, and preserve electronic evidence in various types of cybercrimes.
CO 3	**Evaluate** and utilize forensic tools and technologies for data acquisition, analysis, and recovery in the investigation of cybercrimes.
CO 4	**Analyse** and interpret digital evidence obtained from different sources, such as electronic media, internet crimes, malicious applications, and various forms of cybercrimes.

Ex. No	Experiment Title	Mapped CO/COs
1	Experiment on collecting and preserving electronic media for forensic analysis.	CO 2
2	Experiment on searching and retrieving digital evidence from various storage devices.	CO 2
3	Experiment on handling and analyzing malicious codes, such as Trojans, viruses, and logic bombs.	CO 2
4	Experiment on investigating unauthorized access to computer systems.	CO 2
5	Experiment on packet sniffing and analyzing network traffic for evidence.	CO 2
6	Experiment on identifying and investigating phishing attacks and their variants.	CO 2
7	Experiment on detecting and investigating web spoofing and email spoofing incidents.	CO 2
8	Experiment on cyber stalking investigation techniques.	CO 2
9	Experiment on investigating web defacement incidents and identifying the perpetrators.	CO 2
10	Experiment on investigating financial crimes, including ATM and credit card frauds.	CO 2
11	Experiment on tracing and investigating spamming activities.	CO 2
12	Experiment on investigating cases related to software and hardware piracy.	CO 2
13	Experiment on tracing and investigating money laundering activities.	CO 2
14	Experiment on investigating fraud and cheating cases in the digital realm.	CO 2

15	Experiment on analyzing malicious applications and 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 seizure procedures in digital investigations.	CO 2
18	Experiment on securing and documenting the crime scene in digital forensics.	CO 2
19	Experiment on acquiring and analyzing data from digital devices.	CO 3
20	Experiment on using forensic tools like EnCase and FTK for digital investigations.	CO 3
21	Experiment on countering anti-forensics techniques and retrieving hidden information.	CO 3
22	Experiment on recovering data from damaged SIM cards and other multimedia evidence.	CO 2
23	Experiment on recovering deleted data from desktops, laptops, and mobile devices.	CO 2
24	Experiment on analyzing data from slack space and renamed files.	CO 4
25	Experiment on forensic imaging, including ghosting and analysis of compressed files.	CO 3

Description of experiments:

Session 1:
Topic: Experiment on collecting and preserving electronic media for forensic analysis • Introduction to electronic media collection and preservation in digital forensics

- Techniques for ensuring the integrity and authenticity of collected data
- Chain of custody and documentation procedures

Exercise: Practice collecting electronic media and preserving it for forensic analysis.

Project: Create a comprehensive report on the collection and preservation of electronic media: Document the process of collecting electronic media, maintain a chain of custody, and ensure the integrity of the collected data.

Session 2:

Topic: Experiment on searching and retrieving digital evidence from various storage devices

- Different types of storage devices and their characteristics
- Techniques for searching and retrieving digital evidence from storage devices
- File systems analysis and data carving

Exercise: Search for and retrieve digital evidence from different storage devices.

Project: Analyze and document the process of searching and retrieving digital evidence: Perform data recovery and analysis on different storage devices, document the findings, and present a comprehensive report.

Session 3:

Topic: Experiment on handling and analyzing malicious codes, such as Trojans, viruses, and logic bombs

- Introduction to different types of malicious codes
- Techniques for analyzing and understanding malicious code behavior
- Anti-malware tools and techniques

Exercise: Analyze and dissect different types of malicious codes to understand their behavior.

Project: Develop a comprehensive report on the analysis of malicious codes: Analyze and document the behavior of various malicious codes, identify their impact, and propose countermeasures.

Session 4:

Topic: Experiment on investigating unauthorized access to computer systems

- Understanding the concept of unauthorized access
- Techniques for investigating unauthorized access incidents
- Log analysis and intrusion detection systems

Exercise: Investigate and analyze unauthorized access incidents in computer systems.

Project: Create a detailed investigation report on unauthorized access incidents: Analyze log files, identify the extent of unauthorized access, determine the entry points, and propose preventive measures.

Session 5:

Topic: Experiment on packet sniffing and analyzing network traffic for evidence

- Introduction to packet sniffing and network traffic analysis
- Tools and techniques for capturing and analyzing network packets
- Identifying and extracting relevant evidence from network traffic

Exercise: Capture and analyze network packets to extract evidence.

Project: Prepare a comprehensive report on network traffic analysis for a given scenario: Analyze captured network packets, extract relevant evidence, and present the findings in a structured report.

Session 6:

Topic: Experiment on identifying and investigating phishing attacks and their variants

- Understanding phishing attacks and their impact
- Techniques for identifying and investigating phishing incidents
- Analyzing phishing emails and websites

Exercise: Identify and investigate phishing attacks by analyzing phishing emails and websites.

Project: Perform a comprehensive analysis of a phishing attack: Analyze phishing emails and websites, identify the modus operandi, and propose countermeasures to prevent future attacks.

Session 7:

Topic: Experiment on detecting and investigating web spoofing and email spoofing incidents

- Understanding web spoofing and email spoofing techniques
- Techniques for detecting and investigating web and email spoofing incidents
- Analyzing spoofed web pages and email headers

Exercise: Detect and investigate web spoofing and email spoofing incidents by analyzing spoofed web pages and email headers.

Project: Prepare a detailed investigation report on web and email spoofing incidents: Analyze spoofed web pages and email headers, identify the perpetrators, and suggest preventive measures.

Session 8:

Topic: Experiment on cyber stalking investigation techniques

- Understanding cyber stalking and its implications
- Techniques for investigating cyber stalking incidents
- Gathering digital evidence and documenting the case

Exercise: Investigate and gather digital evidence for a cyber stalking case.

Project: Create a comprehensive investigation report on a cyber stalking incident: Analyze the digital evidence, document the case details, and propose measures to protect the victim.

Session 9:

Topic: Experiment on investigating web defacement incidents and identifying the perpetrators

- Understanding web defacement and its impact
- Techniques for investigating web defacement incidents

- Analyzing web defaced pages and server logs

Exercise: Investigate web defacement incidents and analyze defaced web pages and server logs.

Project: Prepare a detailed investigation report on web defacement incidents: Analyze defaced web pages and server logs, identify the perpetrators, and suggest measures to enhance website security.

Session 10:

Topic: Experiment on investigating financial crimes, including ATM and credit card frauds

- Understanding financial crimes in the digital realm
- Techniques for investigating ATM and credit card frauds
- Analyzing financial transaction records and digital evidence

Exercise: Investigate financial crimes related to ATM and credit card frauds by analyzing financial transaction records and digital evidence.

Project: Create a comprehensive report on the investigation of financial crimes: Analyze financial transaction records, identify fraudulent activities, and propose preventive measures.

Session 11:

Topic: Experiment on tracing and investigating spamming activities

- Understanding spamming activities and their impact
- Techniques for tracing and investigating spamming incidents
- Analyzing spam emails and tracking email senders

Exercise: Trace and investigate spamming activities by analyzing spam emails and tracking email senders.

Project: Prepare a detailed investigation report on spamming activities: Analyze spam emails, trace email senders, identify the source of spamming, and propose measures to mitigate spamming incidents.

Session 12:

Topic: Experiment on investigating cases related to software and hardware piracy

- Understanding software and hardware piracy and its consequences
- Techniques for investigating piracy cases
- Analyzing pirated software and counterfeit hardware

Exercise: Investigate cases related to software and hardware piracy by analyzing pirated software and counterfeit hardware.

Project: Develop a comprehensive report on software and hardware piracy investigations: Analyze pirated software, identify counterfeit hardware, determine the extent of piracy, and propose measures to combat piracy.

Session 13:

Topic: Experiment on tracing and investigating money laundering activities

- Understanding money laundering in the digital realm
- Techniques for tracing and investigating money laundering incidents
- Analyzing financial transaction records and blockchain data

Exercise: Trace and investigate money laundering activities by analyzing financial transaction records and blockchain data.

Project: Prepare a detailed investigation report on money laundering activities: Analyze financial transaction records, track money flow, identify money laundering techniques, and propose measures to prevent money laundering.

Session 14:

Topic: Experiment on investigating fraud and cheating cases in the digital realm

- Understanding fraud and cheating in the digital realm
- Techniques for investigating fraud and cheating cases
- Analyzing digital evidence and transaction records

Exercise: Investigate fraud and cheating cases in the digital realm by analyzing digital evidence and transaction records.

Project: Create a comprehensive investigation report on fraud and cheating cases: Analyze digital evidence, identify fraudulent activities, document the case details, and propose preventive measures.

Session 15:

Topic: Experiment on analyzing malicious applications and their impact on digital devices

- Understanding malicious applications and their impact
- Techniques for analyzing and identifying malicious applications
- Analyzing malware behavior and reverse engineering techniques

Exercise: Analyze and identify malicious applications and study their impact on digital devices.

Project: Prepare a detailed analysis report on malicious applications: Analyze the behavior of different types of malicious applications, identify their impact on digital devices, and propose measures to prevent malware infections.

Session 16:

Topic: Experiment on understanding the role and capabilities of investigation agencies in India

- Introduction to investigation agencies in India
- Understanding the roles and responsibilities of investigation agencies
- Case studies and examples of investigations conducted by Indian agencies

Exercise: Study and understand the roles and capabilities of investigation agencies in India through case studies and examples.

Project: Prepare a report highlighting the role and capabilities of investigation agencies in India: Discuss the functions, powers, and responsibilities of key investigation agencies, and analyze their notable investigations.

Session 17:

Topic: Experiment on following proper evidence collection and seizure procedures in digital investigations

- Understanding the importance of proper evidence collection and seizure
- Techniques and procedures for collecting and preserving digital evidence
- Documentation and chain of custody requirements

Exercise: Practice following proper evidence collection and seizure procedures in digital investigations.

Project: Create a comprehensive report on evidence collection and seizure procedures: Document the process of evidence collection, maintain the chain of custody, and ensure compliance with legal and procedural requirements.

Session 18:

Topic: Experiment on securing and documenting the crime scene in digital forensics

- Importance of securing the crime scene in digital forensics
- Techniques for securing and documenting the crime scene
- Best practices for maintaining the integrity of digital evidence

Exercise: Secure and document the crime scene in a simulated digital forensics case.

Project: Prepare a detailed report on securing and documenting the crime scene: Describe the steps taken to secure the crime scene, document the process, and provide recommendations for improving crime scene management.

Session 19:

Topic: Experiment on acquiring and analyzing data from digital devices

- Techniques for acquiring data from digital devices
- Best practices for preserving the integrity of acquired data
- Analyzing acquired data using forensic tools and techniques

Exercise: Acquire and analyze data from different digital devices using forensic tools and techniques.

Project: Analyze and document the process of acquiring and analyzing data from digital devices: Perform data acquisition, analyze the acquired data, and present the findings in a structured report.

Session 20:

Topic: Experiment on using forensic tools like EnCase and FTK for digital investigations

- Introduction to popular forensic tools like EnCase and FTK
- Familiarization with the features and capabilities of forensic tools
- Hands-on practice with forensic tool usage in digital investigations

Exercise: Use forensic tools like EnCase and FTK to conduct digital investigations on simulated cases.

Project: Prepare a comprehensive report on the usage of forensic tools in digital investigations: Describe the features and capabilities of EnCase and FTK, document the usage in specific investigations, and evaluate their effectiveness.

Session 21:

Topic: Experiment on countering anti-forensics techniques and retrieving hidden information

- Understanding anti-forensics techniques used to hide digital evidence
- Techniques for countering anti-forensics and retrieving hidden information
- Analysis of steganography, encryption, and file obfuscation methods

Exercise: Counter anti-forensics techniques and retrieve hidden information from digital evidence.

Project: Develop a comprehensive report on countering anti-forensics techniques: Analyze different anti-forensics methods, propose countermeasures, and demonstrate the retrieval of hidden information.

Session 22:

Topic: Experiment on recovering data from damaged SIM cards and other multimedia evidence

- Techniques for recovering data from damaged SIM cards
- Recovering data from damaged multimedia evidence like CCTV footage and audio recordings
- Best practices for data recovery from different types of damaged media

Exercise: Recover data from damaged SIM cards and analyze multimedia evidence from various sources.

Project: Prepare a detailed report on data recovery from damaged media: Document the process of recovering data from damaged SIM cards and analyze recovered multimedia evidence.

Session 23:

Topic: Experiment on recovering deleted data from desktops, laptops, and mobile devices

- Techniques for recovering deleted data from different devices
- Understanding file systems and data storage mechanisms
- Analyzing recovered deleted data for evidence

Exercise: Recover deleted data from desktops, laptops, and mobile devices and analyze the recovered data for evidence.

Project: Analyze and document the process of recovering deleted data: Recover deleted data from different devices, analyze the recovered data, and present the findings in a comprehensive report.

Session 24:

Topic: Experiment on analyzing data from slack space and renamed files

- Understanding slack space and its significance in digital forensics
- Techniques for analyzing data from slack space and renamed files
- Extracting hidden information and evidence from slack space and renamed files

Exercise: Analyze data from slack space and renamed files to extract hidden information and evidence.

Project: Prepare a detailed report on the analysis of data from slack space and renamed files: Analyze the data, extract hidden information, and present the findings in a structured report.

Session 25:

Topic: Experiment on forensic imaging, including ghosting and analysis of compressed files

- Understanding forensic imaging and its importance in digital forensics

- Techniques for creating forensic images and conducting analysis
- Analyzing ghost images and compressed files for evidence

Exercise: Create forensic images, analyze ghost images, and conduct analysis on compressed files.

Project: Develop a comprehensive report on forensic imaging and analysis: Describe the process of creating forensic images, analyze ghost images, and analyze compressed files for evidence. Present the findings in a structured report.

AI IN CYBER SECURITY

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
AI in Cyber Security	**ENSP305**	4-0-0	4
Type of Course:	Minor (DEPARTMENT ELECTIVE-I)		

Pre-requisite(s), if any: basic understanding of web development technologies such as HTML, CSS, and JavaScript. Additionally, students should have some familiarity with networking concepts, operating systems, and databases.

Brief Syllabus:

This syllabus covers essential topics in web application security, including injection attacks, authentication and access control, cryptography, testing, security standards, best practices, and risk management. It is divided into four units and may be completed in a semester-long course. Students will gain an understanding of common web application vulnerabilities and how to prevent and mitigate them. They will also learn about authentication and access control mechanisms, cryptography techniques, and web application security testing. Finally, students will explore best practices for secure web application development and incident response and disaster recovery planning.

UNIT WISE DETAILS

Unit Number: 1	**Title: Introduction to AI and Cyber Security**	**No. of hours: 10**

Content Summary:

Overview of Artificial Intelligence and its applications in Cyber Security History and evolution of AI in cyber security, Understanding of the Cyber Security threats landscape, Familiarization with the latest trends and techniques of AI in Cyber Security, Basic principles of Machine Learning and Deep Learning in Cyber Security, Ethical considerations and challenges of using AI in cyber security.

Unit Number: 2	**Title: Machine Learning Techniques for Cyber Security**	**No. of hours: 10**

Content Summary:

An introduction to Machine Learning techniques, Supervised and unsupervised Machine Learning models in Cyber Security, Feature engineering and data preparation for Machine Learning models, Case studies demonstrating the application of Machine Learning to Cyber Security problems.

Unit Number: 3	Title: Deep Learning Techniques for Cyber	No. of hours: 10

Content Summary:

Introduction to Deep Learning techniques ,Convolutional Neural Networks (CNNs) and their application in Cyber Security ,Recurrent Neural Networks (RNNs) and their application in Cyber Security ,GANs and their application in Cyber Security ,Case studies demonstrating the application of Deep Learning to Cyber Security problems.

Unit Number: 4	Title: AI for Cyber Security: Threat Detection and Prevention	No. of hours: 10

Content Summary:

Introduction to AI and its applications in threat detection and prevention ,Overview of different types of threats in cyber security and their characteristics ,Understanding the limitations of traditional threat detection and prevention methods ,Fundamentals of machine learning and deep learning for threat detection and prevention ,Supervised machine learning algorithms for threat detection, such as decision trees, support vector machines, and random forests ,Unsupervised machine learning algorithms for anomaly detection, such as clustering and outlier detection ,Deep learning techniques for threat detection, such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) ,Feature selection and feature engineering for machine learning in threat detection, Emerging trends and challenges in AI for threat detection and prevention, including adversarial machine learning, explainable AI, and privacy concerns.

***Self-Learning Components:**

1) Anomaly Detection
2) Malware Detection
3) Adaptive Access Control
4) Network Traffic Analysis

Please Note:

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

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

Reference Books:

1. Artificial Intelligence for Cybersecurity" by Bhaskar Sinha (Auerbach Publications)
2. Machine Learning and Security: Protecting Systems with Data and Algorithms" by Clarence Chio and David Freeman (O'Reilly Media)

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** Understand the concepts and applications of AI in the field of cyber security.
CO2	**Express** the ethical and legal considerations associated with the use of AI in cyber security.
CO3	**Determine** emerging trends and technologies in AI for cyber security, and their potential impact on the field.
CO4	**Identify** strategies for integrating AI-driven solutions into existing cyber security frameworks, policies, and practices.
CO5	**Articulate** critical thinking and problem-solving skills to address real-world cyber security challenges using AI techniques.

CO6	**Design** machine learning techniques for threat detection and prevention in cyber security, including supervised and unsupervised algorithms.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A1	P1
C02	C3	A3	P2
CO3	C3	A3	P3
CO4	C1	A2	-
CO5	C2	A3	P5
CO6	C6	A4	-

CO-PO Mapping

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

Justification for mapping must be relevant.

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	**Introduction to AI and Cyber Security**
Local	Addresses local understanding of the Cyber Security and its impact on society
Regional	Addresses regional Cyber Security infrastructure requirements.
National	Contributes to national Cyber Security literacy and its impact to the nation.
Global	Aligns with global trends in Cyber Security technologies and network protocols
Employability	Develops skills in using Cyber Security and its tools for network protocols
Entrepreneurship	Build entrepreneurship
Skill Development	Develops basic knowledge and skills in Cyber Security technologies and network protocols
Professional Ethics	-

Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Machine Learning Techniques for Cyber Security**
Local	Addresses local understanding of the Internet and its impact on society
Regional	-
National	Contributes to national digital literacy and internet connectivity strategies
Global	Aligns with global trends in internet technologies and network protocols
Employability	Develops skills in using Machine learning techniques and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in Machine learning techniques technologies and network protocols
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Deep Learning Techniques for Cyber**
Local	Addresses local network security needs and practices
Regional	-
National	Contributes to national network security strategies and protocols

Global	Aligns with global trends in network security techniques and protocols
Employability	Develops skills in Deep learning techniques and network security techniques
Entrepreneurship	-
Skill Development	Develops knowledge and skills in Deep learning techniques and network security
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**AI for Cyber Security: Threat Detection and Prevention**
Local	Addresses local understanding of Threat Detection and Prevention. and implementation of internet-based services
Regional	-
National	Contributes to national digital communication strategies and multimedia applications
Global	Aligns with global trends in internet telephony, multimedia applications, and SEO
Employability	Develops skills in Threat Detection and Prevention.
Entrepreneurship	-
Skill Development	Develops knowledge and skills in Threat Detection and Prevention
Professional Ethics	-
Gender	-

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

AI IN CYBER SECURITY LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
AI in Cyber Security Lab	**ENSP355**	0-0-2	1
Type of Course:	Minor (DEPARTMENT ELECTIVE-I)		
Pre-requisite(s), if any: basic understanding of web development technologies such as HTML, CSS, and JavaScript. Additionally, students should have some familiarity with networking concepts, operating systems, and databases.			

Proposed Lab Experiments

Defined Course Outcomes

COs	Comprehensive Understanding of AI in Cyber Security:
CO 1	**Practical** Experience with AI Tools and Techniques
CO 2	**Enhanced** Malware Detection and Classification Skills
CO 3	**Critical** Thinking and Problem-Solving Abilities
CO 4	**Research** and Innovation in AI Cyber Security

Ex. No	Experiment Title	Mapped CO/COs
1	Malware detection: Develop an AI model to detect and classify different types of malwares.	CO 2

2	Intrusion detection: Build an AI system to identify and alert on network intrusions and suspicious activities.	CO 1
3	Phishing detection: Train an AI algorithm to recognize and flag phishing emails or websites.	CO 1, CO 3
4	Vulnerability assessment: Use AI techniques to identify potential vulnerabilities in software or systems.	CO 1, CO 3
5	Botnet detection: Develop an AI model to detect and track botnet activities on a network.	CO 1
6	Password cracking: Build an AI system to analyze and crack weak passwords.	CO 1, CO 3
7	Network traffic analysis: Use AI algorithms to analyze network traffic and identify patterns or anomalies.	CO 1, CO 3
8	Behavioral authentication: Develop an AI model to authenticate users based on their behavioral patterns.	CO 1, CO 3
9	Anomaly detection: Train an AI system to detect anomalous behavior in user activities or system logs.	CO 1
10	Zero-day vulnerability detection: Use AI techniques to identify unknown or previously undiscovered vulnerabilities.	CO 1, CO 3
11	Social engineering detection: Build an AI system to recognize and alert on social engineering attempts.	CO 1, CO 3
12	Web application security: Develop an AI model to identify and mitigate web application vulnerabilities.	CO 3, CO 4
13	Data exfiltration detection: Train an AI algorithm to detect and prevent unauthorized data exfiltration attempts.	CO 3, CO 4
14	Ransomware detection: Use AI techniques to identify and block ransomware attacks in real-time.	CO 3, CO 4
15	Firewall optimization: Employ AI algorithms to optimize firewall rules and configurations for better security.	CO 3, CO 4

16	Network anomaly prediction: Build an AI system to 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:	**Course Code**	**L-T-P**	**Credits**
Social Media Security	**ENSP307**	4-0-0	4
Type of Course:	Minor (DEPARTMENT ELECTIVE-I)		
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:	**Course Code**	**L-T-P**	**Credits**
Social Media Security Lab	**ENSP357**	0-0-2	1
Type of Course:	Minor (DEPARTMENT ELECTIVE-I)		
Pre-requisite(s), if any:			

Course Outcomes (CO)

COs	Statements
CO1	**Understand** the risks and vulnerabilities associated with social media platforms.
CO2	**Understand** the social and ethical implications of social media security.
CO3	**Develop** practical skills to secure social media accounts and data.
CO4	**Analyze** and respond to social media security incidents.
CO5	**Evaluate** the effectiveness of social media security controls.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/COs
1	Exploring Different Social Media Platforms a. Research and analyze various social media platforms. b. Identify their key features, target audiences, and unique characteristics. c. Compare and contrast their usage, advantages, and challenges.	CO1, CO2, CO5
2	Monitoring Social Media Trends	CO1, CO5

	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.	
3	Social Media Marketing Analysis a. Study real-world social media marketing campaigns. b. Analyze their strategies, target audience engagement, and impact. c. Evaluate the challenges and opportunities in social media marketing.	CO2, CO3
4	Collecting and Analyzing Social Media Data a. Utilize APIs to collect data from online social media platforms. b. Perform content analysis using techniques like Bag-of-Words (BoW) model and TF-IDF. c. Extract insights and patterns from the collected data.	CO3
5	Social Network Analysis a. Perform network analysis on social media data. b. Calculate node centrality measures, degree distribution, average path length, and clustering coefficient. c. Identify key influencers and community structures within the social network.	CO3, CO5
6	Creating Synthetic Networks a. Generate random graphs and preferential attachment models to simulate social networks. b. Analyze the characteristics of the synthetic networks. c. Compare and contrast them with real-world social networks.	CO1, CO5
7	Profile Cloning and Identity Theft a. Study different types of identity theft in social media. b. Analyze profile cloning, social phishing, and compromised accounts. c. Understand the behavioral patterns and impacts of these attacks.	CO1, CO2
8	Dealing with Spam and Misinformation a. Analyze the spread of spam and misinformation in social media. b. Identify techniques to detect and mitigate spamming activities.	CO4

	c. Evaluate the effectiveness of flagging and reporting mechanisms.	
9	Privacy Settings Evaluation a. Evaluate the privacy settings of popular social media platforms. b. Assess the level of protection they provide for Personally Identifiable Information (PII). c. Propose recommendations for enhancing user privacy.	CO2, CO5
10	Privacy Attacks and Anonymity a. Study different privacy attacks in social media, such as inference attacks and de-anonymization attacks. b. Analyze the impact of identity disclosure and attribute disclosure attacks. c. Explore techniques like differential privacy for preserving user privacy.	CO2
11	Privacy Metrics Analysis a. Investigate privacy metrics like k-anonymity and l-diversity. b. Apply these metrics to analyze the privacy risks in social media datasets. c. Discuss the trade-offs between personalization and privacy in social media.	CO2
12	Understanding Social Media Laws and Regulations a. Study the laws and regulations related to social media usage. b. Analyze the legal implications of posting inappropriate content. c. Explore content moderation policies and user responsibilities.	CO2
13	User Authentication and Access Control a. Evaluate user authentication mechanisms in popular social media platforms. b. Analyze access control policies and user permissions. c. Discuss best practices for ensuring secure user authentication.	CO3
14	Security Awareness and Education a. Develop security awareness campaigns for social media users. b. Design educational materials to raise awareness about social media security risks. c. Evaluate the effectiveness of these campaigns through surveys or assessments.	CO2

15	Case Study Analysis - Facebook a. Analyze the security and privacy practices of 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. b. Analyze the response to cybersecurity incidents on the platform. c. Discuss the role of Twitter in addressing misinformation and cyberbullying.	CO1, CO2, CO4
17	Case Study Analysis - Instagram a. Analyze the privacy and security features of Instagram. b. Investigate the effectiveness of content moderation policies. c. Discuss the impact of influencer marketing and brand safety on Instagram.	CO1, CO2, CO4
18	Case Study Analysis - YouTube a. Evaluate the security controls and privacy settings of YouTube. b. Analyze the challenges of content moderation and copyright infringement. c. Discuss the role of YouTube in combating hate speech and harmful content.	CO1, CO2, CO4
19	Case Study Analysis - LinkedIn a. Study the security and privacy considerations on LinkedIn. b. Analyze the protection of professional user data and connections. c. Discuss the impact of LinkedIn in job search and professional networking.	CO1, CO2
20	Case Study Analysis - StackOverflow a. Investigate the security practices implemented on StackOverflow. b. Analyze the trust and reputation systems within the community. c. Discuss the role of StackOverflow in knowledge sharing and code collaboration.	CO1, CO2
21	Case Study Analysis - GitHub a. Analyze the security measures adopted by GitHub for source code repositories.	CO1, CO2

	b. Investigate the role of vulnerability reporting and code review processes. c. Discuss the importance of secure coding practices in open-source projects.	
22	Case Study Analysis - Quora a. Evaluate the privacy controls and content moderation on Quora. b. Analyze the impact of user-generated content and knowledge sharing. c. Discuss the challenges of maintaining a respectful and inclusive community.	CO1, CO2
23	Case Study Analysis - SnapChat a. Study the privacy and security features of SnapChat. b. Analyze the ephemeral messaging and privacy-by-design approach. c. Discuss the challenges of preventing data leaks and unauthorized access.	CO1, CO2
24	Case Study Analysis - Reddit a. Analyze the security and privacy considerations on Reddit. b. Investigate the moderation policies and community-driven content curation. c. Discuss the challenges of maintaining a balance between free speech and harmful content.	CO1, CO2

Summer Internship / Project-II

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

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

The following options can be opted by the students:

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

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

Report Submission and Evaluation Guidelines:

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

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

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

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

Course Outcomes:

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

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

LIFE SKILLS FOR PROFESSIONALS-III

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Life Skills for Professionals -III	**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:

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

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** their critical thinking skills and become adept at analyzing and evaluating information, identifying problems, generating innovative solutions, and making informed decisions.
CO2	**Apply** digital literacy skills necessary for the modern workplace and become proficient in using online platforms relevant to their field.
CO3	**Evaluate** Contribute positively, respect different perspectives, resolve conflicts, and achieve shared goals.
CO4	**Improve** and develop skills related to career planning, job search strategies, and personal branding
CO5	**Create** leadership skills and to motivate and inspire others, manage projects effectively, and demonstrate a proactive and responsible approach to their spoken language.

COs Mapping with Levels of Bloom's taxonomy

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

CO3	C5	-	-
CO4	-	-	P5
CO5	C6	-	-

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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

Justification for mapping must be relevant

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

SOFTWARE ENGINEERING

Department:	**Department of Computer Science and Engineering**		
Course Name: **Software Engineering**	**Course Code**	**L-T-P**	**Credits**
	ENCS305	4-0-0	4
Type of Course:	Major		
Pre-requisite(s), if any:			
Brief Syllabus: Importance of Software Engineering, Software Development Lifecycle and its models, Agile vs. Plan Based development, Development of Software Documents, Version Control system using GitHub and Eclipse IDE, Requirements Engineering technique, Development of UML Diagrams, Software Architecture and Design patterns, Software Testing- Black Box and White Box, Developing Test cases using Equivalence and Boundary value partitioning techniques, Test Driven Development with Junit in Eclipse, Software Refactoring.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to Software Engineering**		**No. of hours: 10**
Content Summary: Importance of Software Engineering, Discipline of Software Engineering; Eclipse Introduction, Overview, and Demo; Lifecycle models: Requirements Engineering, Design and Implementation, Maintenance, Software Process Model Introduction, Waterfall Process, Spiral Process, Evolutionary Prototyping Process, Agile Process, Choosing a Model, Lifecycle Documents.			
Unit Number: 2	**Title: Engineering Requirements**		**No. of hours: 10**

Content Summary:

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

Unit Number: 3	Title: Software Metrics and UML	No. of hours: 10

Content Summary:

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

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

Unit Number: 4	Title: Software Testing and Maintenance	No. of hours: 10

Content Summary:

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

Software Maintenance: Management of Maintenance, Maintenance Process, Maintenance Models, Regression Testing, Reverse Engineering, Software Re-engineering.
***SELF-LEARNING COMPONENTS:** https://onlinecourses.nptel.ac.in/noc20_cs68/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: a) R. Pressman, Software Engineering A Practitioner's Approach (8 ed.), McGraw Hill International, 2019. ISBN 978-1259253157. b) Sommerville, Software Engineering (10 ed.), Person Publications Publishing Company, 2017. ISBN 978-9332582699. c) K. K. Aggarwal & Yogesh Singh, "Software Engineering", New Age International. d) W.S. Jawadekar, "Software Engineering – Principles and Practices", McGraw Hill.

Define Course Outcomes (CO)

COs	Statements
CO1	Demonstrate understanding of Software Engineering as an iterative and systematic process.
CO2	Recall the lifecycle models of software engineering.

CO3	Design the software development process to complement technical understanding of software products.
CO4	Analyze requirements using modeling techniques such as DFD and ER diagrams.
CO5	Generate test case specifications and test cases from given requirements.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	A2	P2
CO2	C1	A1	P3
CO3	C4	A4	P4
CO4	C5	A4	P5
CO5	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
CO2	3	2	3	-	2	-	-	-	-	-	-	2
CO3	3	-	3	-	2	-	-	-	2	-	2	-
CO4	3	3	2	2	2	-	-	-	-	-	-	-
CO5	2	2	2	-	3	-	-	-	-	2	-	-

Justification for mapping must be relevant.

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	**Introduction to Software Engineering**
Local	Can help students understand the local software industry and its specific challenges.
Regional	Can provide insights into the regional software development practices and challenges.
National	Address the broader context of software engineering within a country, including its impact on the economy and society

Global	Explore the global nature of software development and its impact on various industries and sectors worldwide.
Employability	Provide students with a foundational understanding of software engineering concepts and practices, which are valuable skills in the job market.
Entrepreneurship	Provide insights into the software industry, its challenges, and potential opportunities for innovation and business ventures.
Skill Development	Introduce fundamental concepts and techniques used in software engineering.
Professional Ethics	Consideration of ethical issues in software development, such as privacy, security, and responsible use of technology.
Gender	-
Human Values	Impact of software on individuals, societies, and ethical considerations related to human well-being.
Environment & Sustainability	-
Unit II	**Engineering Requirements**
Local	Help in assessing the complexity and quality of software developed within the local context.
Regional	Provide insights into the software development practices and trends within a specific region.
National	contribute to evaluating software quality and productivity within a country's software industry.

Global	Provide standardized measures for assessing software complexity and quality, regardless of the geographical location.
Employability	Commonly used in software development organizations to measure productivity, quality, and project estimation.
Entrepreneurship	Evaluating the feasibility, cost estimation, and risks associated with software development projects.
Skill Development	By enhancing the ability to measure, analyze, and improve software quality and productivity.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Software Metrics and UML**
Local	Standardized techniques can be employed by local software development teams.
Regional	Provide a common language and methodology for software development, facilitating collaboration and communication among regional software development teams.
National	Provide a standardized framework for software development, promoting consistency and interoperability among national software projects.
Global	Widely adopted internationally, allowing for effective communication and collaboration among software development teams across different countries.
Employability	Commonly used in industry, and proficiency in these techniques is valued by employers.
Entrepreneurship	Aiding entrepreneurs in planning, designing, and communicating their software ideas.

Skill Development	Enhancing students' proficiency in software modeling and design.
Professional Ethics	Address the importance of developing reliable software and adhering to quality standards in the software engineering profession.
Gender	-
Human Values	-
Environment & Sustainability	Development of reliable software that reduces wastage, energy consumption, and potential negative environmental impacts.
Unit IV	**Software Testing and Maintenance**
Local	Provide practical knowledge and techniques for testing software developed within the local context.
Regional	Address common testing challenges and practices in software development within the region.
National	Provide essential knowledge and skills required for testing software developed within the country.
Global	Testing is an integral part of software development across different countries and industries worldwide.
Employability	As software testing skills are in high demand by employers seeking quality assurance in software development projects.
Entrepreneurship	Provide knowledge and techniques for ensuring the quality and reliability of software products developed by entrepreneurs.
Skill Development	Introduce essential concepts, methodologies, and tools used in software testing.
Professional Ethics	Addressing ethical considerations in software testing, such as ensuring impartiality, confidentiality, and integrity in the testing process.
Gender	-

Human Values	-
Environment & Sustainability	-
SDG	SDG 4,8,9
NEP 2020	-
POE/4th IR	Emphasizes the responsible and ethical development and deployment of the systems.

Semester: 6

COMPUTER ORGANIZATION & ARCHITECTURE

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Computer Organization & Architecture	**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:

7. "Computer Organization & Architecture", Smruti Ranjan Sarangi, McGraw Hill
8. "Computer System Architecture", Mano M. Morris, Pearson.
9. "Computer Organization and Embedded Systems", 6th Edition by Carl Hamacher, McGraHill Higher Education
10. "Computer Architecture and Organization", 3rd Edition by John P. Hayes, WCB/McGraw-Hill
11. "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:	**Course Code**	**L-T-P**	**Credits**
Computer Networks	**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.)

Define Course Outcomes (CO)

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

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels©	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	C1	-	-
C02	C2	-	-
CO3	C3	A4	-
CO4	C6	-	P5
CO5	-	-	-

CO-PO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	**Evolution of Computer Networking**
Local	Computer networking enables local communication and connectivity within communities, businesses, and educational institutions. It facilitates information sharing, collaboration, and resource sharing at the local level.
Regional	Networking infrastructure connects regions and nations, promoting economic growth, social development, and knowledge sharing. It enables efficient communication, e-commerce, and government services across regions and countries.
National	-
Global	The global network infrastructure, such as the internet, connects people worldwide. It fosters global communication, cultural exchange, international trade, and enables the global dissemination of knowledge and information.
Employability	Computer networking skills are in high demand across industries. Proficiency in networking technologies and protocols enhances employability prospects in fields such as network administration, cybersecurity, cloud computing, and telecommunications.
Entrepreneurship	Networking knowledge is crucial for entrepreneurs to establish and manage their businesses effectively. It enables the creation of scalable, secure, and interconnected systems that support business operations, communication, and data exchange.
Skill Development	Computer networking cultivates essential technical skills, such as network design, configuration, troubleshooting, and optimization. It also fosters critical thinking, problem-solving, and analytical skills required to address complex network challenges.
Professional Ethics	Computer networking professionals must adhere to ethical standards and guidelines. They need to respect user privacy, ensure data security, and practice responsible use of network resources. Professional ethics in networking include principles

	like confidentiality, integrity, accountability, and respect for intellectual property rights.
Gender	Promoting gender diversity and inclusivity in computer networking is crucial. Encouraging women's participation in networking fields helps bridge the gender gap and fosters diverse perspectives and innovative solutions.
Human Values	Computer networking should prioritize human values, such as accessibility, equity, and social responsibility. Access to network resources and services should be inclusive, regardless of geographical location or socioeconomic background. Networking technologies should be leveraged to bridge digital divides and empower underserved communities.
Environment & 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 & Sustainability	Sustainable network design involves optimizing the Network Layer and Transport Services to minimize resource consumption and reduce environmental impact. This includes implementing efficient routing algorithms, congestion control mechanisms, and energy-saving techniques to reduce power consumption and promote environmental sustainability.
Unit IV	**Principles of Network Applications**
Local	Principles of computer network applications enable local communication and connectivity within communities, organizations, and institutions. Local network applications facilitate information sharing, collaboration, and resource utilization at the local level.
Regional	These principles play a crucial role in regional and national connectivity, allowing for efficient communication and data exchange across networks within a region or country.
National	-
Global	The principles of computer network applications are essential for global connectivity, enabling the exchange of data and information across the internet on a global scale.
Employability	Proficiency in the principles of computer network applications enhances employability in various roles such as application developers, network engineers, and system administrators. Employers seek individuals with a strong understanding of network protocols, application design, and development.
Entrepreneurship	Understanding these principles is crucial for entrepreneurs who need to develop and manage networked applications effectively.

	It enables the creation of innovative and scalable applications to support business operations and provide value to users.
Skill Development	The principles of computer network applications contribute to the development of technical skills in application development, network programming, and protocol implementation. It involves knowledge of network protocols, application layer protocols (e.g., HTTP, FTP), and client-server communication.
Professional Ethics	Ethical considerations are important when working with computer network applications. Professionals should prioritize user privacy, data security, and responsible use of network resources. Adhering to ethical guidelines ensures the confidentiality, integrity, and availability of data during application communication.
Gender	Promoting gender diversity and inclusivity in computer network applications is important to ensure diverse perspectives and inclusive designs. Efforts should be made to encourage and support the participation of underrepresented groups in application development and networking fields
Human Values	Principles of computer network applications should prioritize human values such as accessibility, usability, and user-friendliness. Applications should be designed to provide seamless and intuitive user experiences, ensuring equitable access and usability for all users.
Environment & Sustainability	Sustainable application design involves optimizing network communication to minimize resource consumption and reduce environmental impact. This includes implementing efficient data transfer mechanisms, minimizing unnecessary data transmission, and promoting energy-efficient application architectures.
SDG	SDG 4
NEP 2020	-
POE/4th IR	

COMPUTER NETWORKS LAB

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

Defined Course Outcomes

COs	
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.	CO 3, CO 4
22	Design and deploy TCP based Multithreaded Chat client server for your class.	CO 3, CO 4
23	Design and deploy UDP based Multithreaded Chat client server for your class.	CO 3, CO 4
24	Examining real-world network deployments.	CO 3, CO 4
25	Case studies of network failures and their resolutions.	CO 2, CO 3, CO 4

INTRODUCTION OF NEURAL NETWORK AND DEEP LEARNING

Department:	**Department of Computer Science and Engineering**		
Course Name: Introduction to Neural Network and Deep learning	**Course Code**	**L-T-P**	**Credits**
	ENCS306	4-0-0	4
Type of Course:	Major		
Pre-requisite(s), if any:			
Brief Syllabus: The course begins with key concepts of neural networks, feed-forward neural network, and back propagation. The student gets an opportunity to learn the programming languages (Tensor Flow) to train the deep learning models. The student learns the concepts behind deep learning algorithms and its use cases.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Basics of Neural Network**	**No. of hours: 10**	
Content Summary: Basic ideas behind the Neural Network, Social Engineering about the data, Importance, and applications of Neural network Neural network concepts, Information flow in a neural network, understanding the basic structure of biological Neural Networks and ANN. Activation functions and their uses.(Sigmoid, Relu, Tanh etc.)			
Unit Number: 2	**Title: Feedforward neural network**	**No. of hours: 10**	
Content Summary: Linear Models, Training a Neural network, how to determine hidden layers, recurrent neural, multi-layer neural network, Risk minimization, regularization, model selection, and practical optimization.			

Unit Number: 3	Title: Deep Learning	No. of hours: 10

Content Summary: Deep Feed Forward network, bias-variance dilemma, Overfitting, dropouts, Gradient decent algorithm, Convolutional Neural Network, Recurrent Neural Network, Deep Belief Network.

Challenges in designing the best Neural Network ---**Self-learning**

Unit Number: 4	Title: Probabilistic Neural Network and Deep Learning Research	No. of hours: 10

Content Summary: Hopfield Net, Boltzmann machine, RBMs, Need of Encoders and Auto encoders, Object recognition, computer vision, natural language processing.

Research areas in Probabilistic Neural Networks

***SELF-LEARNING COMPONENTS:**

https://nptel.ac.in/courses/117105084

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

Text Books

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

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** neural network and Biological Neural Network
CO2	**Express** proficiency in the handling of feedforward Neural Network
CO3	**Determine** methods to create and manipulate Deep Neural Network
CO4	**Identify** commonly used operations involving in designing Deep Neural Network
CO5	**Articulate** Neural Network, such as Backpropagation, Drop out, overfitting and their use in programs.

COs Mapping with Levels of Bloom's taxonomy

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

CO-PO Mapping

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	**The Neural Network**
Local	Information flow in a neural network
Regional	understanding the basic structure of biological Neural Networks and ANN.
National	Training a network
Global	loss functions, activation functions
Employability	Develops skills in using internet-based services and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in Neural networks.
Professional Ethics	-

Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Feedforward neural network**
Local	Understanding of how to train the neural networks
Regional	-
National	-
Global	Aligns with global trends in Neural networks technologies
Employability	Develops skills in using Neural network
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in Deep learning.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Deep Learning**
Local	Understanding different algorithms used in deep learning
Regional	-
National	Contributes to deep learning technology strategies
Global	Aligns with global trends in Deep neural network
Employability	Develops skills in programming and other techniques
Entrepreneurship	-

Skill Development	Develops knowledge and skills in Deep learning
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Probabilistic Neural Network and Deep Learning research**
Local	
Regional	-
National	Contributes to national business strategies.
Global	Aligns with global trends in deep learning research and applications
Employability	Develops skills in predictive modeling
Entrepreneurship	-
Skill Development	Develops knowledge and skills in data analytics as well as in predictions
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-

POE/4th IR	Aligns with the concepts of Neural network and Deep Learning applications

INTRODUCTION TO NEURAL NETWORKS & DEEP LEARNING LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Introduction to Neural Network and Deep learning Lab	**Course Code**	**L-T-P**	**Credits**
	ENCS354	0-0-2	1
Type of Course:	Major		
Pre-requisite(s), if any:			

Proposed Lab Experiments

Defined Course Outcomes

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

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

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

K.R. MANGALAM UNIVERSITY

COMPETITIVE CODING LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Competitive Programming Lab	**SEC036**	0-0-4	2
Type of Course:	SEC		

Course Outcomes

CO1	**Demonstrate** proficiency in implementing and analyzing various algorithms and data structures commonly used in competitive programming.
CO2	**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	**Cultivate** algorithmic thinking and problem-solving skills by identifying patterns, applying appropriate algorithms, and selecting optimal data structures for a given problem.
CO4	**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	**Gain** familiarity with different online competitive programming platforms, participate in coding competitions, and develop strong problem-solving and critical thinking skills in a competitive programming environment.

List of Experiments

S. No.	Experiment	COs
1	Introduction to Competitive Coding • Overview of competitive coding and its importance in the field of computer science. • Understanding the significance of problem-solving skills and algorithmic thinking in competitive coding.	CO1
2	Data Structures and Algorithms • Review of fundamental data structures: arrays, linked lists, stacks, queues, trees, graphs, and hash tables. • Study of essential algorithms: searching, sorting, recursion, dynamic programming, greedy algorithms, and graph algorithms.	CO1
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.	CO5

	• Understanding the benefits and drawbacks of each paradigm in competitive coding.	
7	Online Judges and Contest Platforms • Familiarization with popular online judge platforms like Codeforces, Topcoder, and LeetCode. • Practice solving problems from online contests and participating in coding competitions. List of suggested links to coding platforms ▪ Codeforces: https://codeforces.com/ ▪ Topcoder: https://www.topcoder.com/ ▪ AtCoder: https://atcoder.jp/ ▪ LeetCode: https://leetcode.com/ ▪ HackerRank: https://www.hackerrank.com/ ▪ CodeChef: https://www.codechef.com/ ▪ HackerEarth: https://www.hackerearth.com/ ▪ Project Euler: https://projecteuler.net/ ▪ UVa Online Judge: https://onlinejudge.org/ ▪ SPOJ (Sphere Online Judge): https://www.spoj.com/ ▪ Google Code Jam: https://codingcompetitions.withgoogle.com/codejam ▪ Kick Start by Google: https://codingcompetitions.withgoogle.com/kickstart ▪ ACM ICPC Live Archive: https://icpcarchive.ecs.baylor.edu/ ▪ A2 Online Judge: https://a2oj.com/ ▪ CodeSignal: https://codesignal.com/	CO5
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 ▪ "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:	CO5

	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

(DEPARTMENT ELECTIVE -II)

NATURAL LANGUAGE PROCESSING

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
NATURAL LANGUAGE PROCESSING	**ENSP302**	4-0-0	4
Type of Course:	Minor (Department Elective II)		
Pre-requisite(s), if any: Strong programming skills, particularly in Python.			
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: 10**	
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: 10**	
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: 10

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: 10

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

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

***SELF-LEARNING COMPONENTS:**

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

Please Note:

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

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

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

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

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the fundamentals of Natural Language Processing (NLP).
CO2	**Analyze** and represent text data using various techniques.
CO3	**Implement** text classification and information extraction techniques
CO4	**Apply** NLP techniques to analyze social media data
CO5	**Develop** practical solutions using NLP for real-world problems

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	2	-	-	-	-	-	-	3
CO3	3	-	--	-	3	-	2	-	-	-	-	3
CO4	-	-	3	-	1	-	-	-		-	2	2
CO5	3	2	-	2	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	**Introduction to NLP**
Local	Understanding NLP in real-world scenarios can address local language processing needs and applications.
Regional	NLP techniques can be applied regionally to various language-related tasks and projects.
National	NLP is significant for various national-level language processing initiatives and applications.
Global	NLP has widespread global applications, addressing language challenges across different cultures and regions.
Employability	Proficiency in NLP opens up employment opportunities in fields requiring language processing, AI, and data analysis skills.
Entrepreneurship	NLP knowledge can inspire entrepreneurial ventures, such as developing innovative NLP models or language-based startups.
Skill Development	Learning NLP enhances analytical and programming skills, vital for developing language-based AI applications.
Professional Ethics	Applying NLP ethically is essential to ensure responsible use of language processing technologies and avoid biases.
Gender	NLP applications should be unbiased and inclusive, considering the diverse linguistic needs of individuals of all genders.
Human Values	Implementing NLP with human values fosters language understanding and communication to improve human interactions.
Environment & Sustainability	NLP can be applied to develop sustainable language technologies and promote multilingual environmental awareness.
Unit II	**Text Representation**
Local	Text representation techniques can be tailored to local language data, improving the effectiveness of NLP applications in local contexts.

Regional	Text representation methods can be applied to regional language data for diverse NLP applications in specific geographic regions.
National	Text representation is crucial for handling various languages used nationally, enhancing the versatility of NLP systems.
Global	Text representation techniques enable effective NLP across different languages and cultures, making it globally applicable.
Employability	Proficiency in text representation methods enhances employability in NLP-related fields, data science, and AI industries.
Entrepreneurship	Knowledge of text representation can inspire the development of language processing tools and solutions catering to specific markets.
Skill Development	Learning text representation methods develops expertise in feature engineering and model training for NLP tasks.
Professional Ethics	Applying text representation ethically is essential to maintain accurate and unbiased language processing systems.
Gender	Gender-aware text representation avoids gender biases and ensures inclusive language understanding in NLP applications.
Human Values	Text representation with ethical considerations promotes human values and fosters responsible use of language technologies.
Environment & Sustainability	Text representation can be applied to promote environmental awareness and communication in diverse languages.
Unit III	**Information Extraction**
Local	Information extraction techniques can be applied to extract valuable insights from local language data for regional applications.
Regional	Regional information extraction applications can address specific language-related challenges in a particular geographic area.

National	Information extraction is valuable for various national-level language processing projects and knowledge discovery applications.
Global	Global information extraction aids in understanding multilingual data, supporting cross-cultural analysis and applications.
Employability	Proficiency in information extraction techniques enhances employability in NLP, data analysis, and information retrieval roles.
Entrepreneurship	Knowledge of information extraction can inspire the development of specialized language processing tools for diverse industries.
Skill Development	Learning information extraction methods develops expertise in pattern recognition and knowledge extraction from unstructured data.
Professional Ethics	Applying information extraction ethically ensures responsible use of data and protects individuals' privacy in language processing.
Gender	Gender-aware information extraction promotes inclusive language analysis and avoids reinforcing gender biases in the output.
Human Values	Information extraction with ethical considerations respects individual values and fosters meaningful knowledge discovery.
Environment & Sustainability	Information extraction can support environmental research and awareness by analyzing language data related to sustainability.
Unit IV	**NLP for Social Media**
Local	NLP for social media can address local language usage in social platforms, supporting community engagement and language understanding.
Regional	Regional NLP applications in social media can capture language nuances specific to various regions and enhance social analytics.

National	NLP for social media is significant for national-level sentiment analysis, understanding public opinions, and monitoring social trends.
Global	Global NLP for social media enables monitoring sentiments across cultures, tracking global trends, and addressing language-based challenges.
Employability	Proficiency in NLP for social media enhances employability in digital marketing, social media analytics, and sentiment analysis roles.
Entrepreneurship	Knowledge of NLP for social media can inspire the development of social media monitoring tools, fake news detection systems, and analytics.
Skill Development	Learning NLP for social media develops expertise in sentiment analysis, language processing for online content, and social data analytics.
Professional Ethics	Applying NLP in social media ethically ensures responsible use of social data, user privacy protection, and unbiased sentiment analysis.
Gender	Gender-aware NLP in social media avoids reinforcing gender stereotypes and respects the diverse language use of individuals of all genders.
Human Values	NLP for social media with ethical considerations promotes constructive online conversations, combats misinformation, and encourages empathy.
Environment & Sustainability	NLP for social media can be applied to analyze social discussions related to environmental issues, promoting awareness and action.
SDG	SDG 4
NEP 2020	-
POE/4th IR	-

NATURAL LANGUAGE PROCESSING LAB

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

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Understand** the fundamental concepts and techniques of web scraping to extract data from websites efficiently and ethically.
CO 2	**Acquire** proficiency in using developer tools to inspect and analyze website elements, facilitating data extraction and understanding the underlying structure of web pages.
CO 3	**Implement** mechanisms to request permission for web scraping, ensuring compliance with legal and ethical guidelines related to data access and usage.
CO 4	**Develop** skills in inspecting specific HTML elements, such as the H1 element and table element, for targeted data extraction and analysis.

CO 5	**Demonstrate** proficiency in data preprocessing and cleaning techniques, including column list creation and cleaning, to prepare raw data for natural language processing tasks.

List of Experiments

Ex. No.	Experiment Title	Mapped COs
1	Write a program to scrap a website	CO1, CO3
2	Write a program to inspect a website using dev tools	CO2
3	Write a program to request permission to scrap a website	CO3
4	Write a program to inspect H1 element of a website	CO2, CO4
5	Write a program to inspect table element of a website	CO2, CO4
6	Write a program to create a column list	CO5
7	Write a program to clean a column list	CO5
8	Write a program for word tokenization	CO5
9	Write a program to implement RegEx for word tokenization	CO5
10	Write a program to implement stopwords	CO5
11	Write a program to implement LSTM	CO5

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.</td></tr>
</table>

Image Enhancement: Frequency and Spatial Domain, Contrast Stretching, Histogram Equalization, Low pass and High pass filtering.		
Unit Number: 2	**Title: Image Restoration and coloring**	**No. of hours: 10**
Content Summary: Model of The Image Degradation Restoration Process, Noise Models, Restoration in the presence of Noise Only Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear Position Invariant Degradations, Estimation of Degradation Function, Inverse filtering, Wiener filtering, Constrained Least Square Filtering, Geometric Mean Filter, Geometric Transformations. Colour Image Processing, Image Segmentation, Texture Descriptors, Colour Features, Edges/Boundaries, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Speeded up Robust Features, Saliency.		
Unit Number: 3	**Title: Image Compression and Segmentation**	**No. of hours: 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:**

Please Note:

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

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.**

Define Course Outcomes (CO)

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

COs Mapping with Levels of Bloom's taxonomy

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

CO-PO Mapping

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

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	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

Defined Course Outcomes

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

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

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

Detailed syllabus

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

• Project: Apply filters on a set of images and analyze the effects of smoothing and sharpening
Session 4: Image degradation and restoration: modeling degradation process, noise reduction
• Session: Introduction to image degradation and restoration • Exercise: Model image degradation process and implement noise reduction techniques • Project: Restore a set of degraded images using various restoration methods
Session 5: Inverse filtering and Wiener filtering for image restoration
• Session: Understanding inverse filtering and Wiener filtering for image restoration • Exercise: Implement inverse filtering and Wiener filtering algorithms in Python • Project: Apply restoration techniques on a set of images and evaluate the performance
Session 6: Geometric mean filter for image denoising
• Session: Introduction to geometric mean filter for image denoising • Exercise: Implement geometric mean filter in Python for denoising images • Project: Apply the filter on noisy images and compare the results with other denoising techniques
Session 7: Geometric transformations: translation, rotation, scaling
• Session: Introduction to geometric transformations in image processing • Exercise: Implement translation, rotation, and scaling operations on images using OpenCV • Project: Apply geometric transformations on a set of images and analyze the transformations' effects
Session 8: Color image processing: color space conversion, histogram-based operations
• Session: Understanding color image processing techniques • Exercise: Perform color space conversion and histogram-based operations on images • Project: Apply color image processing techniques on a set of images and analyze the results
Session 9: Image segmentation using thresholding techniques
• Session: Introduction to image segmentation using thresholding techniques • Exercise: Implement thresholding algorithms for image segmentation in Python • Project: Segment images using various thresholding methods and evaluate the segmentation results
Session 10: Texture analysis and feature extraction

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

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

Session 24: Object representation and description using morphological algorithms
• Session: Understanding object representation and description using morphological algorithms • Exercise: Implement object representation and description techniques using morphological operations • Project: Represent and describe objects in images using morphological algorithms and analyze the results
Session 25: Introduction to computer vision applications
• Session: Overview of computer vision applications and use cases • Exercise: Explore different computer vision applications and their functionalities • Project: Choose a specific computer vision application, implement it, and demonstrate its capabilities
Session 26: Pattern classification using artificial neural networks
• Session: Introduction to pattern classification using artificial neural networks • Exercise: Implement an artificial neural network for pattern classification in Python • Project: Train a neural network model to classify patterns and evaluate its performance
Session 27: Convolutional neural networks for image classification
• Session: Understanding convolutional neural networks (CNNs) for image classification • Exercise: Implement a CNN architecture in Python for image classification • Project: Train a CNN model on a dataset for image classification and evaluate its accuracy
Session 28: Machine learning algorithms for image segmentation
• Session: Introduction to machine learning algorithms for image segmentation • Exercise: Implement machine learning algorithms for image segmentation in Python • Project: Apply machine learning techniques for image segmentation and analyze the segmentation results
Session 29: Motion estimation and object tracking
• Session: Understanding motion estimation and object tracking techniques • Exercise: Implement motion estimation and object tracking algorithms in Python • Project: Track objects in video sequences using motion estimation and analyze the tracking performance
Session 30: Gesture recognition and face/facial expression recognition

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

INTRODUCTION TO GENERATIVE AI

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Generative AI	**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/

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the foundational concepts of Generative AI
CO2	**Apply** probability distributions and random variables in generative models

CO3	**Employ** various generative models, such as VAEs, GANs, and flow-based models, to generate new data samples in different domains.
CO4	**Implement** and **Analyze** generative models
CO5	**Evaluate** emerging trends and future directions in the field of Generative AI
CO6	**Develop** sequence generation models using recurrent neural networks (RNNs) and LSTM

COs Mapping with Levels of Bloom's taxonomy

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

CO-PO Mapping

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

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

CO-PSO Mapping

PO	PO1	PO2	PO3	PSO4
CO1	3	-	-	-
CO2	3	3	-	-
CO3	3	3	3	-
CO4	-	3	-	-
CO5	3	3	-	-
CO6	-	3	3	-

Relevance of the Syllabus to various indicators

Unit I	**Foundations of Generative AI**
Local	-
Regional	-
National	-
Global	Understanding generative AI enables participation in global technological development and collaboration.

Employability	Proficiency in generative AI enhances employability in AI-related fields and industries.
Entrepreneurship	-
Skill Development	Develops technical skills in deep learning, probabilistic modeling
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Generative Models**
Local	-
Regional	-
National	-
Global	Technological development and innovation.
Employability	-
Entrepreneurship	-
Skill Development	Develops technical skills in autoencoders, VAEs, GANs, and autoregressive models.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Generative Adversarial Networks and Flow-based Models**
Local	-

Regional	-
National	-
Global	Developing algorithms and models
Employability	-
Entrepreneurship	-
Skill Development	Develops technical skills in Generative Adversarial Networks and Flow-based Models
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Applications and Future Directions**
Local	-
Regional	-
National	-
Global	Knowledge of emerging trends and future directions in the field of Generative AI
Employability	-
Entrepreneurship	-
Skill Development	Develops skills in applying generative models, analyzing their performance, and exploring future directions.
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
SDG	4,8,9
NEP 2020	Development of a knowledge-based society and promotes interdisciplinary learning.
POE/4th IR	Advancement of AI technologies.

INTRODUCTION TO GENERATIVE AI LAB

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

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Utilize** Python programming to generate random samples from various probability distributions
CO 2	**Apply** knowledge of generative AI models and frameworks
CO 3	**Develop** proficiency in building and training feedforward neural networks and deep learning frameworks
CO 4	**Implement** basic autoencoder models and train them on datasets
CO5	**Evaluate** the performance metrics of trained models, such as accuracy and loss

Ex. No	Experiment Title	Mapped CO/COs
1	Generate random samples from various probability distributions (e.g., normal distribution, uniform distribution) using Python	CO1
2	Implement maximum likelihood estimation (MLE) for a given dataset and estimate the parameters of a selected probability distribution.	CO1
3	Explore and experiment with existing generative AI models and frameworks (e.g., TensorFlow, PyTorch).	CO2
4	Implement a basic generative AI model (e.g., a simple image generator) using a chosen framework.	CO2
5	Implement a feedforward neural network using a deep learning framework (e.g., TensorFlow, PyTorch).	CO3
6	Train the neural network on a benchmark dataset (e.g., MNIST, CIFAR-10) using backpropagation and a chosen optimization algorithm (e.g., stochastic gradient descent).	CO3
7	Evaluate the trained model's performance metrics (e.g., accuracy, loss) on a separate validation set.	CO5
8	Compare and analyze the performance of the trained model with and without transfer learning.	CO5
9	Train an autoencoder on a dataset of images.	CO4
10	Encode a set of images using the trained encoder and visualize their corresponding latent space representations	CO4
11	Build an encoder and a decoder architecture for a VAE using a deep learning framework.	CO4
12	Train the VAE on a dataset of images (e.g., MNIST, CIFAR-10) using a chosen loss function	CO4
13	Implement a basic autoencoder model and train it on a dataset.	CO4

14	Implement an autoregressive model, such as PixelCNN or PixelRNN, using a deep learning framework.	CO3
15	Implement a GAN architecture using a deep learning framework.	CO3
16	Train the GAN on a dataset of images (e.g., MNIST, CIFAR-10) and monitor the generator and discriminator losses.	CO5
17	Analyze the loss functions used in GAN training (e.g., adversarial loss, feature matching loss)	CO5
18	Train an RNN-based model to generate sequences (e.g., text or music)	CO3
19	Train the RNN on a dataset of sequences (e.g., text corpus, MIDI data) using backpropagation through time (BPTT)	CO3
20	Implement a flow-based generative model using a deep learning framework	CO3
21	Fine-tune a pre-trained deep learning model on a new task or dataset.	CO3
22	Implement the Tacotron model using a deep learning framework.	CO3
23	Implement the CycleGAN model using a deep learning framework.	CO3
24	Implement the evaluation metrics using appropriate libraries or frameworks.	CO5
25	Evaluate the performance of different generative models using the implemented metrics.	CO5

Projects:

Project 1: Random Data Analysis
Description: In this project, you will generate random samples from various probability distributions using Python and analyze the generated data.
Tasks:
1. Choose three different probability distributions (e.g., normal distribution, uniform distribution, exponential distribution). 2. Write Python code to generate random samples from each distribution using appropriate libraries or functions. 3. Plot histograms or density plots to visualize the generated samples for each distribution. 4. Compute and display summary statistics (e.g., mean, standard deviation) for each generated sample. 5. Compare the characteristics of the generated samples from different distributions and analyze their differences.
Project 2: Parameter Estimation for a Probability Distribution
Description: In this project, you will implement the maximum likelihood estimation (MLE) algorithm to estimate the parameters of a selected probability distribution based on a given dataset.
Task:
1. Choose a probability distribution (e.g., normal distribution, exponential distribution) and specify its probability density function (PDF) or probability mass function (PMF). 2. Generate a synthetic dataset based on the chosen distribution with known parameters. 3. Implement the MLE algorithm using Python to estimate the parameters of the distribution from the synthetic dataset. 4. Compare the estimated parameters with the known true parameters and calculate the estimation error. 5. Repeat the process for multiple iterations with different dataset sizes to analyze the performance of the MLE algorithm with varying sample sizes.
Project 3: Exploring Pre-trained Generative AI Models

Description: In this mini project, you will explore and experiment with existing pre-trained generative AI models using popular frameworks such as TensorFlow or PyTorch.

Task:

1. Choose a specific generative AI model, such as a pre-trained image generation model (e.g., GAN, VAE) or a text generation model (e.g., language model).
2. Set up the chosen deep learning framework (e.g., TensorFlow or PyTorch) and load the pre-trained model.
3. Understand the input and output requirements of the model and experiment with generating new samples.
4. Analyze and interpret the generated samples in terms of their quality, diversity, or other relevant metrics.
5. Explore different input variations or techniques to generate customized or specific samples.

Project 4: Image Classification using Feedforward Neural Network

Description: In this mini project, you will implement a feedforward neural network using a deep learning framework and train it for image classification on a benchmark dataset.

Task:

1. Choose a benchmark dataset for image classification, such as MNIST or CIFAR-10.
2. Set up the chosen deep learning framework (e.g., TensorFlow or PyTorch) and define the architecture of the feedforward neural network for image classification.
3. Preprocess the dataset, including normalization and splitting into training and validation sets.
4. Implement the training loop for the feedforward neural network using backpropagation and a chosen optimization algorithm (e.g., stochastic gradient descent).
5. Evaluate the trained model's performance metrics (e.g., accuracy, loss) on the separate validation set and analyze the results.

TRANSFER LEARNING

Department:	**Department of Computer Science and Engineering**		
Course Name: **Transfer Learning**	**Course Code**	**L-T-P**	**Credits**
	ENSP308	4-0-0	4
Type of Course:	Minor (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:

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

Text Books

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

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** transfer learning concepts and principles.
CO 2	**Apply** transfer learning techniques to real-world problems.
CO 3	**Analyze** and evaluate the performance of transfer learning algorithms

CO 4	**Synthesize** and adapt pre-trained models for specific tasks.
CO 5	Critically **think**, propose innovative approaches, and effectively communicate transfer learning concepts

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C1,C2	A1	P1
CO2	C3	A2	P2
CO3	C4	A3	P3
CO4	C5	A4	-
CO5	C5	-	P5

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	1	-	-	-	1	-	-	1
CO2	3	2	3	2	3	3	-	-	-	2	-	2
CO3	3	1	3	-	3	-	-	-	2	2	-	3
CO4	-	-	1	-	1	-	-	-	-	-	-	2
CO5	-	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:	**Course Code**	**L-T-P**	**Credits**
Transfer Learning Lab	**ENSP358**	0-0-2	1
Type of Course:	Minor (Department Elective II)		
Pre-requisite(s), if any: NA			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Understand** the fundamentals of transfer learning, including its motivation and applications.
CO 2	**Gain** proficiency in implementing transfer learning techniques and algorithms using Python.
CO 3	**Apply** fine-tuning and model adaptation techniques to transfer knowledge across different domains and tasks
CO 4	**Evaluate** and measure the performance of transfer learning models using appropriate metrics in Python.
CO5	**Analyze** case studies and real-world applications of transfer learning to understand its practical implications

Ex. No	Experiment Title	Mapped CO/COs
1	Fine-tuning Pretrained Models using Python	CO1
2	Introduction to Transfer Learning using Python	CO1
3	Exploring Pretrained Models in Python	CO2
4	Implementing Transfer Learning with Pretrained Models in Python	CO2
5	Feature Extraction from Pretrained Models using Python	CO2
6	Implementing a deep transfer learning model using Python libraries like TensorFlow or PyTorch to address domain shift in image classification tasks.	CO3
7	Fine-tuning a pre-trained CNN architecture, such as VGG or ResNet, in Python to transfer knowledge from a source task to a target task.	CO2
8	Implementing a multi-task learning approach using Python libraries like Keras or TensorFlow to train an RNN model for multiple related tasks in natural language processing.	CO3
9	Building an ensemble of transfer learning models in Python by combining predictions from multiple pre-trained models to improve performance in image recognition tasks.	CO3
10	Utilizing Python libraries like TensorFlow or PyTorch to implement generative models, such as GANs, to handle dataset bias and generate synthetic data for transfer learning.	CO3
11	Preprocess a dataset using Python libraries like NumPy and Pandas, perform data augmentation techniques, and extract relevant features for transfer learning tasks.	CO4
12	Implement fine-tuning techniques using Python and deep learning frameworks like TensorFlow or PyTorch to adapt pre-trained models to new target tasks.	CO3

13	Transfer knowledge from a pre-trained model in one domain to a different domain or task using Python and transfer learning techniques like domain adaptation or multi-task learning.	CO2
14	Implement transfer learning using popular deep learning frameworks like TensorFlow or PyTorch. Students can choose a specific framework, load pre-trained models, and fine-tune them for their desired tasks.	CO3
15	Design experiments to evaluate different transfer learning strategies and techniques, analyze the performance of transfer learning models using Python, and fine-tune the models based on the analysis results	CO4
16	Implement transfer learning techniques using Python and deep learning frameworks like TensorFlow or PyTorch for computer vision tasks such as image classification, object detection, or image segmentation.	CO3
17	Apply transfer learning methods in Python and NLP libraries like NLTK or spaCy for tasks like sentiment analysis, text classification, or named entity recognition.	CO3
18	Utilize Python and speech recognition libraries like SpeechRecognition or PyAudio to develop transfer learning models for speech recognition tasks.	CO3
19	Choose a specific domain like healthcare, finance, or social media analysis and implement transfer learning techniques in Python to address domain-specific tasks such as medical image classification, financial sentiment analysis, or social media text classification.	CO5
20	Apply transfer learning concepts to time-series data using Python and deep learning frameworks like TensorFlow or PyTorch to solve tasks like forecasting, anomaly detection, or sensor data analysis	CO4
21	Study recent research papers on transfer learning and implement cutting-edge transfer learning algorithms or architectures in Python to stay updated with the latest trends in the field	CO5

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. 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: 7

(DEPARTMENT ELECTIVE-III)

COMPUTATIONAL SERVICES IN THE CLOUD

Department:	**Department of Computer Science and Engineering**		
Course Name: Computational Services in The Cloud	**Course Code**	**L-T-P**	**Credits**
	ENSP401	4-0-0	4
Type of Course:	Minor (Department Elective III)		
Pre-requisite(s), if any:			
Brief Syllabus: This course covers evolutionary computing paradigms from multi-processor systems to Cloud, Edge, and Fog Computing. The course design follows cloud deployment models, service models, virtualization techniques and cloud architectural solutions. It also elaborates cloud compliances and security at fine-grained level by following a shared responsibility model. It reveals a design pattern to the students, enabling them to think through the process of designing and implementing cloud infrastructure and optimal IT solutions			
Unit Number: 1	**Title: Introduction to Cloud Computing**		**No. of hours: 10**
Content Summary: Cloud Computing, Adoption of cloud-based IT resources, Service Models: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), Software-as-a-Service(SaaS), Deployment models: Public Cloud, Private Cloud, Hybrid Cloud, Community Cloud, Cloud Computing Characteristics, Challenges of cloud computing, Virtualization concept, Types of virtualizations, Demo of virtualization, Virtualization Merits, Role of virtualization in cloud computing, Virtualization Demerits, VMPlacement, VM Migration, VM Migration Demo, VM clustering, Design Issues in VM			

Clustering, Need of Dockers and Containers, Docker Eco-System, Hypervisor vs Docker.

Unit Number: 2	Title: Microservices	No. of hours: 10

Content Summary:

Microservices, Service-Oriented Architecture, REST API, IP Addressing, Subnetting, Supernetting, Designing of Virtual Private Cloud, Demo of VPC, VPC Peering,VPC Case Study, Cloud Storage, Serverless Computing, Cloud API Gateway, Cloud Databases, Resource Provisioning, Time shared and space shared, Efficient VMConsolidation on cloud server, Task/DAG Scheduling Algorithms, Min-Min, Max-Min, MET, B-level Demo, T-level Demo, Task-VM Mapping, Auto Scaling, Load Balancing.

Unit Number: 3	Title: Case Study	No. of hours: 10

Content Summary:

Case Study: Cloud Market analysis, Security and Compliances, Shared security model in IAAS/PAAS/SAAS, Shared technology issues, Data loss or leakage, Accountor service hijacking, Implementation of cloud security, Security Groups, Network Access Control Lists, Cloud databases, Parallel Query Execution with NoSQLDatabase, Big Data, Handling Big Data on Cloud Platform, Map- Reduce framework for large clusters using Hadoop, Design of data applications based on Map Reducein Apache Hadoop.

Unit Number: 4	Title: Comparative study/analysis of public clouds	No. of hours: 10

Content Summary:

Comparative study/analysis of public clouds, Edge Computing, Fog Computing, Data Offloading, Cloud-Based DevOps Tools, Task Partitioning, Data Partitioning, Data Synchronization, Distributed File System, Data center, Ongoing Research Topics.

***SELF-LEARNING COMPONENTS:** The students are expected to choose a topic in discussion with the industry expert and implement the concepts of cloud computing. The student should present the progress at the end of the semester. **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: 4. Lizhe Wang, Rajiv Ranjan, Jinjun Chen and Boualem Benatallah, Cloud Computing (1 ed.), CRC Press, 2017. ISBN 978-1351833097. **5.** Judith S. Hurwitz and Daniel Kirsch, Cloud Computing For Dummies (2 ed.), Hoboken: John Wiley & Sons, 2020. ISBN 978-1119546658. 6. Prerna Sharma, Moolchand Sharma and Mohamed Elhoseny, Applications of Cloud Computing (1 ed.), CRC Press, 2020. ISBN 9780367904128.

Define Course Outcomes (CO)

COs	**Statements**
CO1	Explain the core concepts of the cloud computing paradigm: how and why this paradigm shift came about, the characteristics, advantages and challenges brought about by the various models and services in cloud computing.
CO2	Apply the fundamental concepts in datacenters to understand the tradeoffs in power, efficiency and cost.
CO3	Identify resource management fundamentals, i.e. resource abstraction, sharing and sandboxing and outline their role in managing infrastructure in cloud computing.

CO4	Analyze various cloud programming models and apply them to solve problems on the cloud.

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	A3	P4
CO2	C3	A4	P2
CO3	C2	A2	P1
CO4	C4	A5	P5

CO-PO Mapping

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

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

Justification for mapping must be relevant.

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	**Introduction to Design thinking**
Local	-
Regional	-
National	-
Global	It promotes international collaboration, data sharing, and connectivity, facilitating global trade, research, and innovation.
Employability	Proficiency in cloud computing technologies, service models, and deployment models enhances employability and career prospects.

Entrepreneurship	-
Skill Development	This includes skills in virtualization, cloud service models, deployment models, and containerization.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Case studies in Design thinking**
Local	-
Regional	-
National	-
Global	In the global context, microservices, service-oriented architecture, and cloud computing are essential technologies driving digital innovation and transformation. Global organizations heavily rely on these technologies to deliver scalable and resilient applications and services to a global user base.
Employability	Acquiring skills in microservices, service-oriented architecture, and cloud computing enhances employability prospects in the IT industry. Proficiency in these technologies is in high demand as organizations increasingly adopt cloud-based architectures and microservice-oriented approaches
Entrepreneurship	-
Skill Development	The course on microservices, service-oriented architecture, and cloud computing promotes skill development in areas such as cloud infrastructure design, API development, virtualization, storage management, and resource provisioning

Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Design Frameworks**
Local	-
Regional	-
National	-
Global	It helps address global challenges such as data privacy, security breaches, and international data transfer regulations.
Employability	Knowledge of cloud market analysis, security, and compliance enhances employability in various roles, including cloud architects, cloud security specialists, and cloud consultants.
Entrepreneurship	-
Skill Development	Studying cloud market analysis, security, and compliance develops critical skills such as risk assessment, security implementation, and compliance management.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Innovation & Creativity**
Local	-
Regional	-

National	-
Global	Cloud computing is a global phenomenon, and a course on comparative study/analysis of public clouds and related topics provides students with a global perspective on cloud technologies.
Employability	Proficiency in cloud computing technologies and understanding the different deployment models, such as public clouds and edge computing, enhances employability prospects in the IT industry.
Entrepreneurship	-
Skill Development	A course on comparative study/analysis of public clouds and related topics enhances various skills such as research, critical analysis, problem-solving, and technical proficiency.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4, 9
NEP 2020	Integration of Emerging Technologies and Skill Development
POE/4th IR	The course on cloud computing aligns with the Fourth Industrial Revolution (IR 4.0) in the following ways: Advanced Infrastructure, Data Management and Analytics and Digital Transformation.

COMPUTATIONAL SERVICES IN THE CLOUD LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Computational Services in The Cloud Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP451	0-0-2	1
Type of Course:	Minor (Department Elective III)		
Pre-requisite(s), if any: Nil			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Apply** the concept cloud computing to solve practical use cases.
CO 2	**Analyzing** different services in cloud computing
CO 3	**Evaluate** different available services provided by cloud vendors
CO 4	**Design** Cloud based application

List of Programs

Ex No	Experiment Title	Mapped CO/COs
1	Install Virtualbox / VMware Workstation with different flavours of linux or windows OS	CO1
2	Install a C compiler in the virtual machine created using virtual box and execute Simple Programs	CO1
3	Install Google App Engine. Create hello world app and other simple web applications using python/java.	CO1
4	Use GAE launcher to launch the web applications.	CO1
5	Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.	CO2
6	Find a procedure to transfer the files from one virtual machine to another virtual machine	CO2
7	Find a procedure to launch virtual machine using trystack (Online Openstack Demo Version)	CO2
8	Install Hadoop single node cluster and run simple applications like wordcount.	CO1
9	Deploy a simple web application using a Platform as a Service (PaaS) offering like AWS Elastic Beanstalk, Azure App Service, or Google App Engine	CO4
10	Create and manage databases using services like AWS RDS, Azure SQL Database, or Google Cloud SQL.	CO3
11	Containerize an application using Docker and create a container registry on a cloud platform.	CO3
12	Deploy and manage containers using container orchestration tools like AWS ECS, Azure Kubernetes Service (AKS), or Google Kubernetes Engine (GKE)	CO4
13	Develop and deploy a serverless function using AWS Lambda, Azure Functions, or Google Cloud Functions	CO4
14	Configure event triggers, access permissions, and monitoring for serverless functions	CO2
15	Utilize cloud-based data analytics tools like AWS Athena, Azure Data Lake Analytics, or Google BigQuery to query and analyze large datasets	CO2
16	Build and train machine learning models using cloud-based services like AWS SageMaker, Azure Machine Learning, or Google Cloud AutoML	CO2

17	Use infrastructure provisioning tools such as AWS CloudFormation, Azure Resource Manager, or Google Cloud Deployment Manager to define and deploy infrastructure components	CO1
18	Set up cloud monitoring and logging services like AWS CloudWatch, Azure Monitor, or Google Cloud Monitoring to track the performance and health of cloud resources	CO3
19	Implement access control policies and roles using AWS IAM, Azure Active Directory, or Google Cloud Identity and Access Management (IAM)	CO4
20	Enable encryption for data at rest and in transit using cloud security services	CO3
21	Explore cost optimization techniques like auto-scaling, spot instances, or reserved instances to optimize cloud resource usage and reduce costs	CO2

MICROSOFT AZURE CLOUD FUNDAMENTALS

Department:	**Department of Computer Science and Engineering**		
Course Name: Microsoft Azure Cloud Fundamentals	**Course Code**	**L-T-P**	**Credits**
	ENSP403	4-0-0	4
Type of Course:	Minor (Department Elective III)		
Pre-requisite(s), if any:			
Brief Syllabus: The Microsoft Azure Cloud Fundamentals course introduces the concepts of cloud computing and the Azure platform. It covers Azure services such as Virtual Machines, Storage, Networking, Identity, App Services, and Databases. The course focuses on security, monitoring, and management in Azure. Real-world case studies and hands-on labs enable practical application. The subject equips students to design trustworthy intrusion detection systems and enhances security in IoT networks using Azure.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to Cloud Computing**		**No. of hours: 10**
Content Summary: Introduction to Cloud Computing and its Characteristics, Benefit, and Challenges of cloud computing. Cloud service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Cloud Deployment Models, for example, Public, private, hybrid, and community clouds. shared responsibility model. Identify appropriate use cases for each cloud model. Consumption-based model. Comparison of cloud pricing models.			
Unit Number: 2	**Title: Introduction to Microsoft Azure**		**No. of hours: 10**

Content Summary: Microsoft Azure cloud platform and its significance in the industry, Azure regions, and availability zones for understanding global data center distribution. Introduction of various Azure services and solutions available for different scenarios.

Unit Number: 3	Title: Azure Virtual Machines (VMs) and Storage	No. of hours: 10

Content summary: Create and manage virtual machines using Azure. Different VM sizes and types based on performance requirements. VM scaling and load balancing for optimizing application performance. Azure storage services: Blob Storage, Table Storage, File Storage, and Disk Storage.

Unit Number: 4	Title: Azure Networking, Identity and Access Management	No. of hours: 10

Content Summary: creation and configuration of virtual networks and subnets in Azure. Azure Load Balancer for distributing incoming network traffic, VPN Azure Active Directory (Azure AD) for managing identities and authentication. Gateway for secure communication between on-premises networks, and Azure. Azure Active Directory (Azure AD) for managing identities and authentication. Database Services, Azure Storage Account for data storage and retrieval.

***SELF-LEARNING COMPONENTS:**

1. https://nptel.ac.in/courses/106105167
2. https://www.mygreatlearning.com/academy/learn-for-free/courses/microsoft-azure-essentials

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 Azure Essentials Fundamentals of Azure by Michael S. Collier and Robin E. Shahan
2. Mastering Microsoft Azure Infrastructure Services by John Savill
3. Azure for Architects by Ritesh Modi

Text Books
Microsoft Azure For Dummie by Timothy L. Warner and Katrina Dow, and Michael Washam

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** Microsoft Azure concepts
CO2	**Express** proficiency in the handling of Azure services
CO3	**Determine** methods to create and manipulate virtual machines
CO4	**Identify** commonly used models to implement cloud network
CO5	**Articulate** Azure database services

COs Mapping with Levels of Bloom's taxonomy

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

C02	C3	-	P2
CO3	C3	-	P4
CO4	C1	-	-
CO5	C1	-	P4

CO-PO Mapping

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	**Introduction to Cloud Computing**
Local	-
Regional	-
National	-
Global	Develops skills in using cloud-based services
Employability	Develops skills in using cloud-based services
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills regarding Cloud concepts as well as in cloud computing, network management, and Azure services
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Introduction to Microsoft Azure**
Local	Understanding of Microsoft Azure services
Regional	-
National	-
Global	Aligns with global trends of Cloud
Employability	Develops cloud-based Knowledge for cloud architects
Entrepreneurship	-
Skill Development	Develops conceptual knowledge of Cloud computing
Professional Ethics	-

Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Azure Virtual Machines (VMs) and Storage**
Local	
Regional	-
National	-
Global	Designing Virtual machines in Azure and storage management
Employability	Develops skills regarding the cloud security and cloud architecture
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Azure Networking, Identity, and Access Management**
Local	
Regional	-
National	-
Global	Access management of data
Employability	Develops skills in cloud security and network management
Entrepreneurship	-

Skill Development	Develops knowledge and skills in data storage and access management
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of technology and coding

MICROSOFT AZURE CLOUD FUNDAMENTALS LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: Microsoft Azure Cloud Fundamentals Lab	**Course Code**	**L-T-P**	**Credits**
	ENSP453	0-0-2	1
Type of Course:	Minor (Department Elective III)		
Pre-requisite(s), if any: Nil			

Proposed Lab Experiments

Defined Course Outcomes

COs	
CO 1	**Acquire** a practical understanding of cloud computing through hands-on lab experiments.
CO 2	**Develop** proficiency in using global data centers.
CO 3	**Demonstrate** the ability to create virtual machines and handle data storage
CO 4	**Analyze** and maintain the security and access management system.

Ex. No.	Experiment Title	Mapped CO/COs
1	Familiarize students with the lab environment, software, and tools.	CO1

2	Creating and Managing Virtual Machines with Virtual Box	CO1
3	Create and configure virtual machines running different operating systems (e.g., Windows and Linux).	CO2
4	Install and configure Next Cloud on a local server or cloud-based virtual machine.	CO2
5	Set up your (user) accounts and storage quotas.	CO2
6	Try to implement -Test file uploads, sharing, and collaboration features	CO1
7	Install pfSense as a virtual router/firewall.	CO2
8	Configure virtual networks, subnets, and VLANs	CO2
9	Network Setup with pf Sense: for Test routing, port forwarding, and firewall rules.	CO1
10	Identity and Access Management with Key Cloak: Explore user authentication methods, roles, and permissions.	CO3
11	Identity and Access Management with Key Cloak Configure single sign-on (SSO) for different applications.	CO3
12	Install Key Cloak as an identity provider on a virtual machine.	CO3
13	Install Azure CLI and PowerShell on your machines.	CO3
14	Configure single sign-on (SSO) for different applications.	CO3
15	Use Azure CLI and PowerShell to create and manage Azure resources (e.g., VMs, storage accounts).	CO3
16	Create a simple web app (e.g., using HTML/CSS/JS or a web framework).	CO3
17	Deploy the web app to Azure App Service using Azure portal or Azure CLI.	CO3
18	Test the app's accessibility and scalability	CO4

19	Create an Azure SQL Database instance.	CO4
20	Monitor security alerts and take remedial actions.	CO4

STORAGE AND DATABASES ON CLOUD

Department:	**Department of Computer Science and Engineering**		
Course Name: **Storages and Databases on Cloud**	**Course Code**	**L-T-P**	**Credits**
	ENSP405	4-0-0	4
Type of Course:	Minor (Department Elective III)		
Pre-requisite(s), if any:			
Brief Syllabus: The course on cloud databases and storage provides a comprehensive understanding of the principles, technologies, and best practices associated with storing and managing data in the cloud. The syllabus covers various topics, starting with an introduction to cloud computing and an exploration of different types of cloud storage and databases, including object storage, block storage, file storage, relational databases, NoSQL databases, and more. Students delve into popular cloud storage and database services, such as Amazon S3, Google Cloud Storage, and Azure Blob Storage gaining practical knowledge of their features, deployment options, scalability, and high availability. The curriculum also includes essential aspects like database design, data migration, security measures, backup and recovery strategies, performance optimization, and monitoring techniques. Real-world case studies provide insights into organizations utilizing cloud storage and databases effectively.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to Storage on cloud**		**No. of hours: 10**
Content Summary: Introduction to Cloud Computing, Overview of cloud databases and cloud storages, types of cloud storages(Object, block and file), different types of cloud database management systems, Gartner Magic Quadrant for Cloud Database Management Systems, Advantages of Working with Cloud Databases, Considerations for Cloud Databases, Top Cloud Database, Factors that help in choosing the right cloud database, Challenges involved in using cloud storages and databases.			

Unit Number: 2	Title: Data Integration, Migration, Security and performance on cloud	No. of hours: 10

Content Summary:

Techniques, tool, methods and considerations for migrating from premise database to cloud databases

Backup, Recovery, and Disaster Planning including automated backups, point-in-time recovery and replication

Performance Optimization and Monitoring including query optimization, indexing, caching, and monitoring tools

Scalability and High Availability: load balancing, replication, sharding, and auto-scaling, Cloud Data Warehousing

Unit Number: 3	Title: AWS Cloud Storage	No. of hours: 10

Content Summary:

Introduction to AWS cloud storage, AWS management console, AWS Storage Services, Uploading files and images , Creating a web server, Overview of Amazon S3, Storage Classes, EC2 Instance Storage, network file system Amazon Elastic Block Store, Amazon Elastic file system, Amazon Cloud Front.

Brief introduction to Google Cloud Storage, and Azure Blob Storage.

Unit Number: 4	Title: Case Study	No. of hours: 10

Content Summary: Case Studies and Real-world Examples of Netflix , Airbnb, Pinterest, spotify, coca-cola etc. Analyzing real-world use cases of organizations using cloud storage and databases, discussing architecture decisions, challenges, and lessons learned.

***Self-Learning Components:**

1) **E**xplore open-source projects related to cloud databases and storage. discover open-source projects from GitHub, learn from the codebase, and contribute to the development of cloud-based storage and database solutions. (https://github.com/topics/cloud-database)

2) Join the course : https://www.coursera.org/specializations/cloud-computing

2) Join Online Courses like

- https://www.udemy.com/topic/cloud-computing/
- https://www.coursera.org/courses?query=data%20storage
- https://www.mygreatlearning.com/academy/learn-for-free/courses/databases-and-files-systems-in-aws
- https://www.youtube.com/watch?v=EN4fEbcFZ_E
- https://www.codecademy.com/catalog/subject/cloud-computing
- https://www.simplilearn.com/tutorials/cloud-computing-tutorial

2) Read case studies of organizations that have successfully implemented cloud storage and database solutions.

- **Case Study of Delloite:** https://www2.deloitte.com/us/en/pages/consulting/articles/cloud-computing-case-studies.html
- **Case Study of Amazon:** https://aws.amazon.com/solutions/case-studies/amazon/

Learn about their challenges, architectural decisions, and best practices they adopted.

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 Cloud Storage: The Essential Guide to Oracle Automatic Storage Management" by Nitin Vengurlekar, 2013

2) "Cloud Database Development and Management" by Lee chao, 2013

3) "Advancing Cloud Database Systems and Capacity Planning with Dynamic Applications" by Narendra Kumar Kamila, 2017

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** & Recall the fundamental concepts and principles of cloud storage and databases. Interpret the security considerations and best practices for cloud storage and databases.
CO2	**Express** ideas and solutions for optimizing performance and improving efficiency in cloud storage and databases through indexing, caching, and query optimization techniques.
CO3	**Determine** the requirements of an application or system and determine the most suitable cloud storage and database solutions to meet those requirements.
CO4	**Identify** different types of cloud storage and database services available.
CO5	**Articulate** the best practices and considerations for designing scalable, reliable, and secure cloud storage and database architectures.
CO6	**Design** data storage architecture for cloud-based 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	C2	-	P1
C02	C3	-	P2
CO3	C3	-	P3
CO4	C2	-	-
CO5	C3	-	P1

CO-PO Mapping

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

Justification for mapping must be relevant.

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	Introduction to cloud databases and storages
Local	local considerations may include factors like local network connectivity, data centre locations, and latency between local systems and cloud databases.
Regional	regional considerations can include regulatory compliance specific to a particular region, data sovereignty issues, and availability zones
National	national considerations such as national data protection laws and regulations, government policies related to cloud computing, and national cybersecurity guidelines that may impact the usage and storage of data in cloud databases.
Global	Aligns with global trends in internet technologies and network protocols accessibility of cloud databases and storage options across multiple regions, data replication and backup strategies for disaster recovery on a global scale
Employability	The unit syllabus may indirectly contribute to employability by introducing students to cloud computing concepts, cloud databases, and storage technologies
Entrepreneurship	-

Skill Development	The unit syllabus primarily focuses on developing skills related to cloud computing, cloud databases, and storage
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Data Integration, Migration, Security and performance on cloud
Local	local considerations may include factors like local network connectivity, data centre locations, and latency between local systems and cloud databases.
Regional	regional considerations can include regulatory compliance specific to a particular region, data sovereignty issues, and availability zones
National	national considerations such as national data protection laws and regulations, government policies related to cloud computing, and national cybersecurity guidelines that may impact the usage and storage of data in cloud databases.
Global	Aligns with global trends in internet technologies and network protocols accessibility of cloud databases and storage options across multiple regions, data replication and backup strategies for disaster recovery on a global scale
Employability	local considerations may include factors like local network connectivity, data centre locations, and latency between local systems and cloud databases.
Entrepreneurship	regional considerations can include regulatory compliance specific to a particular region, data sovereignty issues, and availability zones
Skill Development	national considerations such as national data protection laws and regulations, government policies related to cloud

	computing, and national cybersecurity guidelines that may impact the usage and storage of data in cloud databases.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	AWS Cloud Storage
Local	Primarily focuses on cloud storage technologies and their local implementation within the AWS ecosystem.
Regional	-
National	Contributes to national network security strategies and protocols
Global	AWS, Google Cloud, and Azure are global cloud service providers, enabling businesses worldwide to access their storage services and infrastructure.
Employability	Acquiring knowledge and skills in these cloud storage platforms enhances employability in the field of cloud computing and storage management.
Entrepreneurship	Knowledge of AWS, Google Cloud, and Azure storage services can empower entrepreneurs to build and scale their businesses by utilizing scalable and reliable cloud storage solutions for their applications and data.
Skill Development	The unit syllabus focuses on developing skills related to AWS cloud storage, including uploading files and images, creating a web server, utilizing different storage services
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit IV	Case Studies
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	It supports NEP's objective of enhancing the use of technology in education and research by providing students with knowledge and skills in cloud databases and storage, which are essential components of modern digital infrastructure
POE/4th IR	The course can incorporate discussions on ethical considerations in cloud databases and storage, addressing issues such as data privacy, security, and responsible data management.

STORAGE AND DATABASES ON CLOUD LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **Storages and Databases on Cloud Lab**	**Course Code**	**L-T-P**	**Credits**
	ENSP455	0-0-2	1
Type of Course:	Minor (Department Elective III)		
Pre-requisite(s), if any: Nil			

Proposed Lab Experiments

Defined Course Outcomes

COs	**Understand** the principles and concepts of cloud storage and databases.
CO 1	**Gain** hands-on experience in using cloud storage services for data storage and retrieval.
CO 2	**Implement** backup and recovery strategies for cloud-based storage and databases.
CO 3	**Optimize** database performance in the cloud through indexing and query optimization techniques.
CO 4	**Analyse** real-world case studies to understand the challenges and solutions related to cloud storage and databases.

Ex. No	Experiment Title	Mapped CO/COs
1	**Create accounts and configure cloud storage services such as Amazon S3, Google Cloud Storage, or Azure Blob Storage:** Practice creating buckets/containers, uploading files, setting access permissions, and managing storage resources.	CO1, CO4, CO5
2	**Perform operations on object storage, including uploading, downloading, and deleting files:** Explore advanced features like versioning, lifecycle policies, and metadata management.	CO1, CO2, CO5
3	**Perform Block Storage Configuration:** Create and attach storage volumes to virtual machines, perform formatting and mounting, and understand snapshotting and resizing operations.	CO1, CO3, CO5
4	**File Storage Implementation:** Work with shared file systems such as Amazon EFS, Google Cloud Filestore, or Azure Files. They configure file shares, mount them on virtual machines, and explore features like file locking and access control.	CO1, CO4, CO5
5	**Database Provisioning and Management:** • learn to set up and configure cloud databases like Amazon RDS, Google Cloud SQL, or Azure Database Services • create database instances, manage security settings, and perform basic administration tasks such as backups and restores.	CO1, CO3, CO4, CO5
6	**Data Migration to the Cloud:**	CO1, CO3, CO4, CO5

	• Practice migrating databases from on-premises or other cloud providers to the selected cloud database service. • Explore different migration methods, tools, and validate the successful transfer of data	
7	**Database Design and Schema Management:** • Work on designing and creating database schemas for various scenarios. • Implement tables, relationships, indexes, and constraints to support specific use cases and understand database modelling concepts.	CO1, CO3, CO5, CO6
8	**Data Security and Access Control:** Configure security measures for cloud databases, including setting up user accounts, managing roles and permissions, and implementing encryption techniques to protect data at rest and in transit	CO1, CO5
9	**Performance Tuning and Optimization:** Learn performance tuning techniques for cloud databases, including query optimization, index creation, caching strategies, and monitoring tools to identify and resolve performance bottlenecks	CO1, CO2, CO5
10	**High Availability and Scalability:** • Explore features like replication, automatic scaling, and load balancing to ensure high availability and scalability of databases in the cloud • Configure and test failover scenarios and evaluate the performance impact of scaling operations.	CO1, CO3, CO5
11	**Project** **Backup and Recovery Strategies:** • Practice implementing backup and recovery mechanisms for cloud databases • perform regular backups, schedule automated backups, and simulate recovery scenarios to restore databases to a consistent state.	CO1, CO5
12	**Project** **Cloud Data Warehousing:**	CO1, CO2, CO5, CO6

	• Gain hands-on experience with cloud data warehousing platforms like Amazon Redshift • load data, run complex queries, and analyze performance optimization techniques for data warehousing.	
13	**Project** Design and implement an inventory management system that utilizes cloud storage for storing inventory data. Include features such as real-time inventory tracking, order management, and reporting capabilities.	CO1, CO2, CO6
14	**Project** Build a document management system that leverages cloud storage for storing and organizing documents. Include features like full-text search, document tagging, and access control for secure document sharing.	CO1, CO2, CO5s

APPLICATION DEVELOPMENT AND DEVOPS ON CLOUD

Department:	**Department of Computer Science and Engineering**		
Course Name: **APPLICATION DEVELOPMENT AND DEVOPS ON CLOUD**	**Course Code**	**L-T-P**	**Credits**
	ENSP407	4-0-0	4
Type of Course:	Minor (Department Elective III)		
Pre-requisite(s), if any: Nil			
Brief Syllabus: The syllabus aims to equip students with practical skills and theoretical knowledge to design, develop, and deploy applications in cloud environments while implementing DevOps practices to enhance software development, delivery, and operations on the cloud. It prepares them for a career in the dynamic and rapidly growing field of cloud computing and DevOps, where demand for skilled professionals is high due to the increasing adoption of cloud technologies in various industries.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to Cloud Computing**	**No. of hours: 10**	
Content Summary: Overview of Cloud Computing: Definition, Characteristics, Advantages, and Disadvantages. Cloud Service Models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS). Cloud Deployment Models: Public Cloud, Private Cloud, Hybrid Cloud, Community Cloud.			

Cloud Providers: Introduction to popular cloud service providers (e.g., AWS, Azure, Google Cloud).

Cloud Architecture: Understanding cloud components, virtualization, and multi-tenancy.

Introduction to DevOps: Principles, Practices, and Benefits.

Unit Number: 2	Title: Cloud-Based Application Development	No. of hours: 10

Content Summary:

Cloud Native Applications: Principles and architecture for building applications optimized for cloud environments.

Containerization: Docker and Kubernetes for application deployment, scaling, and management.

Microservices Architecture: Designing, developing, and deploying microservices-based applications.

Serverless Computing: Introduction to serverless architecture and Function as a Service (FaaS).

Application Security in the Cloud: Best practices for securing cloud-based applications.

Cloud-Based Databases: Database options and considerations in cloud environments.

Unit Number: 3	Title: DevOps Practices in Cloud	No. of hours: 10

Content Summary:

Continuous Integration (CI) and Continuous Deployment (CD) in Cloud: Setting up CI/CD pipelines.

Infrastructure as Code (IaC): Automating infrastructure provisioning using tools like Terraform and CloudFormation.

Configuration Management: Managing application configurations in a cloud-based environment.

Monitoring and Logging in Cloud: Tools and techniques for monitoring application performance and gathering logs.

Auto-scaling and Load Balancing: Scaling applications dynamically based on demand.

High Availability and Disaster Recovery: Designing and implementing resilient applications in the cloud.

Unit Number: 4	Title: Cloud-Based DevOps Tools and Best Practices	No. of hours: 10

Content Summary:

Cloud-Based Version Control: Using Git and other version control tools in cloud-based development.

Collaboration and Communication Tools: Utilizing cloud-based collaboration tools for distributed teams.

Cloud-Based Testing and Quality Assurance: Strategies for testing applications in cloud environments.

Cost Management in Cloud: Optimizing cloud resource usage and cost control.

Performance Optimization in Cloud: Techniques for improving application performance in cloud environments.

Case Studies and Real-World Projects: Analyzing successful cloud-based application development and DevOps projects.

***SELF-LEARNING COMPONENTS:**

- https://elearn.nptel.ac.in/shop/iit-workshops/completed/azure-devops-and-micro-services-azure-kubernetes-deployment-models/
- https://nptel.ac.in/courses/106105167

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. Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 2013.

3. Arun Eapen, Docker on Amazon Web Services: Build, deploy, and manage your container applications at scale on AWS, Packt Publishing, 2017.
4. Sam Newman, Building Microservices: Designing Fine-Grained Systems, O'Reilly Media, Inc., 2015.
5. Mark Richards and Neal Ford, Fundamentals of Software Architecture: An Engineering Approach, O'Reilly Media, Inc., 2020.

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the fundamental concepts and principles of cloud computing, including different cloud service models and deployment models. Gain insights into various cloud providers and their offerings to make informed decisions for application development and deployment.
CO2	**Acquire** practical knowledge and hands-on experience in developing cloud-native applications, utilizing containerization with Docker and orchestration using Kubernetes. Demonstrate proficiency in designing and implementing microservices-based architectures.
CO3	**Master** the principles and practices of DevOps in a cloud environment. Learn how to set up Continuous Integration (CI) and Continuous Deployment (CD) pipelines, automate infrastructure provisioning with Infrastructure as Code (IaC), and manage application configurations effectively.
CO4	**Develop** the skills to monitor, log, and optimize the performance of cloud-based applications. Explore auto-scaling and load balancing techniques to ensure high availability and disaster recovery strategies for resilient applications.
CO5	**Apply** cloud-based DevOps tools and best practices to collaborate effectively in distributed teams. Gain knowledge of cloud-based version control, testing, cost management, and performance optimization techniques to deliver efficient and cost-effective cloud solutions.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	C2	-	P1
C02	C3	-	P2
CO3	C3	-	P3
CO4	C1	-	-
CO5	C1	-	P1

CO-PO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	Introduction
Local	Addresses local understanding of the Internet and its impact on society
Regional	Addresses regional internet connectivity and network infrastructure requirements
National	Contributes to national digital literacy and internet connectivity strategies
Global	Aligns with global trends in internet technologies and network protocols
Employability	Develops skills in using internet-based services and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in internet technologies and network protocols
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit II	
Local	Addresses local understanding of the Internet and its impact on society
Regional	-
National	Contributes to national digital literacy and internet connectivity strategies
Global	Aligns with global trends in internet technologies and network protocols
Employability	Develops skills in using internet-based services and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in internet technologies and network protocols
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	
Local	Addresses local network security needs and practices
Regional	-
National	Contributes to national network security strategies and protocols
Global	Aligns with global trends in network security techniques and protocols

Employability	Develops skills in network programming and network security techniques
Entrepreneurship	-
Skill Development	Develops knowledge and skills in client-server programming and network security
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	
Local	Addresses local understanding and implementation of internet-based services
Regional	-
National	Contributes to national digital communication strategies and multimedia applications
Global	Aligns with global trends in internet telephony, multimedia applications, and SEO
Employability	Develops skills in internet telephony, multimedia applications, and SEO
Entrepreneurship	-
Skill Development	Develops knowledge and skills in internet telephony, multimedia applications, and SEO
Professional Ethics	-
Gender	-
Human Values	-

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

APPLICATION DEVELOPMENT AND DEVOPS ON CLOUD LAB

Department:	**Department of Computer Science and Engineering**		
Course Name: **APPLICATION DEVELOPMENT AND DEVOPS ON CLOUD LAB**	**Course Code**	**L-T-P**	**Credits**
	ENSP457	0-0-2	1
Type of Course:	Minor (Department Elective III)		
Pre-requisite(s), if any: Nil			

Proposed Lab Experiments

Defined Course Outcomes

COs	**Course Outcomes (COs)**
CO 1	**Understand** the fundamental concepts of cloud computing, cloud service models, and cloud-based application development
CO 2	**Acquire** hands-on experience in deploying and managing applications on cloud platforms using various cloud services and tools
CO 3	**Implement** DevOps practices in cloud-based application development, including continuous integration, continuous deployment, and version control
CO 4	**Demonstrate** proficiency in using containerization (Docker and Kubernetes), Infrastructure as Code (IaC), and serverless computing for cloud-based application deployment and scaling

CO 5	**Develop** skills in application monitoring, logging, security, and performance optimization for cloud-based applications, and apply cost optimization strategies for cloud resources

Experiment No.	**Experiment Title**	**Mapped COs**
1	Setting up a cloud-based development environment	CO1
2	Deploying a web application on a cloud platform	CO1, CO2
3	Containerizing and deploying with Docker and Kubernetes	CO2, CO4
4	Implementing Continuous Integration (CI)	CO2, CO3
5	Implementing Infrastructure as Code (IaC)	CO2, CO4
6	Configuring auto-scaling for an application	CO2
7	Implementing high availability and disaster recovery	CO2
8	Building a serverless application	CO2, CO4
9	Implementing application monitoring and logging	CO2
10	Creating and managing a cloud-based database	CO2
11	Integrating third-party APIs with an application	CO2
12	Implementing security best practices	CO2
13	Managing application configurations	CO2

14	Performing load testing on an application	CO2
15	Migrating an application to the cloud	CO2
16	Implementing DevOps practices	CO3
17	Deploying a multi-tier application architecture	CO1, CO2
18	Integrating CI/CD pipeline with version control	CO2, CO3
19	Implementing blue-green deployment	CO3
20	Implementing Canary deployment	CO3
21	Performance optimization in cloud	CO2, CO4
22	Implementing feature flags	CO2, CO3
23	Implementing cost optimization strategies	CO2, CO5
24	Deploying a microservices-based application	CO2, CO4
25	Real-world project showcasing cloud-based development	CO1, CO2, CO3, CO4, CO5

1. **Exercise for Setting up a cloud-based development environment**: Exercise: Students set up an account with a cloud service provider (e.g., AWS, Azure) and create a virtual machine instance to host a basic web application.
2. **Project for Deploying a web application on a cloud platform**: Project: Students develop a simple web application and deploy it on a cloud platform using PaaS. They configure auto-scaling based on application demand and perform load testing to observe scaling behavior.
3. **Exercise for Containerizing and deploying with Docker and Kubernetes**: Exercise: Students containerize an existing application using Docker and deploy it on a Kubernetes cluster. They configure Kubernetes services, pods, and replicas for the application.
4. **Exercise for Implementing Continuous Integration (CI)**: Exercise: Students set up a CI/CD pipeline using a cloud-based CI/CD tool (e.g., Jenkins)

to automatically build and test their application whenever code changes are pushed to the repository.

5. **Exercise for Implementing Infrastructure as Code (IaC)**: Exercise: Students use Terraform or CloudFormation to define and provision cloud resources for their application, such as virtual machines, storage, and networking.

6. **Project for Configuring auto-scaling for an application**: Project: Students design a scalable architecture for a multi-tier application and implement auto-scaling based on CPU utilization. They monitor application performance during auto-scaling events.

7. **Exercise for Implementing high availability and disaster recovery**: Exercise: Students configure a highly available architecture using load balancers and multiple availability zones to ensure application resilience. They test disaster recovery scenarios.

8. **Project for Building a serverless application**: Project: Students develop a serverless application using FaaS. They implement serverless functions to handle specific application features and integrate them with event triggers.

9. **Exercise for Implementing application monitoring and logging**: Exercise: Students set up monitoring and logging solutions (e.g., CloudWatch, Stackdriver) for their applications to collect metrics, logs, and perform analysis.

10. **Project for Creating and managing a cloud-based database**: Project: Students design a database schema and implement a cloud-based database (e.g., Amazon RDS, Azure SQL Database). They perform data migration and backup strategies.

11. **Project for Integrating third-party APIs with an application**: Project: Students integrate a popular third-party API (e.g., Google Maps API, Twitter API) into their application to enhance its functionality and showcase real-time data retrieval.

12. **Exercise for Implementing security best practices**: Exercise: Students configure Identity and Access Management (IAM) roles and policies to enforce security for their cloud-based applications. They implement Network Security Groups and security groups to control traffic flow.

13. **Exercise for Managing application configurations**: Exercise: Students use cloud-native configuration management tools (e.g., AWS Systems Manager,

Azure Configuration Management) to manage application configurations across multiple instances.

14. **Project for Performing load testing on an application**: Project: Students use load testing tools (e.g., JMeter, Gatling) to simulate high user loads on their cloud-based applications and analyze performance metrics under heavy traffic.

15. **Project for Migrating an application to the cloud**: Project: Students migrate an existing on-premises application to a cloud platform, considering factors like data transfer, application dependencies, and post-migration testing.

16. **Project for Implementing DevOps practices**: Project: Students collaborate in teams to develop a complete cloud-based application and implement DevOps practices, including version control, CI/CD, and automated testing.

17. **Exercise for Deploying a multi-tier application architecture**: Exercise: Students design and deploy a multi-tier application on the cloud, comprising frontend web servers, application servers, and database servers.

18. **Project for Integrating CI/CD pipeline with version control and issue tracking tools**: Project: Students set up integration between a CI/CD pipeline and version control (e.g., Git) and issue tracking tools (e.g., Jira) for automated build and issue tracking.

19. **Exercise for Implementing blue-green deployment**: Exercise: Students implement blue-green deployment strategies to minimize downtime during application updates, allowing seamless rollback if issues arise.

20. **Exercise for Implementing Canary deployment**: Exercise: Students deploy a new feature of their application to a small subset of users using Canary deployment to gather feedback and monitor performance.

21. **Project for Performance optimization in the cloud**: Project: Students optimize the performance of their cloud-based application by tuning parameters, caching, and optimizing database queries for better response times.

22. **Project for Implementing feature flags**: Project: Students implement feature flags (feature toggles) in their application to enable/disable features dynamically and gradually release new functionalities.

23. **Project for Implementing cost optimization strategies**: Project: Students analyze the cost of their cloud resources and implement cost optimization techniques, such as using reserved instances and rightsizing resources.

24. **Project for Deploying a microservices-based application**: Project: Students design and deploy a microservices-based application architecture on the cloud, using containers and orchestrators like Kubernetes.

25. **Project for Real-world project showcasing cloud-based development**: Project: Students work on a real-world cloud-based development project, applying the concepts learned throughout the course to design, develop, deploy, and manage an application in the cloud.

K.R. MANGALAM UNIVERSITY

(DEPARTMENT ELECTIVE-IV)

MOBILE APPLICATION DEVELOPMENT USING IOS

Department:	**Department of Computer Science and Engineering**		
Course Name: **Mobile Application Development using iOS**	**Course Code**	**L-T-P**	**Credits**
	ENSP409	4-0-0	4
Type of Course:	Minor (Department Elective IV)		
Pre-requisite(s), if any: Basics of Android			
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.			
UNIT WISE DETAILS			
Unit Number: 1	**Title: Introduction to IDE and SDK of iOS App Development**	**No. of hours: 10**	
Content Summary: Xcode-The SDK environment, Supporting tools, Advance settings. Development Technique, Fundamental of Object-Oriented Programming, The MVC architecture.			

Unit Number: 2	Title: Objective-C	No. of hours: 10

Content Summary:

Introduction to Objective C, Primitive Data Types, Conditions, Loops, Functions, Arrays, Pointers, Structures, Classes, Objects, Foundation, Memory Management, Inheritance, Categories, Protocols, Predicates, Blocks, Multi-Threading.

Objects Send and Receive Messages concept, Use of Pointers to Keep Track of Objects, Methods - Return Values.

Unit Number: 3	Title: Encapsulating Data	No. of hours: 10

Content Summary:

Properties of Encapsulation of an Object's Values, Declare Public Properties for Exposed Data, Use Accessor Methods to Get or Set Property Values, Concept of Dot Syntax, Properties Are Backed by Instance Variables.

Dealing with Errors: Use NSError for Most Errors, Some Delegate Methods Alert You to Errors, Some Methods Pass Errors by Reference

Unit Number: 4	Title: Developing iOS Applications	No. of hours: 10

Content Summary:

iOS App Anatomy, Design Principles, Creating a Basic Hello World App with interface elements, UI View & Controller, UI Elements, Trigger Actions, Storyboard, Device Orientations, Using Gestures, Popovers and Modal Dialogs, Creating Universal Apps, Status Bar, Navigation Bar, Tab Bar, Content Views (e.g. Image view, Map View etc.), UI Table View and Table View Controller, Core Data, Test your App, Publishing your App.

***Self-Learning Components:**

2. XCode Documentation

References:

5. https://www.tutorialspoint.com/objective_c/objective_c_quick_guide.htm

6. https://www.coursera.org/learn/introduction-to-ios-mobile-application-development
7. 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:

8. https://developer.apple.com/library/archive/documentation/Cocoa/Conceptual/ProgrammingWithObjectiveC/Introduction/Introduction.html
9. 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	
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.

Define Course Outcomes (CO)

COs	Statements
CO1	**Understand** the principles and benefits of DevOps, and its role in enhancing collaboration and efficiency between development and operations teams.

CO2	**Acquire** hands-on experience with popular DevOps tools such as Git, Jenkins, Docker, Kubernetes, and Ansible for implementing continuous integration, continuous delivery, and automated deployment processes.
CO3	**Demonstrate** proficiency in containerization and orchestration techniques using Docker and Kubernetes for efficient and scalable application deployment and management.
CO4	**Implement** configuration management and Infrastructure as Code (IaC) using Ansible and Terraform to automate the provisioning and management of infrastructure resources.
CO5	**Develop** skills in monitoring, logging, and security practices in the context of DevOps, ensuring application performance, resilience, and adherence to security best practices.

COs Mapping with Levels of Bloom's taxonomy

CO	Cognitive levels© 1. Knowledge 2. Understand 3. Apply 4. Analyze 5. Evaluate 6. Create	Affective levels(A) 1. Receiving 2. Responding 3. Valuing 4. Organizing 5. Characterizing	Psychomotor levels(P) 1. Imitation 2. Manipulation 3. Precision 4. Articulation 5. Improving
CO1	-	-	P1
C02	C2	-	P2
CO3	C3	L3	P3
CO4	C4	-	-
CO5	C5	L5	P5

CO-PO Mapping

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

Justification for mapping must be relevant.

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

CO-PSO Mapping

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

Relevance of the Syllabus to various indicators

Unit I	Introduction
Local	Addresses local understanding of the Internet and its impact on society
Regional	Addresses regional internet connectivity and network infrastructure requirements

National	Contributes to national digital literacy and internet connectivity strategies
Global	Aligns with global trends in internet technologies and network protocols
Employability	Develops skills in using internet-based services and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in internet technologies and network protocols
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	
Local	Addresses local understanding of the Internet and its impact on society
Regional	-
National	Contributes to national digital literacy and internet connectivity strategies
Global	Aligns with global trends in internet technologies and network protocols
Employability	Develops skills in using internet-based services and understanding network protocols
Entrepreneurship	-
Skill Development	Develops basic knowledge and skills in internet technologies and network protocols

Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	
Local	Addresses local network security needs and practices
Regional	-
National	Contributes to national network security strategies and protocols
Global	Aligns with global trends in network security techniques and protocols
Employability	Develops skills in network programming and network security techniques
Entrepreneurship	-
Skill Development	Develops knowledge and skills in client-server programming and network security
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	
Local	Addresses local understanding and implementation of internet-based services
Regional	-

National	Contributes to national digital communication strategies and multimedia applications
Global	Aligns with global trends in internet telephony, multimedia applications, and SEO
Employability	Develops skills in internet telephony, multimedia applications, and SEO
Entrepreneurship	-
Skill Development	Develops knowledge and skills in internet telephony, multimedia applications, and SEO
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 4
NEP 2020	-
POE/4th IR	Aligns with the concepts of internet telephony, multimedia applications, and SEO

K.R. MANGALAM UNIVERSITY

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

Defined Course Outcomes

COs	**Course Outcomes (COs)**
CO 1	**Gain** hands-on experience in setting up version control using Git and performing collaborative software development with branching and merging techniques.
CO 2	**Acquire** practical knowledge in implementing continuous integration and continuous deployment (CI/CD) pipelines using Jenkins, automating the build, test, and deployment processes.
CO 3	**Develop** proficiency in containerization with Docker, including managing Docker containers and images, and deploying applications on Kubernetes for efficient and scalable orchestration.
CO 4	**Demonstrate** skills in infrastructure automation and configuration management using Ansible and Terraform to provision and manage cloud resources and application configurations.

CO 5	**Understand** and **apply** monitoring, logging, and security practices in DevOps, ensuring application performance, resilience, and adherence to security best practices throughout the software development lifecycle.

Ex. No.	**Experiment Title**	**Mapped CO(s)**
1	Setting up version control with Git	CO1
2	Implementing a basic Jenkins CI/CD pipeline	CO2
3	Automating application deployment with Jenkins	CO2
4	Containerizing an application using Docker	CO3
5	Managing Docker containers and images	CO3
6	Deploying applications with Kubernetes	CO3
7	Implementing Kubernetes deployment strategies	CO3
8	Continuous deployment with Kubernetes	CO3
9	Configuring infrastructure with Ansible	CO4
10	Automating application configuration with Ansible	CO4
11	Implementing Infrastructure as Code (IaC) with Terraform	CO4
12	Creating scalable and resilient infrastructure with Terraform	CO4
13	Monitoring application performance with Prometheus	CO5
14	Logging and centralized log management	CO5
15	Implementing security measures in CI/CD pipelines	CO5
16	Implementing feature flags for controlled feature rollout	CO5

17	Load testing and performance optimization	CO5
18	Automating application tests with Selenium	CO2, CO5
19	Integrating automated testing in CI/CD pipelines	CO2, CO5
20	Blue-green deployment for zero-downtime updates	CO3, CO5
21	Canary deployment for testing new features	CO3, CO5
22	Implementing GitOps for application deployments	CO3, CO5
23	Managing secrets and sensitive data securely	CO5
24	Disaster recovery planning and testing	CO5
25	Creating a DevOps project integrating multiple tools	CO1, CO2, CO3, CO4, CO5

1. **Setting up version control with Git**: Exercise: Initialize a Git repository, create branches, perform commits, and push changes to a remote repository. Project: Collaboratively work on a project using branching and merging techniques in Git.
2. **Implementing a basic Jenkins CI/CD pipeline**: Exercise: Set up a simple Jenkins pipeline to build and test a sample application from version control. Project: Develop a complete CI/CD pipeline that includes code building, automated testing, and deployment to a staging environment.
3. **Automating application deployment with Jenkins**: Exercise: Configure Jenkins to automatically deploy the application to a test server upon successful build. Project: Implement a full-fledged CD pipeline with Jenkins, including deployment to production after successful testing.
4. **Containerizing an application using Docker**: Exercise: Dockerize a basic application and run it in a container. Project: Containerize a multi-service application with Docker Compose for easier deployment.
5. **Managing Docker containers and images**: Exercise: Explore Docker commands to manage containers and images, such as starting, stopping, and

cleaning up. Project: Implement a container registry and manage images for different application versions.

6. **Deploying applications with Kubernetes**: Exercise: Set up a Kubernetes cluster and deploy a basic application using YAML manifests. Project: Deploy a microservices-based application with Kubernetes, configuring services and network policies.

7. **Implementing Kubernetes deployment strategies**: Exercise: Implement rolling updates and rollbacks in Kubernetes. Project: Use Kubernetes deployment strategies like blue-green and canary deployments for a real-world application.

8. **Continuous deployment with Kubernetes**: Exercise: Set up a Jenkins pipeline for continuous deployment to Kubernetes. Project: Create an end-to-end automated CD pipeline with Jenkins and Kubernetes.

9. **Configuring infrastructure with Ansible**: Exercise: Use Ansible to provision and configure virtual machines. Project: Create a playbook to configure a complete development environment for an application.

10. **Automating application configuration with Ansible**: Exercise: Create Ansible playbooks to automate application-specific configurations. Project: Implement dynamic inventory and use Ansible roles for better code organization.

11. **Implementing Infrastructure as Code (IaC) with Terraform**: Exercise: Set up a basic Terraform configuration to create cloud resources. Project: Use Terraform to define infrastructure for a scalable and fault-tolerant application.

12. **Creating scalable and resilient infrastructure with Terraform**: Exercise: Implement auto-scaling and load balancing in Terraform. Project: Design a Terraform template for a highly available architecture using multiple availability zones.

13. **Monitoring application performance with Prometheus**: Exercise: Set up Prometheus for monitoring application metrics. Project: Create custom Prometheus metrics and use Grafana for visualization and alerting.

14. **Logging and centralized log management**: Exercise: Configure centralized log collection using tools like Fluentd or Logstash. Project: Set up ELK (Elasticsearch, Logstash, and Kibana) stack for efficient log analysis.

15. **Implementing security measures in CI/CD pipelines**: Exercise: Use Jenkins plugins to implement security checks in CI/CD pipelines. Project:

Implement security scanning tools like SonarQube and integrate them into the pipeline.

16. **Implementing feature flags for controlled feature rollout**: Exercise: Add feature flags to a sample application to enable/disable specific features. Project: Implement a feature flag service for a real-world application and manage feature rollout.

17. **Load testing and performance optimization**: Exercise: Use load testing tools to evaluate application performance under heavy traffic. Project: Analyze performance bottlenecks and optimize the application for scalability.

18. **Automating application tests with Selenium**: Exercise: Use Selenium WebDriver for automating browser-based tests. Project: Develop an automated testing suite covering multiple application features.

19. **Integrating automated testing in CI/CD pipelines**: Exercise: Integrate automated tests into the Jenkins CI/CD pipeline. Project: Implement a complete testing strategy, including unit, integration, and end-to-end tests.

20. **Blue-green deployment for zero-downtime updates**: Exercise: Perform blue-green deployment for a sample application update. Project: Set up a blue-green deployment strategy for a production application.

21. **Canary deployment for testing new features**: Exercise: Implement canary deployment for a specific application feature. Project: Use canary deployment to gradually release new features to a subset of users.

22. **Implementing GitOps for application deployments**: Exercise: Use GitOps principles to manage Kubernetes manifests with Git. Project: Implement a GitOps workflow for application deployment and configuration management.

23. **Managing secrets and sensitive data securely**: Exercise: Utilize Kubernetes secrets or HashiCorp Vault to manage sensitive data. Project: Set up a secure secret management system for a production environment.

24. **Disaster recovery planning and testing**: Exercise: Design a disaster recovery plan for a sample application. Project: Test the disaster recovery plan and validate its effectiveness.

25. **Creating a DevOps project integrating multiple tools**: Exercise: Choose and integrate various DevOps tools into a sample project. Project: Create an end-to-end DevOps project showcasing the integration of tools and best practices.

K.R. MANGALAM UNIVERSITY

.NET FRAMEWORK

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
.NET Framework	**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

Define 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 Development	Learning and applying these technologies contribute to the development of practical skills that are in demand in the industry, improving professional capabilities and career prospects
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	SDG 9, SDG 4, and SDG 8,
NEP 2020	-

POE/4th IR	the content on .NET Core, Entity Framework, and Windows Communication Foundation (WCF) addresses professional ethics and aligns with the demands and innovations of the Fourth Industrial Revolution (4IR).

.NET FRAMEWORK LAB

Department:	**Department of Computer Science and Engineering**		
Course Name:	**Course Code**	**L-T-P**	**Credits**
.NET Framework Lab	**ENSP463**	0-0-2	1
Type of Course:	Minor (Department Elective IV)		
Pre-requisite(s), if any: Nil			

Proposed Lab Experiments

Defined Course Outcomes

COs	
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:**

3. Web programming with GO
4. F# for Data Science and Machine Learning:
5. Metaprogramming and DSLs in Clojure:
6. 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:

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

Online References:

1. https://gobyexample.com/ [
2. https://golang.org/doc/

3. https://www.youtube.com/playlist?list=PLlxmoA0rQ-LwgK1JsnMsakYNACYGa1cjR
4. https://kotlinlang.org/docs/home.html
5. https://docs.microsoft.com/en-us/dotnet/fsharp/
6. https://www.udemy.com/course/learning-functional-programming-with-f/
7. https://clojure.org/guides/getting_started

Course Outcomes (CO)

COs	Statements
CO1	**Understand** the fundamental principles and paradigms of modern programming languages, including functional programming, object-oriented programming, and concurrent programming.
CO2	**Develop** proficiency in using the syntax, data structures, and control flow constructs of each language (GO, F#, Clojure, and Kotlin) to solve programming problems.
CO3	**Explore** the unique features and strengths of each language, such as Go's focus on concurrency, F#'s functional programming capabilities, Clojure's emphasis on immutability and simplicity, and Kotlin's interoperability with existing Java code.
CO4	**Apply** the languages' respective development tools, such as Go's gofmt and go vet, F#'s F# Interactive (FSI), Clojure's Leiningen or Boot, and Kotlin's integrated development environment (IDE) support, to improve code quality and productivity.
CO5	**Design and implement** projects that integrate multiple programming languages, using appropriate inter-language communication mechanisms and libraries (e.g., Go and Kotlin interacting via REST APIs, F# and Clojure communicating via message queue

COs Mapping with Levels of Bloom's taxonomy

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

Course Outcomes (CO)

COs	Statements
CO1	**Understand** the fundamental principles and paradigms of modern programming languages.
CO2	**Develop** proficiency in using the syntax, data structures, and control flow constructs of each language.
CO3	**Explore** the unique features and strengths of each language, such as Go's focus on concurrency, F#'s functional programming capabilities, Clojure's emphasis on immutability and simplicity, and Kotlin's interoperability with existing Java code.
CO4	**Apply** the languages' respective development tools and best practices.
CO5	**Design and implement** projects that utilize the strengths of each language to tackle complex problems or tasks.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/COs
	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 perform common tasks, such as string manipulation or mathematical operations. Use these functions in a separate program to demonstrate their functionality and reusability.	CO1
3	Implement a program that stores a collection of elements using arrays. Perform operations like adding, removing, or updating elements	CO2
4	Define a struct Person with the following members: name, age, job and salary. Create methods associated with the struct to read data in structure and print data.	CO4
5	Develop a program that utilizes pointers to modify and manipulate data in memory. Explore concepts like referencing, dereferencing, and memory allocation/deallocation.	CO2
6	Write a program that demonstrates the use of Go routines and channels to achieve concurrent execution of tasks.	CO3
7	Create a program that handles various error scenarios and provides appropriate error messages or responses. Write unit tests for critical functions and verify their correctness using Go's testing package.	CO5
8	**Mini Project**: Task Manager Application in Go Create a task manager application using the Go programming language. The application should allow users to manage their tasks by adding, updating, and deleting tasks. The tasks should	CO5

		have attributes such as title, description, due date, and status (e.g., "in progress", "completed").	
Practicals on F# Programming Language			
9	a.	WAP to read marks of 4subjects and calculate the Percentage of student and find the result according to given conditions 60>=1st Division 60<&& 50>= 2nd Division 50<&& 40>=3rd Division 40<=fail.	CO2
	b.	WAP to accept an integer and check whether it is prime or not.	
10	a.	Write a function that takes a string as input and returns the reverse of the string. Also check if a given string is a palindrome	CO2
	b.	Create a function that takes a string as input and performs the following transformations: i. If the string contains only alphabetic characters, convert it to uppercase. ii. If the string contains only numeric characters, convert it to an integer and double its value. iii. If the string contains a mix of alphabetic and numeric characters, return it as is.	
	c.	Design a function that validates an email address based on specific rules, such as the presence of an '@' symbol and a valid domain name. Use pattern matching to check if the input string matches the expected email format.	
12		Implement a program that performs various operations on lists using higher-order functions (define a list of integers or strings). Write pure functions that demonstrate the map, filter, reduce/fold operations.	CO1
13		Implement a program that performs multiple I/O-bound or computationally intensive tasks concurrently using F#'s asynchronous workflows and parallel programming constructs.	CO3

14	Create a program that demonstrates the object-oriented programming (OOP) capabilities of F#. Define classes, objects, 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 handling and error management, in Clojure.	CO4

<table>
<tr><td>24</td><td colspan="2">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.</td><td>CO5</td></tr>
<tr><td colspan="4">Practicals on Kotlin Programming Language</td></tr>
<tr><td rowspan="3">25</td><td>19</td><td>WAP for print following o/p
Hello Kotlin!!!</td><td rowspan="3">CO2</td></tr>
<tr><td>20</td><td>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%</td></tr>
<tr><td>21</td><td>WAP to accept an integer and display average of digit.</td></tr>
<tr><td>26</td><td colspan="2">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.</td><td>CO2</td></tr>
<tr><td>27</td><td colspan="2">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.</td><td>CO1</td></tr>
</table>

	b. Explore access modifiers and visibility scopes in Kotlin.	
28	Implement a program that demonstrates the declaration and usage of nullable and non-nullable variables. Utilize safe calls (?.) and the Elvis operator (?:) to handle nullable values and provide alternative values or perform fallback actions.	CO3
29	WAP to implement various collections like lists, sets, and maps in Kotlin and perform common operations on them. Use collection functions and transformations such as map, filter, and reduce to manipulate data.	CO2
30	Implement a DSL for a domain-specific problem, showcasing Kotlin's expressive syntax and extension functions.	CO5
31	Implement a program that demonstrates the creation and usage of extension functions in Kotlin (Choose a specific class or data type, such as String). For example, you can create an extension function that counts the number of vowels in a string or reverses the string.	CO3
32	**Mini Project**: Quiz App Build a quiz application that presents users with multiple-choice questions on various topics. Users can select their answers, and the app provides instant feedback on correctness. Keep track of the user's score and display the result at the end of the quiz. Include features like a timer, score calculation, and a database of questions.	CO5

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. 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)	