K.R. MANGALAM UNIVERSITY
THE COMPLETE WORLD OF EDUCATION

School of Engineering and Technology

Programme Handbook
(Programme Study & Evaluation Scheme)

Bachelor in Science (B.Sc. (Hons.) Data Science)

Programme Code: 84

THREE YEARS UNDERGRADUATE PROGRAMME

with effective from 2024-25 session

Approved in the 34th Meeting of Academic Council Held on 29 June 2024

Contents

Preface

Welcome to the School of Engineering and Technology at K. R. Mangalam University. It is with great enthusiasm that we introduce you to an institution dedicated to nurturing future leaders in engineering and technology.

Established in 2013, our School has rapidly evolved into a premier center for innovation, quality education, and skill development. With a focus on imparting advanced knowledge and fostering creativity, we are committed to providing a transformative educational experience. Our state-of-the-art infrastructure, cutting-edge laboratories, and a distinguished team of faculty members collectively create an environment where academic and professional excellence thrives.

Our diverse programs encompass undergraduate degrees (B.Tech, BCA, B.Sc), postgraduate studies (M.Tech, MCA), and doctoral research across all engineering disciplines. Notably, we offer specialized B.Tech programs in areas such as Artificial Intelligence & Machine Learning, Data Science, Cyber Security, Full Stack Development, and UI/UX Development. These programs are designed to equip students with both technical proficiency and a deep understanding of emerging technologies.

At the heart of our mission is a commitment to a curriculum that integrates the best practices from leading global institutions while also incorporating insights from the Open-Source Society University. This curriculum emphasizes problem-solving, interdisciplinary learning, and innovative teaching methodologies.

Our emphasis on industry integration is reflected in our collaborations with renowned organizations such as IBM, Samatrix, Xebia, E.C Council, and ImaginXP. These partnerships ensure that our students gain practical experience and insights that are directly applicable to industry demands. Elective options across diverse domains, including AI, Cloud Computing, Cyber Security, and Full Stack Development, offer students the flexibility to tailor their educational experience to their career aspirations.

We are also dedicated to fostering a culture of innovation and entrepreneurship through our Entrepreneurship and Incubation Center and initiatives like ’MindBenders,’ ’Hack-KRMU,’ and participation in the ’Smart India Hackathon.’ These programs are designed to inspire and prepare students to become forward-thinking leaders in the technology sector.

Our modern computing facilities and comprehensive infrastructure support advanced research, simulations, and hands-on projects, ensuring that our students are well-prepared for the challenges of the professional world. K. R. Mangalam University is recognized for its commitment to providing quality education, and our alumni have made notable contributions across various sectors, from multinational corporations to public sector enterprises.

We are excited to accompany you on this journey and look forward to supporting your academic and professional growth. Welcome to a community where excellence and innovation are at the core of everything we do.

School of Engineering and Technology
K. R. Mangalam University.

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 a futuristic curriculum and progressive pedagogy with cutting-edge technology.
- **Instill** the 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 with an understanding of ethical values and environmental realities.

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.

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

Our strength lies in our highly qualified, research oriented, and committed teaching faculty. We believe in empowering minds through expert guidance, ensuring that our students receive a world-class education that prepares them for the challenges of the ever-evolving technological landscape.

The School of Engineering & Technology is committed to providing a cutting-edge curriculum by integrating the best practices from top global universities and leveraging the rich knowledge resources of the Open-Source Society University. The curriculum focuses on problem-solving, design, development, interdisciplinary learning, skill development, research opportunities and application of various emerging technologies with focus on innovative teaching learning methodologies. Our curriculum is designed to provide a holistic and contemporary learning experience.

We take pride in offering an industry-integrated curriculum that goes beyond traditional education. Collaborations and training led by industry experts, along with partnerships with renowned organizations such as IBM, Samatrix, Xebia, E.C Council, ImaginXP etc ensure that our students gain practical insights and skills that align with real-world industry demands.

With elective options across various domains, including AI, Cloud Computing, Cyber Security, and Full Stack Development, we empower students to customize their learning experience. Our goal is to provide the flexibility needed for each student to shape their academic and professional future.

We prioritize career growth by offering comprehensive training, placements, international internships, and preparation for further studies. Our commitment to nurturing globally competitive professionals is reflected in the diverse pathways we pave for our students. SOET aims at transforming the students into competitive engineers with adequate analytical skills, making them more acceptable to potential employers in the country. At our school, we emphasize learning through doing. Whether it's project-based learning, field projects, research projects, internships, or engaging in competitive coding, our students actively shape their futures by applying theoretical knowledge to practical scenarios. We provide opportunities for industrial projects, R&D projects, and start-up projects in the final year, ensuring that our students engage in real-world innovation.

We are dedicated to fostering a culture of innovation and entrepreneurship, recognizing these as essential pillars for the success of our students in the rapidly evolving world of technology. We inspire innovation and entrepreneurship through our dynamic Entrepreneurship and Incubation Center, engaging contests like 'MindBenders' ,'HackKRMU,' participation in 'Smart India Hackathon', International Conference 'MRIE' empowering students to become forward-thinking leaders in the ever-evolving realm of technology.

We pride ourselves on providing state-of-the-art computing facilities and infrastructure. Our modern labs and computing resources are equipped to support the diverse needs of our students, enabling them to engage in advanced research, simulations, and hands-on projects. K.R. Mangalam University has marked its presence in Delhi NCR as a value-based university, successfully imparting quality education in all domains. Our alumni are working across all sectors of technology, from MNCs to PSUs.

School Vision & Mission

Vision

To excel in scientific and technical education through integrated teaching, research, and innovation.

Mission

- **Creating** a unique and innovative learning experience to enhance quality in the domain of Engineering & Technology.
- **Promoting** Curricular, co-curricular and extracurricular activities that support overall personality development and lifelong learning, emphasizing character building and ethical behavior.
- **Focusing** on employability through research, innovation and entrepreneurial mindset development.
- **Enhancing** collaborations with National and International organizations and institutions to develop cross-cultural understanding to adapt and thrive in the 21st century.

About the Programme

Definitions

- **Programme Outcomes (POs):** Programme Outcomes are statements that describe what the students are expected to know and would be able to do upon graduation. These relate to the skills, knowledge, and behaviour that students acquire through the programme.
- **Programme Specific Outcomes (PSOs):** Programme Specific Outcomes define what the students should be able to do at the time of graduation, and they are programme-specific. There are two to four PSOs for a programme.
- **Programme Educational Objectives (PEOs):** Programme Educational Objectives of a degree programme are the statements that describe the expected achievements of graduates in their career, and what the graduates are expected to perform and achieve during the first few years after graduation.
- **Credit:** Credit refers to a unit by which the coursework is measured. It determines the number of hours of instruction required per week. One credit is equivalent to 14-15 periods for theory, or 28-30 periods for workshop/labs and tutorials.

Programme Educational Objectives (PEO)

- **PEO1:** Successful professionals in industry, government, academia, research, entrepreneurial pursuits, and consulting firms.
- **PEO2:** Able to apply their knowledge of computer science & engineering principles to solve societal problems by exhibiting a strong foundation in both theoretical and practical aspects of the field.
- **PEO3:** Dedicated to upholding professional ethics and social responsibilities, with a strong commitment to advancing sustainability goals.
- **PEO4:** Demonstrating strong leadership skills and a proven ability to collaborate effectively in diverse, multidisciplinary teams to successfully achieve project objectives.

Programme Outcomes (PO)

Graduates will be able to:

- **PO1 Core Competencies in Engineering:** Graduates will possess a strong foundation in computer science principles, critical problem analysis, and solution design, equipped with skills for conducting thorough investigations to solve complex challenges.
- **PO2 Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern IT tools including prediction and modeling to complex computer science activities with an understanding of the limitations.

- **PO3 Societal and Environmental Responsibility:** Apply contextual knowledge to evaluate societal, health, safety, legal, and cultural issues, while understanding the impact of engineering solutions on the environment and advocating for sustainable development.

- **PO4 Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the computer science practice.

- **PO5 Effective Communication and Team Collaboration:** Excel in both individual and team roles within diverse and multidisciplinary settings, while communicating complex computer science concepts clearly through effective reports, presentations, and interactions.

- **PO6 Project Management:** Apply engineering and management principles to lead and manage projects effectively in computer science contexts.

- **PO7 Life-long Learning:** Embrace and actively pursue continuous learning to stay current with technological advancements and evolving practices in computer science.

Programme Specific Outcomes (PSO)

- **PSO1:** Understanding the core concepts, theories, tools, techniques, and methodologies of Data Science.

- **PSO2:** Applying Data Science principles to solve real-world data challenges.

- **PSO3:** Analysing data contexts, problems, and issues using appropriate methodologies.

- **PSO4:** Evaluating alternative data solutions and making informed decisions to optimize results.

- **PSO5:** Designing and developing innovative data-driven solutions to address complex problems.

Career Avenues

Diverse career avenues available to graduates of the B.Sc (Hons.) Data Science 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. Specialization areas include web development, mobile app development, game development, or enterprise software development.

2. **Systems Analyst:** Systems analysts evaluate an organization's computer systems and procedures to enhance efficiency. They design and implement new systems, conduct feasibility studies, and identify areas for improvement.

3. **Data Scientist:** In response to the rising data volumes, data scientists are in high demand. They leverage data analysis, statistics, and machine learning to extract insights from large datasets, facilitate data-driven decisions, and develop predictive models.

4. **Artificial Intelligence Engineer:** AI engineers are sought after for developing AI algorithms and systems. They focus on creating intelligent machines, natural language processing systems, computer vision applications, and other AI-driven solutions.

5. **Cybersecurity Analyst:** Cybersecurity analysts protect systems and data in the face of growing threats. They identify vulnerabilities, implement security measures, conduct risk assessments, and respond to security incidents to ensure the safety of computer networks.

6. **Network Engineer:** Network engineers design, implement, and maintain computer networks, ensuring security, reliability, and performance while troubleshooting issues to keep systems operational.

7. **IT Project Manager:** IT project managers oversee the planning, execution, and delivery of technology projects, managing resources, tracking progress, and ensuring timely completion within budget.

8. **Database Administrator:** Database administrators ensure the integrity, security, and performance of databases. They design database structures, implement backup and recovery procedures, and optimize systems for efficient data storage and retrieval.

9. **Software Quality Assurance Engineer:** QA engineers maintain software quality by developing test plans, identifying and reporting issues, and collaborating with developers to ensure reliability and performance.

10. **Research and Development:** Graduates can contribute to R&D in innovative projects, exploring cutting-edge technologies in academia, research labs, or industry R&D departments.

Duration

3 Years (6 Semesters) - Full-Time Program

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.

Student's Structured Learning Experience in the Programme

University Education Objective

- **Focus Employability and Entrepreneurship through Holistic Education**

Importance of Structured Learning Experiences

- **Holistic and Structured Academic Journey:** The curriculum focuses on employability, entrepreneurship, and personal development through a balanced education that integrates major selection, internships, projects, coding, and hands-on industry experience.

- **Comprehensive Learning and Support:** Students benefit from experiential learning through labs, workshops, and guest lectures, while academic support, mentor-mentee programs, and counselling services cater to the needs of both slow and advanced learners.

- **Continuous Evaluation and Growth:** A robust assessment framework with regular feedback, emphasis on academic integrity, and structured evaluation methods ensures ongoing student development and success.

Educational Planning and Execution

Effective educational planning and execution is a cornerstone of delivering a high-quality academic experience. At the School of Engineering & Technology, we focus on a structured and dynamic approach to ensure that students gain the knowledge, skills, and competencies required to excel in the rapidly evolving technological landscape. Our planning and execution encompass the following key aspects:

- **Curriculum Design:** The curriculum is meticulously crafted. It integrates theoretical learning with practical application, focusing on interdisciplinary knowledge, skill development, and the latest trends in technology, such as AI and ML, Cybersecurity, Full Stack, and Data Science, etc.

- **Learning Objectives:** Each course is designed with clear learning outcomes to ensure students understand the relevance of their education to real-world applications. The focus is on building foundational knowledge while advancing to specialized skills that enhance employability and entrepreneurship.

- **Academic Scheduling:** A well-structured academic calendar is developed, ensuring a balanced distribution of coursework, projects, internships, and examinations. Students are guided in course registration, ensuring a smooth academic journey through carefully timed assessments, practical experiences, and project work.

- **Project-Based Learning:** We emphasize experiential and project-based learning to foster critical thinking, problem-solving, and innovation. Through real-world projects, internships, contests, and collaborative opportunities, students gain practical insights into engineering challenges.

- **Continuous Evaluation:** An ongoing evaluation system is employed with periodic assessments, ensuring continuous learning and improvement. The system includes practical exams, theoretical assessments, internships, and project evaluations, providing a holistic view of student progress.

Through strategic educational planning and precise execution, we ensure that our students graduate with the skills and knowledge required to meet the demands of industry and society.

Academic Journey

Program Scheme

Program Name	B.Sc (Hons.) Data Science
Total Credits	***135***
Total Semesters	***6***

Semester-wise Progression

Semester	Total Credits	Key Components
I (Odd)	25	• **Major Courses:** Fundamentals of Web Technologies, MATLAB Programming, Fundamentals of Software Engineering • **Lab Courses (Major):** Fundamentals of Web Technologies Lab, MATLAB Programming Lab, Programming in Python Lab • **Skill Enhancement Courses (SEC):** Linux Environment Lab • **Value-Added Courses (VAC):** Environmental Studies & Disaster Management • **MOOC Courses:** Essentials of Computer Science (MOOC)

Semester	Total Credits	Key Components
II (Even)	24	• **Major Courses:** Introduction to Discrete Structures, Basics of Operating Systems, Concepts of Object-Oriented Programming Using C++ • **Lab Courses (Major):** Basics of Operating Systems Lab, Concepts of Object-Oriented Programming Using C++ Lab • **Skill Enhancement Courses (SEC):** Introduction to Programming in Python • **Value-Added Courses (VAC):** Community Service • **Projects:** Project-I • **Open Electives:** Open Elective-I • **Audit Courses:** Competitive Coding-I
III (Odd)	27	• **Major Courses:** Introduction to Data Structures, Basics of Probability & Statistics, Introduction to Java Programming • **Lab Courses (Major):** Introduction to Java Programming Lab, Introduction to Data Structures Lab, Machine Learning Lab • **Ability Enhancement Courses (AEC):** Verbal Ability • **Skill Enhancement Courses (SEC):** Fundamentals of Machine Learning • **Discipline Specific Electives (DSE):** Choose between Cloud Computing or Full Stack Development • **Value-Added Courses (VAC):** VAC-III (Design Thinking & Innovations for Engineers, AWS Cloud Fundamentals, etc.) • **Internships (INT):** Summer Internship-I • **Audit Courses:** Competitive Coding-II • **Communication Skills (CS):** Club/Society Participation

Semester	Total Credits	Key Components
IV (Even)	24	• **Major Courses:** Fundamentals of Algorithm Design & Analysis, Introduction to Database Management Systems, Introduction to Computer Networks • **Lab Courses (Major):** Introduction to Database Management Systems Lab, Fundamentals of Algorithm Design & Analysis Lab, Introduction to Computer Networks Lab • **Ability Enhancement Courses (AEC):** Communication & Personality Development • **Projects:** Project-II • **Open Electives:** Open Elective-II • **Audit Courses:** Competitive Coding-III • **Skill Enhancement Courses (SEC):** Fundamentals of Algorithm Design & Analysis Lab
V (Odd)	23	• **Major Courses:** Computer Organization and Architecture • **Discipline Specific Electives (DSE):** Cloud Computing or Full Stack Development • **Internships (INT):** Summer Internship-II • **Ability Enhancement Courses (AEC):** Arithmetic and Reasoning Skills • **Value-Added Courses (VAC):** Applied Programming and Problem-Solving Skills for Campus Interviews (Infosys Connect Program) • **Projects:** Discipline Specific Elective Lab
VI (Even)	12	• **Projects:** Industry Project / Research Project

Table 1: Semester-wise Academic Journey for B.Sc (Hons.) Data Science Program

Key Milestones and Experiences

- **Internships:**
  - **Summer Internship-I (Semester III):** Provides students with six weeks of industry exposure, allowing them to apply theoretical concepts in real-world scenarios.
  - **Summer Internship-II (Semester V):** Offers an extended internship experience, encouraging deeper engagement with industry projects, research & development, or startup initiatives.
- **Projects:**
  - **Projects I and II (Semester II and IV):** Focused on specific areas of study, these projects enable students to delve into practical applications of their coursework.
  - **Major Project (Semester VI):** A capstone project that integrates knowledge from the entire program, fostering innovation and problem-solving skills.
- **Discipline Specific Electives (DSE):**
  - **Cloud Computing (Discipline Specific Elective I):** Covers computational services in the cloud, including hands-on labs with Microsoft Azure.
  - **Full Stack Development (Discipline Specific Elective II):** Focuses on mobile application development, DevOps, and modern programming frameworks.
- **Skill Enhancement Courses (SEC):** Practical labs and courses designed to bolster technical skills in areas such as Linux environments, data structures, and data science essentials.
- **Value-Added Courses (VAC):** Programs aimed at developing soft skills, ethical understanding, and career readiness, including boot camps and community engagement services.
- **Audit Courses:** Optional courses like Competitive Coding Bootcamps that allow students to enhance their coding proficiency through practice and challenges.
- **Ability Enhancement Courses (AEC):** Courses designed to enhance students' communication skills, critical thinking, and other essential abilities necessary for academic and professional success.
- **Communication Skills (CS):** Participation in clubs and societies to foster teamwork, leadership, and extracurricular engagement.

Overall Credit Distribution

The program ensures a balanced distribution of credits across various course categories to promote a well-rounded education:

Course Category	Credits
Ability Enhancement Courses (AEC)	9
Audit Courses	0
Internships (INT)	4
Major Courses	61

Course Category	Credits
Discipline Specific Electives (DSE)	27
Open Electives	6
Skill Enhancement Courses (SEC)	4
Projects (PROJ.)	16
Value-Added Courses (VAC)	8
Total	**135**

Table 2: Overall Credit Distribution for B.Sc. (Hons.) Data Science Program

Program Credits Summary

The academic journey is supported by a structured credit distribution across six semesters, ensuring that students meet the total requirement of 135 credits upon graduation. Below is a summary of the credit allocation per semester:

Semester	Credits
Semester I	25
Semester II	24
Semester III	27
Semester IV	24
Semester V	23
Semester VI	12
Total	**135**

Table 3: Credit Allocation per Semester

Discipline Specific Electives

To cater to diverse interests and emerging industry trends, students can choose from specialized electives in their final semesters:

Discipline Specific Elective I: Cloud Computing

- Computational Services in The Cloud
- Microsoft Azure Cloud Fundamentals
- Storage and Databases on Cloud
- Application Development and DevOps on Cloud

Discipline Specific Elective II: Full Stack Development

- Mobile Application Development using iOS
- DevOps & Automation
- .Net Framework

- New Age Programming Languages

Curriculum Structure and Degree Requirements

The B.Sc (Hons.) Data Science program at the School of Engineering & Technology offers a comprehensive, structured curriculum designed to meet the demands of the rapidly evolving field of data science. The program is spread across six semesters, balancing foundational knowledge, advanced topics, practical skills, and interdisciplinary learning. The total credit requirement for the B.Sc (Hons.) Data Science program is 135 credits.

Course Categories and Credit Distribution

1. **Ability Enhancement Courses (AEC) – 9 credits:** Courses designed to enhance students' communication skills, critical thinking, and other essential abilities necessary for academic and professional success.

2. **Audit Courses – 0 credits:** Non-credit courses aimed at sharpening students' skills in specific areas such as Competitive Programming, providing opportunities to engage in coding practice and challenges.

3. **Internships (INT) – 4 credits:** Practical industry experience through internships, allowing students to apply theoretical knowledge in real-world settings and gain valuable professional exposure.

4. **Major Courses – 61 credits:** Core courses in data science covering key topics such as programming, data structures, algorithms, databases, software engineering, computer networks, machine learning, and statistical analysis, forming the foundation of the degree.

5. **Discipline Specific Electives (DSE) – 27 credits:** Elective courses that allow students to specialize in areas such as Artificial Intelligence, Full Stack Development (FSD), Cyber Security, and Cloud Computing, fostering interdisciplinary learning and providing flexibility in their academic journey.

6. **Open Electives – 6 credits:** Courses offered from other disciplines, enabling students to explore a variety of subjects beyond their primary field of study in data science.

7. **Skill Enhancement Courses (SEC) – 4 credits:** Practical, hands-on courses focused on developing specific technical skills, including programming languages, software tools, and other industry-relevant proficiencies.

8. **Projects (PROJ.) – 16 credits:** Significant project work, both individual and group-based, encouraging students to apply their knowledge to solve complex problems and innovate within the field.

9. **Value-Added Courses (VAC) – 8 credits:** Courses aimed at fostering holistic development, emphasizing ethics, social responsibility, entrepreneurship, and leadership capabilities.

Course Category and Credits Summary

Course Category	Credits
Ability Enhancement Courses (AEC)	9
Audit Courses	0
Internships (INT)	4
Major Courses	61
Discipline Specific Electives (DSE)	27
Open Electives	6
Skill Enhancement Courses (SEC)	4
Projects (PROJ)	16
Value-Added Courses (VAC)	8
Total	**135**

Table 4: Course Category and Credits Distribution for B.Sc. (Hons.) Data Science Program

Program Name	Semester						Total Credits
	I	II	III	IV	V	VI	
B.Sc (H) Data Science	25	24	27	24	23	12	**135**

Course Registration and Scheduling

Effective course registration and scheduling are pivotal to the academic success of students in the B.Sc (Hons.) Data Science program. This section outlines the procedures and guidelines for selecting Majors and Discipline Specific Electives (DSE), as well as the integration of internships and projects into the curriculum.

Major and Discipline Specific Electives Selection

In the B.Sc (Hons.) Data Science program, students have the opportunity to specialize in their field through Major and Discipline Specific Electives (DSE) selections, allowing them to tailor their academic journey according to their interests and career aspirations.

Major Selection

The Major component comprises **61 credits** of core Data Science and related courses, providing a robust foundation in fundamental concepts such as algorithms, data structures, software engineering, machine learning, statistical analysis, and computer networks. These courses are essential for developing the technical expertise required for advanced studies and professional practice in the field.

Discipline Specific Electives (DSE) Selection

The Discipline Specific Electives (DSE) component offers **27 credits** of department-specific electives across several cutting-edge domains:

1. **Artificial Intelligence (AI)**
2. **Full Stack Development (FSD)**
3. **Cyber Security**
4. **Cloud Computing**

This flexibility empowers students to gain specialized knowledge and skills in areas of their choice, enabling them to pursue diverse career paths or advanced studies in these high-demand fields. Selecting DSE allows students to complement their Major coursework with focused expertise, thereby preparing them for dynamic roles in the evolving tech industry.

Internships, Projects, and Experiential Learning

In alignment with our commitment to providing practical, hands-on experiences that complement academic learning, the curriculum incorporates a range of internships, projects, and other experiential learning opportunities. These components are designed to enhance students' skills, apply theoretical knowledge in real-world settings, and prepare them for successful careers in data science and technology. Below is an overview of the related courses offered:

1. **Summer Internships:** Summer internships are integrated into our curriculum at various stages to ensure students gain relevant industry experience. These internships are structured as follows:
   - **SIBC251: Summer Internship I (2 Credits)**
     - **Objective:** To provide students with their first exposure to a professional work environment, enabling the application of fundamental concepts learned in coursework.
     - **Duration:** Summer term, typically spanning 6-8 weeks.
     - **Focus:** Gaining initial industry experience, understanding professional practices, and developing workplace skills.
   - **SIBC351: Summer Internship II (2 Credits)**
     - **Objective:** To deepen students' industry experience by engaging them in more complex tasks and projects.
     - **Duration:** Summer term, typically spanning 6-8 weeks.
     - **Focus:** Applying advanced concepts and techniques, participating in meaningful projects, and refining technical and soft skills.
2. **Projects:** Projects offer students the opportunity to engage in focused, project-based learning, emphasizing the application of core concepts in practical scenarios.
   - **Project-I (Semester II):** Focused on specific areas of study, this project enables students to delve into practical applications of their coursework.
   - **Project-II (Semester IV):** Building on the skills acquired in Project-I, with increased complexity and scope.
   - **Major Project (Semester VI):** A capstone project that integrates knowledge from the entire program, fostering innovation and problem-solving skills.

These experiential learning components are integral to our educational philosophy, ensuring that students not only acquire theoretical knowledge but also develop practical skills and gain valuable industry experience. Our structured approach to internships and projects prepares students to meet the demands of the data science profession and excel in their future careers.

Academic Support Services (Slow & Advanced Learners)

Identifying slow and advanced learners is crucial for providing personalized and effective education. By assessing students' performance through mid-term evaluations and internal assessments, institutions can tailor support to meet individual learning needs. Slow learners benefit from remedial classes, extra assignments, and personalized attention, helping them bridge knowledge gaps and progress academically. Meanwhile, advanced learners are offered opportunities for academic enrichment, including participation in technical events, research projects, and career counseling. This structured approach ensures holistic development, fosters individual growth, and enhances overall academic performance.

Mechanism for identifying slow and advanced learners

- **Mid-term Evaluation:** Conduct mid-term exams with a weightage of 20%.
- **Assessment of Learning Levels:** Evaluate students based on their performance in the mid-term and other internal assessments.
- **Slow Learners Identification:**
  - If a student's marks are $\leq$55%, they are categorized as slow learners.
  - Remedial support includes additional classes, extra assignments, and notes.
- **Advanced Learners Identification:**
  - If a student's marks are $\geq$80%, they are categorized as advanced learners.
  - They are provided with opportunities for career counseling, participation in technical events, and advanced courses.

Student Support Services

- **Mentor-Mentee:** Personalized guidance from experienced mentors to support academic and professional growth.
- **Counselling and Wellness Services:** Mental health and wellness support to ensure students maintain a healthy balance between academics and personal life.
- **Career Services and Training:** Comprehensive career services, including resume building, interview preparation, and job placement assistance.

Learning and Development Opportunities

- **Laboratories and Practical Learning:** State-of-the-art labs equipped with the latest technologies to provide hands-on experience.

- **Experiential Learning:** Real-world projects and internships to apply theoretical knowledge in practical settings.
- **Case-Based Learning/Problem-Based Learning/Project Based Learning:** Interactive learning methodologies to enhance critical thinking and problem-solving skills.
- **Workshops, Seminars, Guest Lectures:** Regular workshops and seminars conducted by industry experts to keep students updated with the latest trends.
- **Inside & Outside Classroom Learning:** A blend of classroom learning and external experiences to provide a holistic education.
- **Holistic Education:** Emphasis on overall development, including technical, soft, and ethical skills.

Assessment and Evaluation

Grading Policies and Procedures for Theory Courses, Practical Courses, Projects, Internships, Dissertation

Theory Courses: Grading for theory courses is based on a comprehensive evaluation scheme designed to assess both continuous performance and final examination results. The assessment is divided as follows:

- **Continuous Assessment (30 Marks):** Includes diverse components such as project work, quizzes, assignments, essays, presentations, participation, case studies, and reflective journals. These components are evenly spaced throughout the semester to gauge ongoing student performance.
- **Mid-Term Exam (20 Marks):** A formal examination conducted midway through the semester to assess understanding and retention of the material covered up to that point.
- **End-Term Examination (50 Marks):** A comprehensive exam covering the entire syllabus, designed to evaluate students' overall understanding and application of the course content.

Practical Courses: Practical assessments focus on the students' ability to apply theoretical knowledge to practical tasks. The evaluation components include:

- **Conduct of Experiment (10 Marks):** Assessment of the student's practical skills and ability to follow experimental procedures.
- **Lab Records (10 Marks):** Evaluation of the completeness and accuracy of lab documentation.
- **Lab Participation (10 Marks):** Involvement and engagement in laboratory activities.
- **Lab Project (20 Marks):** Performance and results of a project-based laboratory assignment.
- **End-Term Practical Exam and Viva Voce (50 Marks):** A comprehensive practical examination and oral assessment to evaluate the application of lab skills and theoretical knowledge.

Projects: Projects are assessed based on the depth of research, problem-solving abilities, innovation, and the quality of the final report and presentation.

Internships: Internships are evaluated based on the completion of assigned tasks, professional conduct, and the submission of a comprehensive internship report.

Dissertation: The dissertation is assessed on the originality of research, methodology, analysis, and the clarity of presentation.

Note: Students must secure at least 40% in both internal and external components (theory and practical) to pass the course.

Feedback and Continuous Improvement Mechanisms

Feedback is integral to fostering continuous improvement and enhancing the learning experience. Our feedback mechanisms include:

- **Student Feedback Surveys:** Regular surveys to collect student opinions on course content, teaching methods, and overall learning experience.
- **Peer Reviews:** Evaluation of teaching practices by peers to ensure adherence to educational standards and continuous improvement.
- **Faculty Reviews:** Periodic reviews of faculty performance based on feedback and assessment outcomes to support professional development.
- **Continuous Improvement:** Driven by analyzing feedback, implementing necessary changes, and reviewing the effectiveness of modifications.

Academic Integrity and Ethics

Upholding academic integrity and ethical standards is crucial in maintaining the quality of education. Our policies include:

- **Cheating Prevention:** Procedures to prevent and address cheating during exams and assignments.
- **Ethical Conduct:** Clear guidelines on academic conduct and ethics, with emphasis on honesty and responsibility in all academic work.

Examination and Evaluation Methods

Our examination and evaluation methods ensure a fair and comprehensive assessment of student performance:

- **Theory Examinations:** A mix of continuous assessments and formal exams to evaluate students' understanding and application of course material.
- **Practical Examinations:** Assessment of hands-on skills and practical knowledge through lab experiments and projects.
- **ICT Tools:** Utilization of Moodle LMS and interactive teaching boards to support teaching and assessment, providing students with access to course materials, assignments, and feedback.

Evaluation Components:

- **Lecture PPTs and Video Lectures:** Used to deliver course content and reinforce key concepts.
- **Problem-Based and Project-Based Assignments:** Encourage practical application of theoretical knowledge and critical thinking.
- **Question Banks and Model Papers:** Provide practice and preparation for exams.
- **Continuous Assessment and Support:** Regular assessments and feedback to monitor and support student progress throughout the semester.

Semester I (Odd Semester)

SN	Category	Course Code	Course Title	L	T	P	C
1	Major-1	ENBC101	Fundamentals of Web Technologies	4	-	-	4
2	Major-2	ENBC103	MATLAB Programming	4	-	-	4
3	SEC-1	SEC050	Linux Environment Lab	-	-	4	2
4	SEC-2	ENSP107	Introduction to Programming in Python	4	-	0	4
5	Major-3	ENBC151	Fundamentals of Web Technologies Lab	-	-	2	1
6	Major-4	ENBC153	MATLAB Programming Lab	-	-	2	1
7	SEC-3	ENSP155	Programming in Python lab	-	-	2	1
8	VAC-1	VAC-151	Environmental Studies & Disaster Management	2	-	-	2
9	Major-5	ENBC105	Fundamentals of Software Engineering	4	-	-	4
10	MOOC-1	SEC067	Essentials of Computer Science[1]	-	-	-	2
Total				**18**	**0**	**10**	**25**

[1] Course "**Essentials of Computer Science**" will be offered in an online self-paced mode. Students will be required to complete the suggested online module and produce the certification. Marks shall be allocated based on internal evaluation of 100 marks.

Semester II (Even Semester)

SN	Category	Course Code	Course Title	L	T	P	C
1	SEC-4	ENSP110	Essentials of Data Science	4	-	-	4
2	Major-6	ENBC102	Introduction to Discrete Structures	3	1	-	4
3	Major-7	ENBC104	Basics of Operating Systems	3	1	-	4
4	Major-8	ENBC106	Concepts of Object Oriented Programming Using C++	3	1	-	4
5	SEC-5	ENSP162	Data Science Lab	-	-	2	1
6	Major-9	ENBC152	Concepts of Object Oriented Programming Using C++ Lab	-	-	2	1
7	Major-10	ENBC154	Basics of Operating Systems Lab	-	-	2	1
8	Open Elective-1		Open Elective-I	3	-	-	3
9	Proj-1	ENSI152	Minor Project-I[2]	-	-	-	2
Total				**16**	**3**	**6**	**24**

[2] Marks for "**Minor Project-I**" shall be allocated based on internal evaluation of 100 marks. No End term evaluation is required.

Semester III (Odd Semester)

SN	Category	Course Code	Course Title	L	T	P	C
1	Major-11	ENBC201	Introduction to Data Structures	3	1	-	4
2	SEC-6	ENSP205	Fundamentals of Machine Learning	4	-	-	4
3	Major-12	ENBC203	Basics of Probability & Statistics	4	-	-	4
4	Major-13	ENBC205	Introduction to Java Programming	3	1	-	4
5	AEC-1	AEC006	Verbal Ability	3	-	-	3
6	Major-14	ENBC251	Introduction to Java Programming Lab	-	-	2	1
7	Major-15	ENBC253	Introduction to Data Structures Lab	-	-	2	1
8	SEC-7	ENSP257	Machine Learning Lab	-	-	2	1
9	VAC-2	VAC-II	VAC-III	-	-	-	2
10	INT-1	SIBC251	Summer Internship-I[3]	-	-	-	2
11	AUDIT-1		Competitive Coding Bootcamp- I	2	-	-	0
12	CS-1	CS001	Club/Society	1	-	-	1
Total				**20**	**2**	**6**	**27**

[3] Note: For "**Summer Internship-I**" students have to complete 6 weeks internship during the summers and submit a completion certificate. Students will be evaluated on a scale of 100 based on their learning outcomes during the 3rd semester for allocation of marks for internship.

VAC-II

S.No	Course Code	Course Title	L	T	P	C
1	**VAC170**	Design Thinking & Innovations for Engineers	-	-	-	2
2	**VAC171**	AWS Cloud Fundamentals	-	-	-	2
3	**VAC172**	Web Development with Open Source Frameworks	-	-	-	2
4	**VAC173**	Google Data Analytics	-	-	-	2
5	**VAC174**	Software Testing using Open Source Frameworks	-	-	-	2
6	**VAC175**	Database Management with Open Source Frameworks	-	-	-	2
7	**VAC176**	Cyber Security with Open Source Frameworks	-	-	-	2
8	**VAC185**	Practical Robotics and UAV Applications	-	-	-	2
9	**VAC186**	Applied Automotive Engineering: Hands-On Practices and Innovations	-	-	-	2
10	**VAC187**	Practical Research Methodology for Engineers	-	-	-	2

Semester IV (Even Semester)

SN	Category	Course Code	Course Title	L	T	P	C
1	Major-16	ENBC202	Fundamentals of Algorithm Design & Analysis	3	1	-	4
2	Major-17	ENBC204	Introduction to Database Management Systems	3	1	-	4
3	Major-18	ENBC206	Introduction to Computer Networks	3	1	-	4
4	Major-19	ENBC252	Introduction to Database Management Systems Lab	-	-	2	1
5	Major-20	ENBC254	Fundamentals of Algorithm Design & Analysis Lab	-	-	2	1
6	Major-21	ENBC256	Introduction to Computer Networks Lab	-	-	2	1
7	AEC-2	AEC007	Communication & Personality Development	3	-	-	3
8	Proj-2	SIBC252	Minor Project-II[4]	-	-	-	2
9	Open Elective-2		Open Elective-II	3	-	-	3
10	AUDIT-2		Competitive Coding Bootcamp- II	3	-	-	0
11	CS-2	CS002	Community Service	1	-	-	1
Total				**19**	**3**	**6**	**24**

[4] Note: For the "**Minor Project-II**," students will undergo internal evaluation, which will be graded on a scale of 100 marks.

Semester V (Odd Semester)

SN	Category	Course Code	Course Title	L	T	P	C
1	Major-22	ENBC301	Computer Organization and Architecture	3	1	-	4
2	DSE-1		Discipline Specific Elective -I	4	-	-	4
3	DSE-2		Discipline Specific Elective -I Lab	-	-	2	1
4	DSE-3		Discipline Specific Elective -II	4	-	-	4
5	DSE-4		Discipline Specific Elective -II Lab	-	-	2	1
6	SEC-8	ENSP369	Natural Language Processing Lab	-	-	4	2
7	INT-2	SIBC351	Summer Internship-II[5]	-	-	-	2
8	AEC-3	AEC008	Arithmetic and Reasoning Skills	3	-	-	3
9	MOOC-2		Applied Programming and Problem-Solving Skills for Campus Interviews (Infosys Connect Program)	-	-	-	2
Total				**14**	**1**	**8**	**23**

Semester VI (Even Semester)

SN	Category	Course Code	Course Title	L	T	P	C
1	Proj-3	SIBC352	Major Project/Industrial Training	-	-	-	12
Total				-	-	-	**12**

[5] **Note:**

- For the "Summer Internship," students are required to complete a 6-week full-time industry internship during the summer and submit a completion certificate. The evaluation will occur in the 7th semester, with students graded on a scale of 100 marks.
- Students are required to undertake a full-time industry internship for the entire semester. They are not permitted to enroll in any courses as an alternative to the internship. Students can choose from the following internship options:
  - Industry project
  - Research & Development project
  - Start-up project
- Evaluation will be based on internal assessments, with no end-term exams applicable.

Discipline Specific Elective I (Cloud Computing)

SN	Category	Course Code	Course Title	L	T	P	C
(i)	DSE	ENSP401	Computational Services in The Cloud	4	-	-	4
(ii)	DSE	ENSP451	Computational Services in The Cloud Lab	-	-	2	1
(iii)	DSE	ENSP403	Microsoft Azure Cloud Fundamentals	4	-	-	4
(iv)	DSE	ENSP453	Microsoft Azure Cloud Fundamentals Lab	-	-	2	1
(v)	DSE	ENSP405	Storage and Databases on Cloud	4	-	-	4
(vi)	DSE	ENSP455	Storage and Databases on Cloud Lab	-	-	2	1
(vii)	DSE	ENSP407	Application Development and DevOps on Cloud	4	-	-	4
(viii)	DSE	ENSP457	Application Development and DevOps on Cloud Lab	-	-	2	1

Discipline Specific Elective II (Full Stack Development)

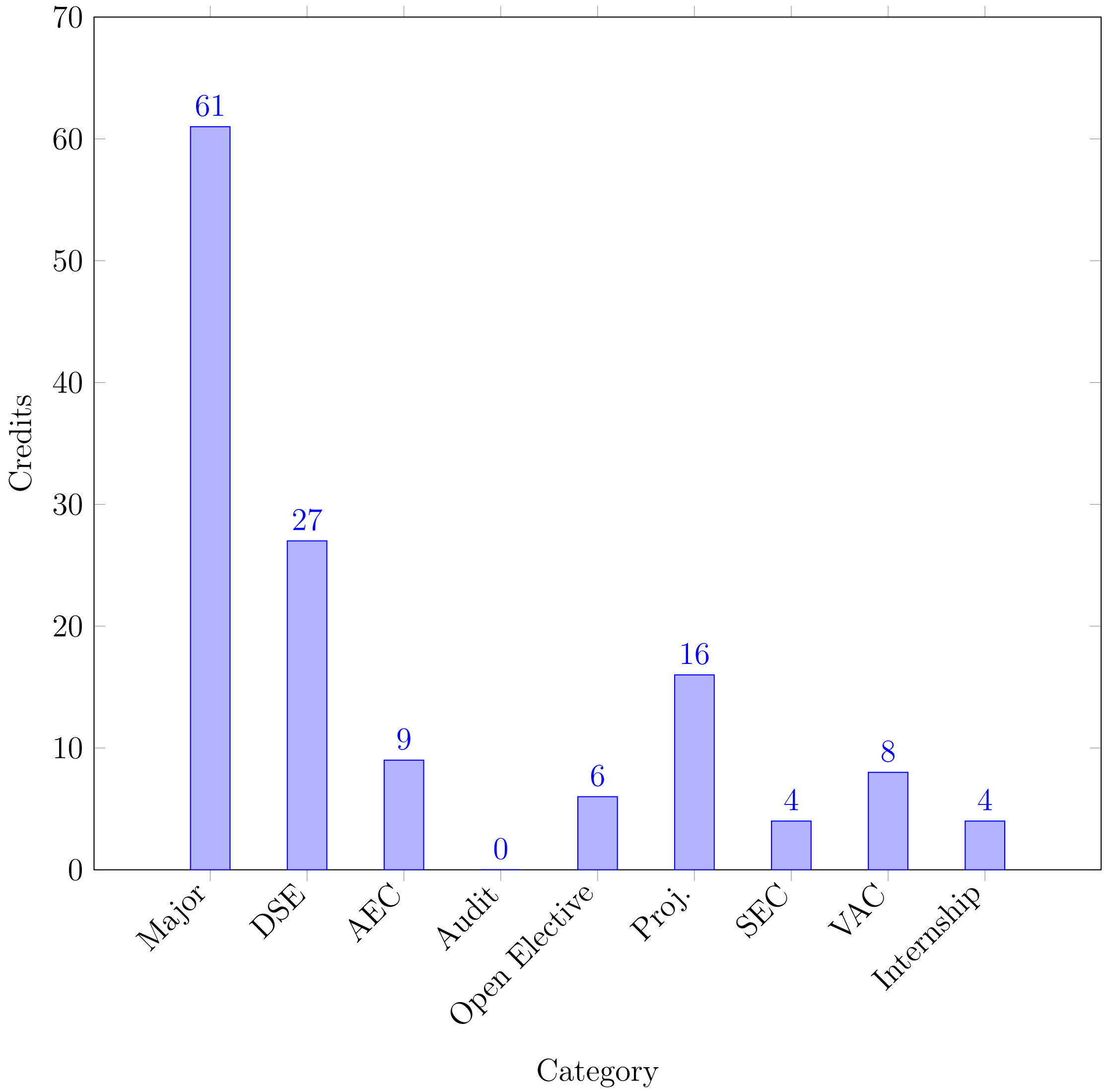
SN	Category	Course Code	Course Title	L	T	P	C
(i)	DSE	ENSP409	Mobile Application Development using iOS	4	-	-	4
(ii)	DSE	ENSP459	Mobile Application Development using iOS Lab	-	-	2	1
(iii)	DSE	ENSP411	DevOps & Automation	4	-	-	4
(iv)	DSE	ENSP461	DevOps & Automation Lab	-	-	2	1
(v)	DSE	ENSP413	.Net Framework	4	-	-	4
(vi)	DSE	ENSP463	.Net Framework Lab	-	-	2	1
(vii)	DSE	ENSP415	New Age Programming Languages	4	-	-	4
(viii)	DSE	ENSP465	New Age Programming Languages Lab	-	-	2	1

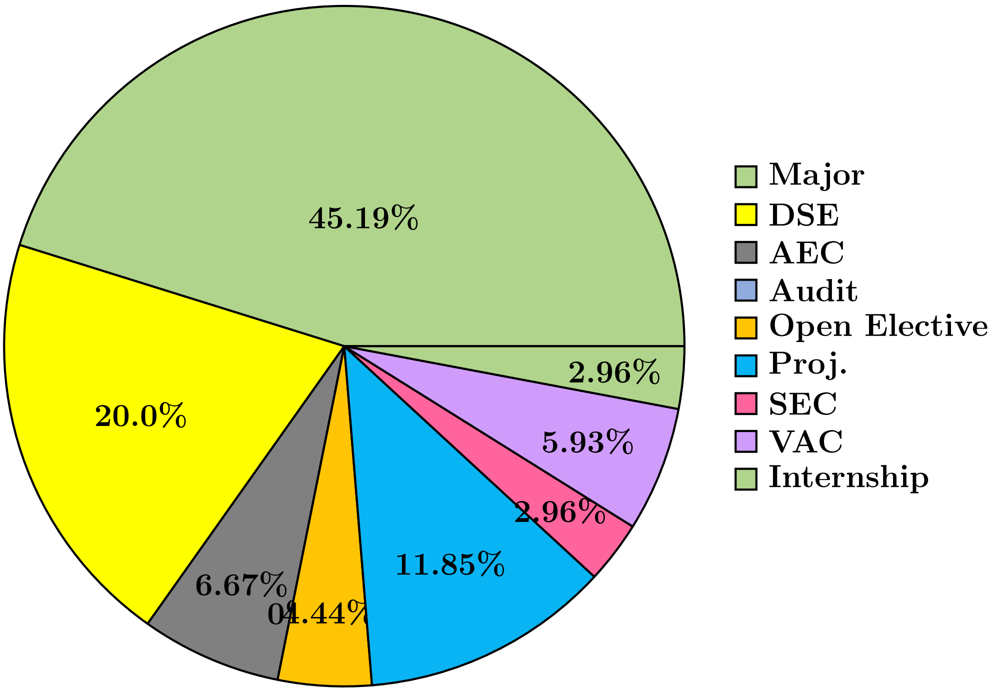
Program Credits

Program Name	Semester						Total Credits
	I	II	III	IV	V	VI	
B.Sc (H) DS	25	24	27	24	23	12	***135***

Total Credits: ***135***

Course Categories Distribution





Evaluation Scheme (Theory)

Evaluation Components	Weightage
Internal Marks (Theory) 1. **Continuous Assessment (30 Marks)** (All the components to be evenly spaced) Project/ Quizzes/ Assignments and Essays/ Presentations/ Participation/ Case Studies/ Reflective Journals (minimum of five components to be evaluated)	**30 Marks**
2. **Internal Marks (Theory) – Mid Term Exam**	**20 Marks**
External Marks (Theory): - End term Examination	**50 Marks**
Total	**100 Marks**

Note: *It is compulsory for a student to secure **40%** marks in Internal and End Term Examination separately to secure minimum passing grade.*

Evaluation Scheme (Laboratory)

Evaluation Components	**Weightage**
Internal Marks (Practical)	
1. Conduct of Experiment	**10 Marks**
2. Lab Records	**10 Marks**
3. Lab Participation	**10 Marks**
4. Lab Project	**20 Marks**
External Marks (Practical): -	**50 Marks**
End term Practical Exam and Viva Voce	
Total	**100 Marks**

Note: *It is compulsory for a student to secure **40%** marks in Internal and End Term Practical Exam and Viva Voce separately to secure minimum passing grade.*

Detailed Syllabus

Semester: 1

Fundamentals of Web Technologies

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Fundamentals of Web Technologies	ENBC101	4-0-0	4
Type of Course:	Major		
Pre-requisite(s):	Basic knowledge of computer systems		

Course Perspective: This course introduces the foundational concepts and technologies of the World Wide Web (WWW). It covers the architecture of web systems, client-side scripting, web design principles, and advanced web technologies like XML and AJAX. The course aims to equip students with the skills to create, design, and manage effective web systems. The course is divided into 4 units:

1. Introduction to Web Technology
2. Client-side Scripting
3. Concepts of Effective Web Design
4. XML and Advanced Web Technologies

The Course Outcomes (COs)

On completion of the course the participants will be:

COs	Statements
CO 1	Applyinging foundational concepts of web technology, including WWW, OSI and TCP/IP models, HTTP, and HTML5, to understand and create web systems.
CO 2	Developinging client-side scripting skills using JavaScript and CSS3 to enhance web page interactivity and styling.
CO 3	Implementinging effective web design principles to address design issues, user-centric design, and website navigation.
CO 4	Utilizinging XML, web services, and AJAX for advanced web technologies to create dynamic and efficient web applications.

A student is expected to have learnt concepts and demonstrated/developed abilities or skills related to strategic management at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to Web Technology**	**No. of hours: 8**
Content:		
• Concept of WWW, Internet and WWW • OSI Reference Model • Understanding Web System Architecture • Understanding 3-Tier Web Architecture • **Layers in the TCP/IP Model**: Physical, Link, Internet, Transport, Application • Web Browsers • **Retrieving Documents on the Web**: URL and Domain Name System • **Overview of HTTP**: Request and Response • **HTML5**: Introduction, Document structure tags, comments, Text formatting, inserting special characters, anchor tag, adding images and sound, lists, tables, frames, forms, Image maps, Meta tags, Character entities		
Unit Number: 2	**Title: Client-side Scripting**	**No. of hours: 12**
Content:		
• **JavaScript**: Data Types, Control Statements, Operators, Built-in and User Defined Functions, Objects in JavaScript, Handling Events • HTML Document Object Model • **Page Styling**: Separation of content and presentation in HTML, CSS3 - Types of Style Sheets – Internal, inline, and External style sheets, customizing common HTML elements, types of CSS selectors • **Introduction to Forms and HTML Controls**: Creating Forms, Using HTML Controls		
Unit Number: 3	**Title: Concepts of Effective Web Design**	**No. of hours: 12**
Content:		

<table>
<tr><td colspan="3">• Concepts of effective web design
• Web design issues including Browser, Bandwidth and Cache, Display resolution, Look and Feel of the Website, Page Layout and linking, User-centric design, Sitemap, Planning and publishing website, Designing effective navigation, Browser architecture, and Website structure
• Introduction to DHTML</td></tr>
<tr><td><b>Unit Number: 4</b></td><td><b>Title: XML and Advanced Web Technologies</b></td><td><b>No. of hours: 8</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• <b>Introduction to XML</b>: Markup languages, XML Syntax, XML Declaration, Elements, Attributes, Valid XML Documents, Viewing XML, XML Parser
• <b>Introduction to Web Services</b>: UDDI, SOAP, WSDL, Web Service Architecture
• <b>AJAX</b>: Introduction, AJAX programming, improving web page performance using AJAX</td></tr>
</table>

Learning Experience

Classroom Learning Experience

- **Interactive Lectures:** Engage students with detailed explanations of web technology concepts using diagrams, live coding demonstrations, and interactive discussions on client-side and server-side technologies.

- **Hands-On Labs:** Provide practical sessions where students design and develop web pages, implement JavaScript functionality, and create interactive web elements using HTML, CSS, and JavaScript.

- **Group Projects:** Encourage collaborative learning through group projects where students design and develop complete websites, applying concepts like responsive design, form validation, and dynamic content generation.

- **Assignments & Case Studies:** Assign tasks that involve real-world scenarios, such as creating web pages that follow industry standards, optimizing web performance, and implementing security measures.

- **Support & Feedback:** Offer ongoing support through office hours, online forums, and coding workshops. Provide detailed feedback on assignments, projects, and lab work to guide students in improving their technical skills.

- **Assessments:** Include quizzes, coding exercises, and final exams that test students' understanding of web technologies, their ability to implement web solutions, and their design proficiency.

Outside Classroom Learning Experience

- **Assignments:** Extend classroom concepts through take-home tasks, requiring students to design web pages, implement JavaScript functions, and explore advanced HTML and CSS techniques.
- **Online Forums:** Facilitate discussions on complex web development topics and troubleshooting, encouraging collaborative learning outside the classroom.
- **Self-Study:** Encourage students to independently explore web development tools, frameworks, and design practices to enhance their understanding of the subject.
- **Group Work:** Promote collaboration on larger projects that involve the application of web development techniques to create fully functioning websites.
- **Additional Resources:** Provide access to coding tutorials, videos, and documentation for deeper exploration of web technologies.
- **Peer Feedback:** Encourage students to review each other's work, share feedback, and suggest improvements through collaborative online platforms.

Text Books

- "Web Technologies: HTML, JavaScript, PHP, Java, JSP, XML and AJAX, Black Book" by Kogent Learning Solutions Inc

Reference Books

- Web Technologies, Uttam K. Roy, Oxford University Press
- HTML Black Book, Stephen Holzner, Wiley Dreamtech.
- Web Technology, Rajkamal, Tata McGraw-Hill.
- Web Technologies: A Computer Science Perspective, Jeffrey C. Jackson, Pearson.
- XML: How to Program, Deitel & Deitel Nieto

Additional Readings

Self-Learning Components:

1. Link to W3Schools HTML tutorial: https://www.w3schools.com/html/
2. Link to Mozilla Developer Network (MDN) JavaScript documentation: https://developer.mozilla.org/en-US/docs/Web/JavaScript
3. Link to CSS-Tricks for CSS resources and guides: https://css-tricks.com/
4. Link to XML tutorial by W3Schools: https://www.w3schools.com/xml/
5. Link to AJAX tutorial by W3Schools: https://www.w3schools.com/xml/ajax_intro.asp
6. Link to NPTEL Web Technologies course: https://onlinecourses.nptel.ac.in/noc21_cs30/

MATLAB Programming

Program Name:	B.Sc (Hons.) Data Science)		
Course Name:	**Course Code**	**L-T-P**	**Credits**
MATLAB Programming	ENBC103	4-0-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course aims to introduce students to MATLAB programming, covering fundamental concepts, programming constructs, data visualization, file I/O operations, and advanced applications. The course is divided into 4 units:

1. Introduction to MATLAB
2. Programming Constructs
3. Data Visualization and File I/O
4. Introductory Applications in MATLAB

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding and applying basic concepts and environment of MATLAB, including its history, features, syntax, scripts, and functions.
CO 2	Implementing programming constructs in MATLAB, such as control statements, loops, vectors, matrices, built-in functions, and user-defined functions.
CO 3	Utilizing MATLAB for data visualization and file I/O operations, including 2D/3D plotting, advanced plotting techniques, and handling various file formats.
CO 4	Exploring advanced MATLAB topics and applications, such as image processing, signal processing, and Simulink for solving real-world problems.

A student is expected to have learnt concepts and demonstrated/developed abilities or skills related to MATLAB programming at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to MATLAB**	**No. of hours: 8**
Content:		
• Overview of MATLAB: History, Features, and Applications • MATLAB Environment: Command Window, Workspace, and Command History • Basic Syntax: Variables, Data Types, and Operators • Scripts and Functions: Creating, Saving, and Running Scripts • Input and Output: Getting User Input, Displaying Output		
Unit Number: 2	**Title: Programming Constructs**	**No. of hours: 12**
Content:		
• Control Statements: Conditional Statements (if, else, switch) • Loops: for, while, and nested loops • Vectors and Matrices: Creating, Indexing, and Manipulating • Built-in Functions: Using common mathematical and statistical functions • User-Defined Functions: Writing and calling functions, function handles		
Unit Number: 3	**Title: Data Visualization and File I/O**	**No. of hours: 12**
Content:		
• Plotting: 2D and 3D plots, Customizing Plots (labels, titles, legends) • Advanced Plotting Techniques: Subplots, Logarithmic plots, Bar and Pie charts • File I/O: Reading from and writing to files, File formats (txt, csv, xls) • Data Import and Export: Importing data from external sources, Exporting results		
Unit Number: 4	**Title: Introductory Applications in MATLAB**	**No. of hours: 8**
Content:		

- Basic Numerical Methods: Solving simple linear equations, Numerical integration, and differentiation
- Basic Data Analysis: Statistical analysis, Curve fitting, and interpolation
- Introduction to Image Processing: Simple image manipulation and analysis
- Simulink: Introduction to Simulink, Creating simple models
- Basic Algorithm Implementation: Implementing simple algorithms like Fibonacci series, factorial calculation, and basic sorting techniques

Learning Experience

Classroom Learning Experience

- **Interactive Lectures:** Engage students with detailed explanations of MATLAB concepts and programming constructs using live coding sessions and interactive demonstrations of key features, such as plotting and data analysis.
- **Hands-On Labs:** Provide extensive lab sessions where students work directly in the MATLAB environment, writing scripts, creating functions, and manipulating data. These labs help students reinforce theoretical knowledge through practical application.
- **Group Projects:** Encourage collaborative learning by assigning group projects where students develop complex MATLAB programs to solve real-world problems, such as data visualization tasks or basic algorithm implementation.
- **In-Class Problem Solving:** Conduct problem-solving sessions where students work on MATLAB challenges related to engineering, data science, and mathematical modeling.
- **Immediate Feedback:** Provide in-class feedback through quizzes and lab exercises, ensuring students' understanding of key MATLAB programming concepts.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign practical tasks and case studies that require students to apply MATLAB programming to real-world scenarios, such as engineering simulations, image processing, and data analysis.
- **Online Forums:** Facilitate discussions and troubleshooting sessions on MATLAB programming, encouraging peer-to-peer learning and collaboration outside the classroom.
- **Self-Study:** Encourage students to explore additional MATLAB features, toolboxes, and documentation to enhance their understanding of advanced topics.
- **Collaborative Projects:** Promote group work outside of class where students can apply MATLAB programming to develop real-world solutions and share their progress.

- **Practice Problems:** Provide access to additional practice exercises, problem sets, and example scripts that students can work on to improve their programming skills.

- **Peer Feedback:** Encourage students to review each other's MATLAB code, providing constructive feedback to help them improve their coding techniques.

Text Books

- Stormy Attaway, *MATLAB: A Practical Introduction to Programming and Problem Solving*, 4th Edition, Elsevier, 2013.

Reference Books

- Amos Gilat, *MATLAB: An Introduction with Applications*, 5th Edition, Wiley, 2014.

- Steven C. Chapra, *Applied Numerical Methods with MATLAB for Engineers and Scientists*, 3rd Edition, McGraw-Hill, 2012.

- Holly Moore, *MATLAB for Engineers*, 4th Edition, Pearson, 2017.

Additional Readings

Self-Learning Components:

1. Link to MATLAB documentation: https://www.mathworks.com/help/MATLAB/

2. Link to MATLAB tutorials on MathWorks: https://www.mathworks.com/learn/tutorials/MATLAB-onramp.html

3. Link to MATLAB Central for user-contributed content and discussions: https://www.mathworks.com/MATLABcentral/

4. Link to NPTEL MATLAB course: https://onlinecourses.nptel.ac.in/noc18_cs06/preview

MATLAB Programming Lab

Program Name:	B.Sc (Hons.) Data Science)		
Course Name:	**Course Code**	**L-T-P**	**Credits**
MATLAB Programming Lab	ENBC153	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

COs	Statements
CO 1	Implementing basic programming constructs and algorithms to solve computational problems.
CO 2	Applying numerical methods and techniques for solving mathematical problems.
CO 3	Analyzing data using visualization and reporting solutions.
CO 4	Creating advanced Matlab applications for image processing, signal processing, and simulation.

Proposed Lab Experiments

S.N	Lab Task	Mapped CO/COs
1	Write a MATLAB script to display "Hello, World!" and get user input to display a personalized message.	CO1
2	Create a MATLAB script that performs basic arithmetic operations (addition, subtraction, multiplication, division) on two user-input numbers and displays the results.	CO1
3	Write a MATLAB function to convert temperatures from Celsius to Fahrenheit and vice versa.	CO1
4	Develop a MATLAB script to solve a quadratic equation ($ax^2 + bx + c = 0$) and display the roots.	CO2
5	Implement a MATLAB script that uses `if-else` statements to categorize a given number as positive, negative, or zero.	CO2
6	Write a MATLAB script that demonstrates the use of `for` and `while` loops to compute the factorial of a number.	CO2
7	Create a MATLAB function that takes a matrix as input and returns the transpose of the matrix.	CO2
8	Write a MATLAB script to perform matrix addition, subtraction, and multiplication using user-defined matrices.	CO2

S.N	Lab Task	Mapped CO/COs
9	Develop a MATLAB script to plot a sine wave and a cosine wave on the same graph with appropriate labels and legends.	CO3
10	Implement a MATLAB script to read data from a CSV file and plot it using a bar chart.	CO3
11	Write a MATLAB script to create subplots of various mathematical functions (sine, cosine, exponential) in a single figure.	CO3
12	Create a MATLAB script to read and display an image, then convert it to grayscale.	CO4
13	Develop a MATLAB script to solve a system of linear equations using matrix inversion.	CO4
14	Implement a MATLAB script for numerical integration of a given function using the trapezoidal rule.	CO4
15	Write a MATLAB script to fit a polynomial to a set of data points and plot the result.	CO4
16	Create a MATLAB script that performs statistical analysis (mean, median, standard deviation) on a dataset.	CO4
17	Develop a MATLAB script to implement the Fibonacci series using a loop.	CO2, CO4
18	Write a MATLAB function to calculate and plot the factorial of a number using recursion.	CO2, CO4
19	Create a MATLAB script to import data from an Excel file and perform basic data analysis (sum, average).	CO3, CO4
20	Develop a MATLAB script to perform simple image processing operations like edge detection and histogram equalization.	CO4
21	**Personal Expense Tracker:** Track daily expenses and generate summary reports. Create a MATLAB application to allow users to input daily expenses under various categories, store the data, and generate weekly and monthly summary reports with graphical visualizations of spending patterns.	CO3, CO4
22	**Temperature Converter:** Convert temperatures between Celsius, Fahrenheit, and Kelvin. Develop a MATLAB program that takes user input for temperature values and converts them between Celsius, Fahrenheit, and Kelvin. The application should provide a user-friendly interface and display the conversion results.	CO1, CO4
23	**Simple Calculator:** Perform basic arithmetic operations. Create a MATLAB application that functions as a simple calculator, supporting addition, subtraction, multiplication, and division operations. Implement error handling for invalid inputs and division by zero.	CO2, CO4

S.N	Lab Task	Mapped CO/COs
24	**Data Visualization of Student Scores:** Generate charts and graphs. Develop a MATLAB program to read student score data from a file, perform basic statistical analysis, and generate visualizations such as bar charts, histograms, and scatter plots to represent the data.	CO3, CO4
25	**Loan Amortization Schedule:** Calculate loan payment schedules. Write a MATLAB application that calculates and displays the loan amortization schedule based on user input for loan amount, interest rate, and loan term. The application should provide a detailed breakdown of each payment.	CO3, CO4
26	**Image Processing – Edge Detection:** Implement edge detection using MATLAB functions. Develop a MATLAB script to read an image file, apply edge detection algorithms (such as Sobel or Canny), and display the original and processed images side by side.	CO4
27	**Simulation of Projectile Motion:** Visualize projectile trajectories. Create a MATLAB application to simulate the motion of a projectile given initial velocity and angle. The application should plot the trajectory and allow users to adjust parameters to see the effect on the motion.	CO1, CO4
28	**Weather Data Analysis:** Analyze and visualize weather data trends. Write a MATLAB program to read weather data from a file, perform analysis such as calculating averages and trends, and generate visualizations like line plots and histograms to represent temperature, humidity, and precipitation data over time.	CO3, CO4

Online Learning Resources

- **Codecademy:** Interactive coding platform that offers hands-on MATLAB courses, teaching both the basics and more advanced topics. Ideal for practicing specific programming tasks.
  https://www.codecademy.com/learn/learn-MATLAB
- **HackerRank:** Provides a vast range of programming problems across various domains of computer science, along with a dedicated MATLAB domain. Great for practicing coding skills and understanding algorithms.
  https://www.hackerrank.com/domains/tutorials/10-days-of-MATLAB
- **LeetCode:** Known for its extensive array of programming challenges that can help improve your understanding of data structures and algorithms. It's particularly good for preparing for technical job interviews.
  https://leetcode.com/
- **GitHub:** Not just a code repository, GitHub offers collaborative features and a wealth of open-source projects where students can engage in real-world software development and contribute to ongoing projects.
  https://github.com/

Linux Environment Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Linux Environment Lab	SEC050	0-0-4	2
Type of Course:	SEC		

Defined Course Outcomes

COs	Statements
CO 1	Understanding the fundamental concepts and operations of the Linux operating system, including file management, directory structures, and basic shell commands.
CO 2	Applying basic scripting skills to automate routine tasks and simplify system management in a Linux environment.
CO 3	Analyzing system performance and security logs to identify potential issues and optimize Linux system operations.
CO 4	Creating and manage network configurations and security settings to ensure safe and efficient operation of Linux servers.

Proposed Lab Experiments

S.N	Lab Task	Mapped CO/COs
1	Navigate and manipulate files and directories using basic shell commands in Linux. Learn to manage file systems effectively.	CO1
2	Use grep and sed to perform text processing and data extraction from logs. Focus on extracting useful information from system logs for troubleshooting.	CO1
3	Write a shell script to automate the backup of files and directories, ensuring data integrity and recoverability.	CO2
4	Monitor system performance using commands like top, vmstat, and iotop. Identify and report on resource usage and potential bottlenecks.	CO3
5	Configure and manage user permissions and ownerships in a Linux environment, emphasizing security best practices.	CO1
6	Install and configure software packages using the package manager, understanding repository management and package dependencies.	CO1
7	Create and execute a shell script that automates system updates and cleanup processes, ensuring system efficiency and security.	CO2

S.N	Lab Task	Mapped CO/COs
8	Analyze security logs to detect potential unauthorized access or vulnerabilities, enhancing system security through log analysis.	CO3
9	Set up and manage network services such as SSH, FTP, and web servers, focusing on secure and efficient network operations.	CO4
10	Implement basic firewall settings using iptables or firewalld, securing the system against unauthorized network access.	CO4
11	Write advanced bash scripts incorporating loops, conditions, and functions to automate complex administrative tasks.	CO2
12	Utilize crontab to schedule and manage routine tasks across the system, ensuring regular maintenance and operations automation.	CO2
13	Configure and manage virtual hosts on an Apache or Nginx web server, focusing on hosting multiple websites on a single server.	CO4
14	Set up and secure a basic MySQL or PostgreSQL database server, ensuring data integrity and access control.	CO4
15	Use system monitoring tools to create performance reports and identify bottlenecks, optimizing server performance.	CO3
16	Automate the monitoring and alerting of system resources using custom scripts, enhancing proactive system management.	CO2
17	Configure and manage file sharing services using NFS or Samba, focusing on seamless file access within a network.	CO4
18	Implement a RAID array to manage disk redundancy and performance, ensuring data availability and fault tolerance.	CO4
19	Develop scripts to manage network configurations and troubleshoot common issues, enhancing network reliability and performance.	CO2
20	Secure Linux systems by configuring SELinux or AppArmor policies, focusing on enforcing strict security policies and controls.	CO3
1	**LAMP Stack Configuration:** Configure and deploy a full LAMP (Linux, Apache, MySQL, PHP) stack. Develop a comprehensive environment that allows for the hosting of dynamic websites and applications. The project should include setting up a virtual server, configuring Apache, installing MySQL, and deploying a sample PHP application.	CO4
2	**Dockerized Web Application:** Create a Docker container setup for deploying web applications efficiently. Students will develop Dockerfiles, manage Docker containers, and deploy a lightweight web application using Docker. This project should demonstrate the use of containers to streamline development and production workflows.	CO4
3	**Intrusion Detection System:** Develop a basic intrusion detection system (IDS) using open-source tools on a Linux system. The project involves setting up Snort or similar tools to monitor network traffic for suspicious activities, configuring alert systems, and analyzing intrusion attempts.	CO3

S.N	Lab Task	Mapped CO/COs
4	**Linux Server Backup Solution:** Implement a comprehensive backup solution for Linux servers. This project should cover the creation of backup scripts, scheduling of automatic backups, and restoration procedures. Students will explore different tools and methods for efficient data backup and recovery.	CO2
5	**Network Monitoring with Nagios:** Set up Nagios on a Linux server to monitor network health and performance. The project should include configuring Nagios to monitor critical network parameters, setting up alerts for system failures, and creating reports for network status. This provides practical experience in network management and monitoring.	CO4

Online Learning Resources

- **Codecademy:** Interactive platform offering courses on Linux command-line basics and shell scripting.
  https://www.codecademy.com/learn/learn-the-command-line

- **Linux Journey:** Comprehensive resource for learning Linux, from basic to advanced concepts.
  https://linuxjourney.com/

- **The Linux Documentation Project:** Offers extensive documentation and guides on various Linux topics.
  http://www.tldp.org/

- **GitHub:** Explore and contribute to open-source Linux projects and scripts.
  https://github.com/

Introduction to Programming in Python

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Programming in Python	ENSP107	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: This course introduces Python programming with a focus on data science applications. It covers Python fundamentals, secure coding practices, and key concepts relevant to data science.

The Course Outcomes (COs)

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

COs	Statements
CO 1	Interpreting the fundamental Python syntax and semantics and be fluent in the use of Python control flow statements.
CO 2	Expressing proficiency in the handling of strings and functions.
CO 3	Determining methods to create and manipulate Python programs utilizing data structures like lists, dictionaries, tuples, and sets.
CO 4	Identifying commonly used operations involving file systems and regular expressions.
CO 5	Articulating Object-Oriented Programming concepts such as encapsulation, inheritance, and polymorphism as used in Python.

Students are expected to demonstrate knowledge of Python programming concepts with a focus on cybersecurity by the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to Python and Program Flow Control**	**No. of hours: 12**
Content:		
• Python variables, basic operators, and Python blocks. • Python data types (int, float, etc.), numeric data type usage. • Conditional blocks: if, else, and elif. • Simple loops: for loop (ranges, strings, lists, dictionaries). • While loops, loop manipulation (pass, continue, break, and else). • Programming with conditional and loop blocks.		
Unit Number: 2	**Title: Python Data Structures**	**No. of hours: 8**
Content:		
• Strings and their operations, string manipulation methods. • Lists, list slicing, and manipulation. • Tuples and their uses. • Dictionaries and dictionary manipulation. • Defining functions and using them in Python programs. • Organizing code with functions.		
Unit Number: 3	**Title: File Operations and Regular Expressions**	**No. of hours: 8**
Content:		
• Reading and writing files: read(), readline(), readlines(), write(), writelines(). • Manipulating file pointers using seek(). • Introduction to regular expressions. • Pattern matching and text processing with regular expressions.		
Unit Number: 4	**Title: Object-Oriented Programming (OOP) Concepts in Python**	**No. of hours: 8**
Content:		

- Introduction to Object-Oriented Programming (OOP) in Python.
- Classes and Objects: Defining and using classes, creating objects from classes.
- Encapsulation: Understanding private and public attributes, getter and setter methods.
- Inheritance: Single and multiple inheritance, overriding methods.
- Polymorphism: Method overloading and overriding in Python.
- Constructors and Destructors: Understanding __init__() and __del__() methods.
- Special Methods in Python: __str__(), __repr__(), operator overloading.
- Case Studies and examples to demonstrate the practical use of OOP concepts in Python.

Learning Experience for Clean Coding with Python

Classroom Learning Experience

- **Interactive Lectures:** Engage students with in-depth explanations of Python syntax and clean coding practices, using real-world examples and interactive coding sessions to illustrate key concepts.
- **Hands-On Labs:** Provide practical lab sessions where students write Python code, focusing on clean code principles such as proper naming conventions, code organization, and error handling. These labs reinforce best practices in Python programming.
- **In-Class Code Reviews:** Conduct peer code reviews during lab sessions to provide immediate feedback on clean coding practices, helping students refine their Python skills.
- **Group Projects:** Encourage collaboration through group projects where students apply clean coding principles to develop Python programs, working together to refactor and improve code quality.
- **Immediate Feedback:** Provide feedback during lectures and lab sessions through quizzes and code challenges that test students' understanding of clean coding principles.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign tasks and case studies that challenge students to apply clean coding techniques in Python to solve complex problems, such as data handling and machine learning tasks.

- **Online Discussions:** Facilitate discussions on clean coding practices, common pitfalls, and best solutions through online forums, encouraging peer-to-peer support and knowledge sharing.
- **Self-Study:** Encourage students to independently explore advanced Python libraries and tools while practicing clean coding techniques.
- **Collaborative Coding Projects:** Promote teamwork on Python projects where students apply clean coding techniques outside the classroom, helping each other refine their code structure and readability.
- **Peer Code Review:** Set up peer code review activities where students critique and offer feedback on each other's code outside of class, fostering continuous improvement.
- **Practice Problems:** Provide additional clean coding practice exercises for students to complete on their own, reinforcing best practices in Python.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign tasks and case studies that challenge students to apply clean coding techniques in Python to solve complex problems, such as data handling and machine learning tasks.
- **Online Discussions:** Facilitate discussions on clean coding practices, common pitfalls, and best solutions through online forums, encouraging peer-to-peer support and knowledge sharing.
- **Self-Study:** Encourage students to independently explore advanced Python libraries and tools while practicing clean coding techniques.
- **Collaborative Coding Projects:** Promote teamwork on Python projects where students apply clean coding techniques outside the classroom, helping each other refine their code structure and readability.
- **Peer Code Review:** Set up peer code review activities where students critique and offer feedback on each other's code outside of class, fostering continuous improvement.
- **Practice Problems:** Provide additional clean coding practice exercises for students to complete on their own, reinforcing best practices in Python.

The course fosters a balance between theoretical knowledge and practical skills, ensuring that students not only understand Python programming but also know how to apply it effectively in cybersecurity contexts and beyond.

Textbooks

- T1: Wesley J. Chun, "Core Python Applications Programming", 3rd Edition, Pearson Education, 2016
- T2: Lambert, Fundamentals of Python: First Programs with MindTap, 2nd Edition, Cengage Learning publication

- T3: Charles Dierbach, “Introduction to Computer Science using Python”, Wiley, 2015
- T4: Jeeva Jose & P. Sojanlal, “Introduction to Computing and Problem Solving with PYTHON”, Khanna Publishers, New Delhi, 2016

Reference Books

- R1: Mark Lutz, “Learning Python”, 5th Edition, O’Reilly Publication, 2013
- R2: John Zelle, “Python Programming: An Introduction to Computer Science”, 2nd Edition, Course Technology Cengage Learning Publications, 2013
- R3: Michel Dawson, “Python Programming for Absolute Beginners”, 3rd Edition, Course Technology Cengage Learning Publications, 2013
- R4: David Beazley, Brian Jones, “Python Cookbook”, 3rd Edition, O’Reilly Publication, 2013

Online Learning Resources

The following online resources will help students further enhance their understanding of Python programming and cybersecurity applications:

- **Codecademy:** Interactive platform offering courses on Python programming, from basics to advanced topics, including applications in cybersecurity.
  https://www.codecademy.com/learn/learn-python-3
- **Coursera:** Courses on Python for cybersecurity offered by leading universities and institutions. Recommended course: "Python for Cybersecurity" specialization.
  https://www.coursera.org/specializations/python-for-cybersecurity
- **edX:** Offers various courses on Python and its applications, including data analysis and cybersecurity. Recommended course: "Introduction to Python for Data Science."
  https://www.edx.org/course/introduction-to-python-for-data-science
- **Kaggle:** Data science community with extensive Python tutorials and hands-on projects, including cybersecurity-related data science challenges.
  https://www.kaggle.com/learn/python
- **Real Python:** A comprehensive Python learning platform offering tutorials, coding exercises, and courses on Python programming, including security-related tasks.
  https://realpython.com/
- **GitHub:** An open-source platform to explore Python projects related to cybersecurity, contribute to projects, and learn from code written by experienced programmers.
  https://github.com/
- **Python Docs:** The official Python documentation is an excellent resource to learn Python, including detailed explanations of libraries and modules used for cybersecurity.
  https://docs.python.org/3/

- **Udemy:** Offers a variety of Python courses with practical projects, including topics on Python for cybersecurity.
  https://www.udemy.com/

Fundamentals of Web Technologies Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Fundamentals of Web Technologies Lab	ENBC151	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

COs	Statements
CO 1	Understanding the fundamentals of Web Technology, including the OSI model, TCP/IP layers, and web system architecture.
CO 2	Developing client-side scripts using JavaScript and style web pages effectively using CSS3.
CO 3	Applying principles of effective web design to create user-centric websites.
CO 4	Utilizing XML and AJAX to enhance web applications and develop basic web services.

S.N	Lab Task	Mapped CO/COs
1	Create a simple HTML page to understand basic HTML5 tags and structure including headings, paragraphs, and divs.	CO1
2	Utilize CSS3 to style a web page by applying different styles to HTML elements using class and id selectors.	CO2
3	Develop a multi-page website incorporating images, tables, and lists to demonstrate the usage of HTML5 structural elements.	CO1
4	Implement client-side form validation using JavaScript to enhance user interaction and data integrity.	CO2
5	Explore the Document Object Model (DOM) by dynamically modifying the content and style of a webpage with JavaScript.	CO2
6	Design a responsive web layout using CSS3 media queries to ensure the webpage is adaptable to different devices like tablets and smartphones.	CO2
7	Create a navigation menu using CSS to demonstrate the practical use of CSS styling and positioning.	CO2
8	Simulate a web shopping cart using JavaScript arrays and objects to handle dynamic data.	CO2
9	Construct a simple AJAX application to fetch data from the server without reloading the web page.	CO4

S.N	Lab Task	Mapped CO/COs
10	Introduce XML by creating a simple XML document that includes elements and attributes to store data about books or movies.	CO4
11	Use CSS Flexbox to design a flexible and efficient layout for a web page that adjusts content based on the screen size.	CO2
12	Develop a small project to parse XML data using JavaScript and display it in a structured format on a webpage.	CO4
13	Implement a basic web service using AJAX and SOAP to interact with external data sources.	CO4
14	Design and implement a website using all learned technologies to demonstrate effective web design principles and user-centric interfaces.	CO3
15	Enhance a web page by integrating interactive elements using DHTML to improve user experience.	CO3
16	Create a sitemap and a wireframe for a proposed website to illustrate the planning phase of web design.	CO3
17	Develop a user login system using HTML forms, JavaScript validation, and CSS styling.	CO2
18	Utilize JavaScript to create interactive sliders and content tabs that enhance the dynamic functionality of a web page.	CO2
19	Implement an interactive web-based calendar using JavaScript and AJAX to manage events and appointments.	CO2, CO4
20	Create an XML schema to validate the structure of an XML document used in a web application.	CO4
1	**Responsive Web Design Project:** Develop a fully responsive portfolio website that showcases a variety of media queries and CSS styles to ensure proper display on all devices.	CO2, CO3
2	**JavaScript Game:** Create an interactive web-based game using JavaScript and HTML5 canvas that includes event handling and real-time updates.	CO2
3	**Web Service Integration:** Design a web application that consumes multiple web services to provide a unified functionality, such as a weather forecast combined with local events.	CO4
4	**AJAX-driven Social Media Feed:** Implement a social media feed that uses AJAX to load content dynamically, simulating real-world social media platforms.	CO4
5	**XML Data Management:** Create a web application that uses XML to manage data (like a content management system), includes creating, editing, and deleting XML content.	CO4

Online Learning Resources

- **W3Schools:** Comprehensive tutorials and references on web development languages including HTML, CSS, JavaScript.
  https://www.w3schools.com/

- **MDN Web Docs:** Resources for developers, by developers, with documentation and tutorials on web technologies.
  https://developer.mozilla.org/en-US/

- **Codecademy:** Interactive platform offering web development courses in HTML, CSS, and JavaScript.
  https://www.codecademy.com/learn/paths/web-development

- **freeCodeCamp:** Learn to code for free with interactive lessons and build projects along the way.
  https://www.freecodecamp.org/

Programming in Python Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Programming in Python Lab	ENSP155	0-0-2	1
Type of Course:	SEC		

Defined Course Outcomes

COs	Statements
CO 1	Developing Python programs with a focus on secure coding practices and fundamental control structures.
CO 2	Implementing Python programs utilizing various data structures such as lists, dictionaries, tuples, and sets.
CO 3	Working with file operations and regular expressions to securely handle and process data.
CO 4	Implementing Object-Oriented Programming concepts such as encapsulation, inheritance, and polymorphism in Python.

Proposed Lab Experiments

Ex. No	Experiment Title	Mapped CO/COs
1	Develop Python programs to demonstrate control structures, focusing on secure coding practices.	CO 1
2	Implement Python programs to work with lists, focusing on secure data handling and manipulation.	CO 2
3	Implement Python programs to work with dictionaries, focusing on key-value pair management.	CO 2
4	Develop Python programs using tuples, focusing on immutability and its applications.	CO 2
5	Implement functions in Python, emphasizing secure input validation and error handling.	CO 1
6	Work with file operations in Python, including reading and writing files, and manipulating file pointers.	CO 3
7	Develop Python programs using regular expressions for pattern matching and text processing.	CO 3
8	Create and implement classes and objects in Python, demonstrating OOP concepts like encapsulation and inheritance.	CO 4
9	Develop Python programs with polymorphism, method overloading, and method overriding.	CO 4
10	Create Python programs that implement exception handling and secure error management.	CO 1
11	Develop programs using constructors and destructors in Python to manage object lifecycles securely.	CO 4
12	Demonstrate practical use of operator overloading and special methods in Python (e.g., __str__(), __repr__()).	CO 4

Online Learning Resources

- **Codecademy:** Interactive platform offering Python programming exercises.
  https://www.codecademy.com/learn/learn-python-3
- **Coursera:** Courses on Python programming fundamentals.
  https://www.coursera.org/specializations/python-for-everybody
- **Kaggle:** Online platform for Python projects, tutorials, and challenges.
  https://www.kaggle.com/learn/python
- **GitHub:** Explore and contribute to open-source Python projects.
  https://github.com/

Fundamentals of Software Engineering

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Fundamentals of Software Engineering	ENBC105	4-0-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course aims to introduce students to the principles and practices of software engineering, covering fundamental concepts, requirement analysis, design, project management, UML, testing, and maintenance. The course is divided into 4 units:

1. Introduction to Software Engineering
2. Software Requirement Analysis, Design & Construction
3. Software Project Management and UML
4. Software Testing & Maintenance

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the fundamental concepts of software engineering, including software process models and quality concepts.
CO 2	Analyzing and document software requirements using various modeling techniques and design principles.
CO 3	Managing software projects using estimation techniques, quality management, and UML diagrams.
CO 4	Applying software testing strategies and maintain software using different testing techniques and maintenance models.

A student is expected to have learnt concepts and demonstrated/developed abilities or skills related to software engineering at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to Software Engineering**	**No. of hours: 10**
Content:		
• Introduction to Software Engineering • Software Evolution • Software Characteristics • Software Crisis: Problem and Causes • Software process models: Waterfall, Incremental, Evolutionary, Agile • Software quality concepts and process improvement • Software process capability maturity models • Personal Software Process and Team Software Process • Overview of Agile Process		
Unit Number: 2	**Title: Software Requirement Analysis, Design & Construction**	**No. of hours: 10**
Content:		
• Problem Analysis • Requirement elicitation and Validation • Requirements modeling: Scenarios, Information and analysis classes, flow and behavioral modeling • Documenting Software Requirement Specification (SRS) • System design principles: levels of abstraction, separation of concerns, information hiding, coupling and cohesion • Structured design, object-oriented design, event driven design, component-level design, test driven design, aspect oriented design • Design patterns • Coding Practices: Techniques, Refactoring		
Unit Number: 3	**Title: Software Project Management and UML**	**No. of hours: 10**
Content:		

• Software Project Management: Scope, time, and cost estimation • Quality Management • Plan for software Quality Control and Assurance • Earned Value Analysis • UML: UML Structural Diagrams, UML Behavioural Diagrams		
Unit Number: 4	**Title: Software Testing & Maintenance**	**No. of hours: 10**
Content:		
• Testing: Levels of Testing, Functional Testing, Structural Testing • Test Plan, Test Case Specification, Software Testing Strategies • Verification & Validation • Unit, Integration Testing • Top Down and Bottom-Up Integration Testing • Alpha & Beta Testing • White box and black box testing techniques • System Testing and Debugging • Software Maintenance: Maintenance Process, Maintenance Models • Reverse Engineering • Software Re-engineering		

Learning Experience

Classroom Learning Experience

- **Interactive Lectures:** Engage students through detailed explanations of software engineering principles, process models, and design techniques. Interactive sessions include real-world examples, case studies, and discussions on current industry practices.

- **Hands-On Labs:** Provide practical lab sessions where students apply software engineering concepts such as requirement analysis, UML modeling, and software testing. These labs help bridge the gap between theory and practice, enabling students to work on mini-projects and case studies.

- **Group Projects:** Encourage collaborative learning by assigning group projects that require students to manage software development from requirements gathering through design, implementation, and testing. These projects simulate real-world software development environments, promoting teamwork and project management skills.

- **In-Class Problem Solving:** Facilitate problem-solving sessions where students tackle real-world software engineering challenges, applying concepts learned in class to practical scenarios.
- **Immediate Feedback:** Provide quizzes, code reviews, and in-class exercises to offer timely feedback on students' understanding of software engineering principles and methodologies.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign tasks that challenge students to apply software engineering methodologies to analyze and solve complex software development problems. Case studies focus on software process improvement, design patterns, and testing strategies.
- **Collaborative Projects:** Promote teamwork on larger projects outside the classroom, where students can simulate the complete software development lifecycle, from gathering requirements to testing.
- **Online Discussions:** Facilitate online forums where students can discuss software engineering concepts, share experiences, and troubleshoot project challenges.
- **Self-Study:** Encourage students to explore advanced software engineering topics and tools independently, further enhancing their understanding of real-world practices.
- **Peer Reviews:** Organize peer reviews where students assess each other's project deliverables, providing constructive feedback on software design, code quality, and adherence to engineering best practices.
- **Practice Problems:** Provide access to additional practice exercises focused on software design, modeling, and testing, allowing students to hone their skills outside the classroom.

Text Books

- "Software Engineering" by Ian Sommerville
- "Software Engineering: A Practitioner's Approach" by Roger S. Pressman

Reference Books

- "Fundamentals of Software Engineering" by Rajib Mall
- "Software Engineering" by K.K. Aggarwal and Yogesh Singh
- "Object-Oriented Software Engineering" by Ivar Jacobson
- "Software Engineering Concepts" by Richard Fairley
- "Software Engineering: Theory and Practice" by Shari Lawrence Pfleeger and Joanne M. Atlee

Additional Readings

Self-Learning Components:

1. Link to SEI Software Engineering Institute: https://www.sei.cmu.edu/
2. Link to IEEE Software Engineering Standards: https://standards.ieee.org/
3. Link to Agile Alliance resources: https://www.agilealliance.org/
4. Link to NPTEL Software Engineering course: https://onlinecourses.nptel.ac.in/noc21_cs24/
5. Link to Coursera Software Engineering courses: https://www.coursera.org/courses?query=software%20engineering

Essentials of Computer Science

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Essentials of Computer Science	—-	0-0-0	2
Type of Course:	SEC (Self-Paced Course)		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the Fundamentals of Computer Science, covering essential concepts and techniques used in computing and programming. The course emphasizes both theoretical understanding and practical application and is divided into 4 units:

1. Introduction to Computer Science and Programming Basics
2. Data Structures and Algorithms
3. Software Development and Engineering
4. Advanced Topics and Applications

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Developing a basic understanding of the foundational principles and history of computer science.
CO 2	Developing a basic understanding of fundamental programming skills using languages such as Python, C++, and JavaScript.
CO 3	Develoing a basic understanding of essential data structures and algorithms.
CO 4	Developing a basic understanding of software development and engineering principles, including web development, databases, and cybersecurity basics.

A student is expected to have learnt concepts and demonstrated/developed abilities or skills related to strategic management at the end of the course.

Course Outline

Unit Number: 1	Title: Introduction to Computer Science and Programming Basics	No. of hours: NA

Content:

- Introduction to Computer Science
  - Overview of computer science
  - History and impact of computing
  - Basic computer architecture
  - Number system & conversion
- Basics of Programming
  - Introduction to programming languages (Python, C, JavaScript)
  - Basic syntax and semantics
  - Writing and running simple programs
- Problem-Solving Techniques
  - Algorithms and pseudocode
  - Debugging and error handling
  - Basic problem-solving strategies
- Basics of Windows and Linux Commands
  - Introduction to operating systems
  - Basic Windows commands (e.g., dir, copy, del)
  - Basic Linux commands (e.g., ls, cp, rm)
  - File system navigation and management
  - Understanding working environments and command-line interfaces
- Introduction to Networks
  - Basics of computer networks
  - Network topologies and protocols
  - Introduction to the Internet and how it works

Unit Number: 2	Title: Data Structures and Algorithms	No. of hours: NA

Content:

• Basic Data Structures – Arrays and lists – Stacks and queues – Linked lists • Algorithms – Sorting algorithms (bubble sort, merge sort, quicksort) – Searching algorithms (linear search, binary search) – Algorithm analysis (time and space complexity) • Recursion – Introduction to recursion – Recursive problem solving – Examples of recursive algorithms (e.g., factorial, Fibonacci sequence)		
Unit Number: 3	**Title: Software Development and Engineering**	**No. of hours: NA**
Content:		

- Software Development Lifecycle
  - Requirements analysis
  - Design and architecture
  - Implementation and testing
- Programming Paradigms
  - Procedural programming
  - Object-oriented programming
  - Functional programming
- Software Tools and Environment
  - Integrated Development Environments (IDEs)
  - Version control systems (Git)
  - Debugging and profiling tools
- Open-Source Tools
  - Introduction to open-source tools and platforms
  - Using GitHub for version control and collaboration
  - Data science and machine learning with Kaggle
  - Other useful open-source tools (e.g., Jupyter Notebooks, Visual Studio Code)
- Agile Methodologies
  - Introduction to Agile principles
  - Scrum framework
  - Kanban and other Agile methodologies

Unit Number: 4	**Title: Advanced Topics and Applications**	**No. of hours: NA**
Content:		

- Web Development
  - HTML, CSS, and JavaScript
  - Client-server architecture
  - Introduction to web frameworks
- Databases
  - SQL and relational databases
  - NoSQL databases
  - Basic database design and querying
- Cybersecurity Basics
  - Principles of cybersecurity
  - Common threats and vulnerabilities
  - Basic encryption and security protocols
- Latest Technologies and Careers in Computer Science
  - Overview of latest technologies (e.g., AI, blockchain, IoT, cloud computing)
  - Emerging domains in computer science
  - Various careers in computer science
  - Skills and qualifications needed for different career paths
- Introduction to Machine Learning
  - Basic concepts of machine learning
  - Types of machine learning (supervised, unsupervised, reinforcement learning)
  - Introduction to neural networks

Online Learning Modules

Students can choose any one of the following online modules for certification:

1. CS50's Introduction to Computer Science by Harvard University
   Platform: Harvard Online Learning
   Link: https://cs50.harvard.edu/

2. Computer Science 101 by Stanford University
   Platform: Stanford Online
   Link: https://online.stanford.edu/courses/sohs-ydkcs101-computer-science-101

3. Fundamentals of Computing by Rice University
   Platform: Coursera
   Link: https://www.coursera.org/specializations/computer-fundamentals

4. Introduction to Computer Science
   Platform: Udemy
   Link: https://www.udemy.com/course/introduction-to-computer-science/

5. Computer Science 101 - Computers & Programming for Beginners
   Platform: Udemy
   Link: https://www.udemy.com/course/computer-science-101-computers-programming-fo

6. IT Fundamentals - Everything you need to know about IT
   Platform: Udemy
   Link: https://www.udemy.com/course/it-fundamentals-everything-you-need-to-know-a

7. Master Computer Fundamentals Course-Beginner to Intermediate
   Platform: Udemy
   Link: https://www.udemy.com/course/master-computer-fundamentals-skills-beginner-t

Please Note:

1. **Enrollment:** Students must enroll in any one of the above specified courses on their respective platforms.

2. **Certification:** Students will be required to submit the course completion certificate as an outcome.

3. **Self-paced:** Students will be required to complete any of the certifications on their own. No physical classes shall be conducted.

4. **Assignments:** Complete all assignments, quizzes, and problem sets as required by each course.

Learning Experience

Classroom Learning Experience

- **Interactive Lectures:** Engage students with foundational concepts in computer science through interactive discussions, real-world examples, and demonstrations of basic programming, data structures, and algorithms.

- **Hands-On Labs:** Provide practical sessions where students write and run simple programs, implement basic data structures, and solve algorithmic problems. These labs reinforce theoretical knowledge through hands-on experience with programming languages like Python, C, and JavaScript.

- **In-Class Problem Solving:** Facilitate coding exercises and problem-solving sessions to allow students to immediately apply theoretical concepts in the classroom setting.

- **Group Projects:** Encourage collaborative group projects where students design and implement solutions to real-world problems using the concepts of algorithms, data structures, and basic programming.

- **Immediate Feedback:** Provide quizzes and in-class coding challenges to offer real-time feedback on students' understanding of computer science concepts.

Outside Classroom Learning Experience

- **Self-Paced Learning:** Encourage students to explore course materials at their own pace, using self-paced modules that cover key concepts such as software development, networks, and operating systems. This approach allows for personalized learning experiences.

- **Assignments & Case Studies:** Assign practical tasks that challenge students to apply their knowledge to solve problems, such as implementing sorting algorithms or designing basic web applications. Case studies provide context and deepen understanding of computer science fundamentals.

- **Collaborative Projects:** Promote teamwork on larger, more complex projects outside the classroom where students apply foundational computer science concepts to solve problems.

- **Online Discussions:** Facilitate online forums where students can collaborate, discuss course topics, and troubleshoot programming challenges together.

- **Peer Review:** Set up peer review activities where students critique and provide feedback on each other's code and assignments, fostering improvement in programming practices.

- **Practice Problems:** Provide additional problem sets and programming challenges for students to practice independently and strengthen their grasp of essential computer science concepts.

Semester: 2

Essentials of Data Science

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Essentials of Data Science	ENSP110	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: The course provides a comprehensive overview of the key concepts, tools, and techniques in data science. It introduces students to the entire data science process, from data collection and cleaning to exploratory analysis, visualization, and predictive modeling. The course emphasizes practical, hands-on experience with real-world datasets, preparing students to apply data science methods in various domains. The course is structured into 4 key units:

1. Introduction to Data Science and Data Wrangling
2. Exploratory Data Analysis (EDA) and Data Visualization
3. Statistical Methods and Machine Learning Fundamentals
4. Applications of Data Science and Case Studies

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the data science workflow, including data collection, cleaning, and preprocessing techniques.
CO 2	Performing exploratory data analysis (EDA) and use data visualization tools to uncover insights.
CO 3	Applying statistical methods and machine learning algorithms to solve data-driven problems.
CO 4	Working with real-world datasets and develop models to address practical challenges in various domains.
CO 5	Communicating data-driven insights and results effectively using visualization and storytelling techniques.

By the end of the course, students will be equipped with essential skills to work as data scientists and apply data-driven decision-making in various fields.

Course Outline

Unit Number: 1	**Title: Introduction to Data Science and Data Wrangling**	**No. of hours: 10**
Content:		
• Introduction to Data Science: Definitions and Applications • Data Collection Methods and Sources • Data Types and Formats (Structured, Unstructured, Semi-structured) • Data Cleaning Techniques: Handling Missing Data, Outliers, and Duplicates • Introduction to Data Wrangling using Python: Pandas, NumPy		
Unit Number: 2	**Title: Exploratory Data Analysis (EDA) and Data Visualization**	**No. of hours: 10**
Content:		
• Exploratory Data Analysis: Descriptive Statistics and Summary Statistics • Identifying Patterns and Trends in Data • Data Visualization: Introduction to Matplotlib, Seaborn, Plotly • Visualizing Relationships, Distributions, and Trends in Data • Storytelling with Data: How to Present and Communicate Insights		
Unit Number: 3	**Title: Statistical Methods and Machine Learning Fundamentals**	**No. of hours: 10**
Content:		
• Basic Statistical Methods: Probability, Hypothesis Testing, Regression • Introduction to Supervised Learning: Regression and Classification • Introduction to Unsupervised Learning: Clustering and Dimensionality Reduction • Overview of Machine Learning Tools in Python: Scikit-learn • Evaluation Metrics: Accuracy, Precision, Recall, F1 Score, Confusion Matrix		
Unit Number: 4	**Title: Applications of Data Science and Case Studies**	**No. of hours: 10**
Content:		

- Case Studies in Data Science: Healthcare, Finance, Marketing, and E-commerce
- Working with Real-World Datasets
- Developing Data Science Models for Specific Use Cases
- Data Science Project Life Cycle: Problem Definition to Model Deployment
- Ethical Considerations and Bias in Data Science

Text Books

- T1: "Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking" by Foster Provost and Tom Fawcett
- T2: "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" by Wes McKinney

Reference Books

- R1: "The Elements of Statistical Learning: Data Mining, Inference, and Prediction" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman
- R2: "Introduction to Machine Learning with Python: A Guide for Data Scientists" by Andreas C. Müller and Sarah Guido

Online Learning Resources

- **Kaggle:** Online platform with hands-on data science projects and Python tutorials. https://www.kaggle.com/learn/overview
- **Coursera:** Data Science courses by leading universities and institutions. https://www.coursera.org/specializations/jhu-data-science
- **DataCamp:** Interactive platform for learning data science with Python and R. https://www.datacamp.com/
- **GitHub:** Explore and contribute to open-source data science projects. https://github.com/

Learning Experiences

Learning Experiences

Classroom Learning Experience

- **Interactive Lectures and Discussions:** Engage students with multimedia-rich lectures using PPTs, videos, and real-world case studies to introduce key data science concepts such as data wrangling, exploratory data analysis (EDA), and machine learning.

- **Hands-On Coding Sessions:** In-class coding sessions will focus on practical exercises using Python, with students applying data wrangling techniques, performing EDA, and implementing machine learning models using libraries like Pandas, NumPy, Matplotlib, and Scikit-learn.

- **Group Projects:** Students will collaborate on group projects where they work together to analyze real-world datasets, develop predictive models, and present their insights using data visualization tools.

- **Case Study Analysis:** Analyze case studies of how data science is applied in various industries such as healthcare, finance, and marketing, providing context for how data-driven decision-making is implemented in practice.

- **Continuous Assessment and Feedback:** Students will receive regular feedback through quizzes, coding assignments, and project presentations to ensure they understand core concepts and can apply them in practical scenarios.

Outside Classroom Learning Experience

- **Independent Data Science Projects:** Students will be assigned individual projects where they will work with publicly available datasets, applying the techniques learned in class to solve real-world problems. They will be required to preprocess the data, perform EDA, build models, and evaluate their performance.

- **Utilizing Online Platforms:** Platforms like Kaggle and DataCamp will be used to enhance learning through hands-on challenges, where students can practice coding and participate in data science competitions.

- **Collaboration on Open-Source Projects:** Students will be encouraged to contribute to open-source data science projects on GitHub, enabling them to learn from peers, gain practical experience, and improve their problem-solving and teamwork skills.

- **Moodle LMS and ICT Tools:** All course materials, assignments, and coding exercises will be available on Moodle LMS. Students will use the platform for discussions, to access additional resources, and to collaborate on group projects.

- **Self-Led Study:** In addition to guided classroom sessions, students are encouraged to explore reference books and online learning platforms to deepen their understanding of advanced topics in data science, such as deep learning, big data processing, and ethical AI practices.

Outside Classroom Learning Experience

- **Independent Data Science Projects:** Students will be assigned individual projects where they will work with publicly available datasets, applying the techniques learned in class to solve real-world problems. They will be required to preprocess the data, perform EDA, build models, and evaluate their performance.

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Introduction to Discrete Structures

Program Name:	B.Tech Computer Science and Engineering		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Discrete Structures	ENBC102	3-1-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of discrete structures, focusing on set theory, logic, relations, graph theory, combinatorics, and number theory. The course is divided into 4 units:

1. Set Theory and Logic
2. Relations and Graph Theory
3. Combinatorics and Discrete Structures
4. Number Theory and Cryptography

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the basic concepts of set theory and logic, including set operations and logical connectives.
CO 2	Applying relations and basic graph theory concepts to solve problems.
CO 3	Utilizing combinatorial principles and discrete structures to analyze problems.
CO 4	Understanding basic number theory and cryptography concepts and their applications.

A student is expected to have learned concepts and demonstrated abilities or skills related to discrete structures at the end of the course.

Course Outline

Unit Number: 1	**Title: Set Theory and Logic**	**No. of hours: 10**
Content:		
• **Set Theory** – Basic Concepts: Notations and terminology (union, intersection, complement), Types of sets (finite, infinite, empty, universal), Multisets (elements with multiplicity) – Ordered Pairs and Cartesian Product: Definition of ordered pairs, Properties of Cartesian product – Set Algebra and Proofs: Set operations (union, intersection, difference), Proofs of set identities (De Morgan's laws, distributive properties) • **Logic** – Propositional Logic: Syntax and semantics, Truth tables for logical connectives (AND, OR, NOT), Tautologies and contradictions – Predicate Logic: Quantifiers (universal and existential), Predicate calculus, Proofs using mathematical induction		
Unit Number: 2	**Title: Relations and Graph Theory**	**No. of hours: 10**
Content:		
• **Relations** – Representation and Properties: Matrices, graphs, and directed graphs, Reflexive, symmetric, and transitive relations – Equivalence Relations and Partitions: Equivalence classes, Equivalence partitions • **Graph Theory Basics** – Definitions: Vertices, edges, degree – Types of graphs: Simple, directed, weighted – Graph representations: Adjacency matrix, adjacency list • **Graph Algorithms** – Depth-First Search (DFS), Breadth-First Search (BFS), Shortest path algorithms (Dijkstra's)		
Unit Number: 3	**Title: Combinatorics and Discrete Structures**	**No. of hours: 10**
Content:		

- **Combinatorics**
  - Counting Principles: Product rule, sum rule, Permutations and combinations, Binomial coefficients
  - Inclusion-Exclusion Principle: Solving problems with overlapping sets
- **Discrete Structures**
  - Trees and Recurrence Relations: Tree properties (rooted, binary), Solving linear recurrence relations
  - Finite State Machines and Regular Languages: Deterministic Finite Automata (DFA), Regular expressions, Regular languages
  - Formal Languages and Grammars: Context-free grammars

Unit Number: 4	**Title: Number Theory and Cryptography**	**No. of hours: 10**
Content:		

- **Number Theory**
  - Divisibility and Modular Arithmetic: Greatest common divisor (GCD), Modular inverses
  - Congruences: Solving congruences
- **Cryptography**
  - Symmetric-Key Cryptography: Basic concepts
  - Public-Key Cryptography: Basic concepts

Learning Experience for Introduction to Discrete Structures

Classroom Learning Experience

- **Interactive Lectures:** Engage students with fundamental concepts of discrete structures, including set theory, logic, and graph theory, through interactive lectures. These sessions include problem-solving activities and discussions that help students grasp abstract concepts.

- **Hands-On Problem Solving:** Provide students with ample opportunities to solve problems in set theory, combinatorics, and graph theory during class and in dedicated problem-solving sessions. These exercises are designed to reinforce theoretical understanding through practical application.

- **Group Projects:** Encourage collaboration by assigning group projects that require students to apply concepts from discrete structures to real-world scenarios. Projects may include designing algorithms, working on graph-related problems, or exploring combinatorial designs.

- **Immediate Feedback:** Conduct quizzes and in-class exercises that provide students with immediate feedback on their grasp of discrete structures concepts and their problem-solving approaches.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign regular homework and case studies that challenge students to apply discrete mathematics concepts to solve complex problems. Case studies focus on applications in computer science, such as algorithm design and cryptography.
- **Collaborative Projects:** Encourage students to work together on larger projects outside the classroom, where they can apply discrete structures concepts to solve practical problems in fields like network theory and cryptographic algorithms.
- **Online Discussions:** Facilitate online forums where students can discuss discrete structures problems, share ideas, and collaborate on assignments and projects.
- **Peer Review:** Organize peer review activities where students critique and provide feedback on each other's solutions to complex problems, promoting deeper understanding and refining problem-solving skills.
- **Self-Study:** Encourage self-paced learning with additional problem sets and study materials that allow students to explore advanced topics in discrete structures, such as Boolean algebra and advanced graph theory.
- **Practice Problems:** Provide additional exercises for students to work on independently, reinforcing their understanding of key concepts in discrete structures.

Text Books

- "Discrete Mathematics and Its Applications" by Kenneth H. Rosen
- "Discrete Mathematics" by Seymour Lipschutz and Marc Lipson

Reference Books

- "Discrete Mathematics with Applications" by Susanna S. Epp
- "Discrete Mathematics" by Richard Johnsonbaugh

Additional Readings

Self-Learning Components:

1. Link to Discrete Mathematics course on NPTEL: https://nptel.ac.in/courses/106/106/106106094/
2. Link to Discrete Mathematics on Coursera: https://www.coursera.org/courses?query=discrete%20mathematics
3. Link to Graph Theory resources: https://www.graphclasses.org/

4. Link to Set Theory tutorials: https://www.tutorialspoint.com/discrete_mathematics/discrete_mathematics_set_theory.htm

5. Link to Combinatorics lectures: https://www.math.cmu.edu/~bkell/21110-2010s/lectures.shtml

Basics of Operating Systems

Program Name:	B.Tech Computer Science and Engineering		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Basics of Operating Systems	ENBC104	3-1-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course provides an introduction to operating systems, covering fundamental concepts such as process management, CPU scheduling, memory management, and file systems. The course is divided into 4 units:

1. Introduction to Operating Systems, Process and CPU Scheduling
2. Threads, Synchronization, Deadlock and Memory Management
3. Virtual Memory, Device Management and Secondary-Storage Structure
4. File-System Interface, Implementation and Security

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	**Statements**
CO 1	Understanding the basic concepts and structure of operating systems.
CO 2	Managing processes, threads, and CPU scheduling in operating systems.
CO 3	Applying synchronization techniques and handle deadlocks.
CO 4	Managing memory, virtual memory, and file systems in operating systems.

A student is expected to have learned concepts and demonstrated abilities or skills related to operating systems at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to Operating Systems, Process and CPU Scheduling**	**No. of hours: 10**
Content:		
• Introduction: Definition, Role, Types of Operating Systems, Batch Systems, Multiprogramming, Time–sharing • Operating system structure, components, and services • Processes: Concept, Scheduling, Operations, Cooperating Processes, Threads • CPU Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms		
Unit Number: 2	**Title: Threads, Synchronization, Deadlock and Memory Management**	**No. of hours: 10**
Content:		
• Threads: Overview, Benefits, User and Kernel Threads, Multithreaded Models • Synchronization: Critical-Section Problem, Semaphores, Classical Problems, Monitors • Deadlocks: Characterization, Handling Deadlocks, Prevention, Avoidance, Detection, Recovery • Memory Management: Logical vs. Physical Address space, Swapping, Contiguous allocation, Paging, Segmentation		
Unit Number: 3	**Title: Virtual Memory, Device Management and Secondary-Storage Structure**	**No. of hours: 10**
Content:		
• Virtual Memory: Demand Paging, Page-replacement Algorithms, Thrashing • Device Management: Techniques, Dedicated Devices, Shared Devices, Buffering, Device Allocation • Secondary-Storage Structure: Disk Structure, Disk Scheduling, Disk Management, Swap Space Management		
Unit Number: 4	**Title: File-System Interface, Implementation and Security**	**No. of hours: 10**
Content:		

- File-System Interface: File Concept, Access Methods, Directory Structure
- File-System Implementation: Structure, Basic File System, Allocation Methods, Free-Space Management
- Security: Problems, Goals, Access matrix, Authentication, Program threats, System threats

Learning Experience for Basics of Operating Systems

Classroom Learning Experience

- **Interactive Lectures:** Introduce students to core operating system concepts, such as process management, memory management, and file systems, through interactive lectures. These sessions are designed to facilitate understanding by including real-world examples, case studies, and problem-solving activities.
- **Hands-On Labs:** Provide practical lab sessions where students implement and experiment with operating system concepts like CPU scheduling, memory management techniques, and file-system operations. These labs help reinforce theoretical knowledge through hands-on experience with operating system simulators or Linux-based environments.
- **Group Projects:** Encourage collaborative learning by assigning group projects that require students to analyze, design, and implement operating system components, such as a simple scheduler or memory manager. These projects simulate real-world scenarios and promote teamwork and problem-solving skills.
- **Immediate Feedback:** Provide in-class quizzes, coding exercises, and interactive problem-solving sessions to give students timely feedback on their understanding of operating system concepts.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign regular homework and case studies that challenge students to apply operating system concepts to solve complex problems, such as optimizing CPU scheduling or improving file-system security. Case studies focus on practical applications and help students understand the impact of different operating system strategies.
- **Collaborative Projects:** Encourage students to work together on larger projects outside the classroom, where they can apply operating system concepts to design and implement components such as memory managers or file systems.
- **Online Discussions:** Facilitate online forums where students can discuss operating system topics, share solutions to challenging problems, and collaborate on project ideas.
- **Peer Review:** Organize peer review activities where students critique and provide feedback on each other's work on operating system projects, fostering improvement in design and implementation skills.

- **Self-Study:** Encourage self-paced learning by providing additional reading materials, practice problems, and exercises to explore advanced operating system topics, such as virtual memory and deadlock management.
- **Practice Problems:** Provide supplementary problem sets and challenges for students to complete independently, helping reinforce core concepts in operating systems.

Text Books

- "Operating System Concepts" by Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne
- "Modern Operating Systems" by Andrew S. Tanenbaum

Reference Books

- "Operating Systems: Internals and Design Principles" by William Stallings
- "Operating Systems: A Design-Oriented Approach" by Charles Crowley

Additional Readings

Self-Learning Components:

1. Link to Operating System course on NPTEL: https://nptel.ac.in/courses/106/106/106106144/
2. Link to Operating Systems on Coursera: https://www.coursera.org/courses?query=operating%20systems
3. Link to Operating Systems resources: https://www.os-book.com/
4. Link to Operating Systems tutorials: https://www.tutorialspoint.com/operating_system/index.htm
5. Link to Operating Systems lectures: https://ocw.mit.edu/courses/electrical-engineering-
   6-828-operating-system-engineering-fall-2012/

Concepts of Object Oriented Programming Using C++

Program Name:	B.Tech Computer Science and Engineering		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Concepts of Object Oriented Programming Using C++	ENBC106	3-1-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of object-oriented programming using C++, focusing on classes and objects, inheritance, polymorphism, and advanced features of C++. The course is divided into 4 units:

1. Foundations of Object-Oriented Programming
2. Classes and Objects
3. Inheritance and Polymorphism
4. Advanced C++ Features

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the basic concepts and principles of object-oriented programming.
CO 2	Implementing classes and objects in C++ and manage memory using constructors and destructors.
CO 3	Applying inheritance and polymorphism concepts to enhance code reusability and flexibility.
CO 4	Utilizing advanced C++ features such as templates and exception handling.

A student is expected to have learned concepts and demonstrated abilities or skills related to object-oriented programming using C++ at the end of the course.

Course Outline

Unit Number: 1	**Title: Foundations of Object-Oriented Programming**	**No. of hours: 10**
Content:		
• Programming Approaches: Procedure-Oriented Approach vs. Object-Oriented Approach • Introduction to C++: Basic syntax and structure of a C++ program, Data Types and Variables, Operators and Expressions, Control Structures, Functions, Arrays and Strings, Pointers • Basic Concepts of Object-Oriented Programming: Objects and Classes, Principles of OOP: Abstraction, Encapsulation, Inheritance, Polymorphism, Dynamic Binding, and Message Passing • Characteristics of Object-Oriented Languages: Benefits and features of OOP languages		
Unit Number: 2	**Title: Classes and Objects**	**No. of hours: 10**
Content:		
• Abstract Data Types and Classes: Concept of abstract data types, Objects and classes, attributes, and methods • C++ Class Declaration: Declaring classes in C++, State, identity, and behaviour of objects • Objects: Local Objects and Global Objects, Scope resolution operator • Functions in C++: Friend Functions, Inline Functions • Constructors and Destructors: Instantiation of objects, Types of constructors (default, parameterized, copy), Static Class Data, Array of Objects, Constant member functions and objects • Memory Management Operators: New and delete operators for dynamic memory allocation		
Unit Number: 3	**Title: Inheritance and Polymorphism**	**No. of hours: 10**
Content:		

• Inheritance: Types of inheritance (single, multiple, hierarchical), Access specifiers: public, private, and protected, Abstract Classes • Advanced Inheritance Concepts: Aggregation and composition vs. classification hierarchy • Polymorphism: Types of Polymorphism (compile-time and run-time), Function Overloading, Operator Overloading • Pointers and Virtual Functions: Pointer to objects, this pointer, Virtual Functions		
Unit Number: 4	**Title: Advanced C++ Features**	**No. of hours: 10**
Content:		
• Strings and Streams: Manipulating strings, Streams and file handling • Operators and Error Handling: Overloading operators, Error handling during file operations, Formatted I/O • Generic Programming: Function templates, Class templates • Exception Handling: Throwing an exception, The try block, Catching an exception		

Learning Experience for Concepts of Object Oriented Programming Using C++

Classroom Learning Experience

- **Interactive Lectures:** Introduce students to the fundamental concepts of object-oriented programming through engaging lectures. These sessions will cover key topics such as classes, objects, inheritance, and polymorphism, supported by real-world examples and problem-solving activities to enhance understanding.

- **Hands-On Programming Labs:** Provide practical lab sessions where students write and debug C++ programs that implement object-oriented concepts. Labs will focus on creating classes, utilizing inheritance, and applying polymorphism, allowing students to gain hands-on experience with C++ programming.

- **Group Projects:** Encourage collaborative learning by assigning group projects that require students to design and implement a complete object-oriented system in C++. Projects will simulate real-world scenarios, fostering teamwork and problem-solving skills.

- **Immediate Feedback:** Provide quizzes, coding challenges, and in-class exercises to give real-time feedback on students' understanding of object-oriented programming concepts.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign regular programming assignments and case studies that challenge students to apply object-oriented principles to solve complex problems. Case studies will include the design and implementation of software systems using C++, focusing on code reusability, maintainability, and efficiency.
- **Collaborative Projects:** Promote teamwork on larger projects outside the classroom, where students work together to design and implement object-oriented systems, applying C++ concepts to real-world challenges.
- **Online Discussions:** Facilitate online discussion forums where students can collaborate on coding problems, share insights on object-oriented design, and troubleshoot project challenges together.
- **Peer Review:** Organize peer code review sessions where students critique and provide feedback on each other's C++ programs, improving code quality and deepening their understanding of object-oriented principles.
- **Self-Study:** Encourage self-paced exploration of advanced object-oriented concepts and C++ libraries through additional reading materials, tutorials, and exercises.
- **Practice Problems:** Provide supplementary coding challenges and problem sets for students to work on independently, reinforcing their understanding of key object-oriented programming concepts in C++.

Text Books

- "C++ Programming Language" by Bjarne Stroustrup
- "Object-Oriented Programming in C++" by Robert Lafore

Reference Books

- "C++ Primer" by Stanley B. Lippman, Josée Lajoie, and Barbara E. Moo
- "Effective C++" by Scott Meyers

Additional Readings

Self-Learning Components:

1. Link to C++ Language Reference: https://en.cppreference.com/w/
2. Link to C++ Tutorials on GeeksforGeeks: https://www.geeksforgeeks.org/c-plus-plus/
3. Link to C++ Programming course on NPTEL: https://nptel.ac.in/courses/106/106/106106093/

4. Link to Object-Oriented Programming in C++ on Coursera: https://www.coursera.org/courses?query=object%20oriented%20programming%20in%20c++

5. Link to C++ lectures: https://ocw.mit.edu/courses/electrical-engineering-and-compute 6-096-introduction-to-c-january-iap-2011/

Data Science lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Data Science lab	ENSP162	0-0-2	1
Type of Course:	SEC		

The Course Outcomes (COs)

On completion of the lab, students will be able to:

COs	Statements
CO 1	Using Python for data collection, cleaning, and preprocessing.
CO 2	Performing exploratory data analysis (EDA) and visualize insights using Python libraries.
CO 3	Applying statistical methods and machine learning algorithms on real-world datasets.
CO 4	Developing Python scripts to automate data science workflows and present results.
CO 5	Working on real-world case studies and implement data-driven decision-making solutions.

S.N	Experiment Title	Mapped CO/COs
P1	Project Title: Data Cleaning and Preprocessing with Python Problem Statement: Use Python libraries like Pandas and NumPy to clean and preprocess a dataset by handling missing values, duplicates, and outliers.	CO1
P2	Project Title: Exploratory Data Analysis (EDA) Problem Statement: Perform EDA on a dataset to uncover insights using descriptive statistics and data visualization with Matplotlib and Seaborn.	CO2
P3	Project Title: Data Wrangling with Pandas Problem Statement: Use Pandas to load, manipulate, and transform large datasets, applying groupby, merge, and filter operations.	CO1
P4	Project Title: Data Visualization and Storytelling Problem Statement: Create effective data visualizations using Matplotlib, Seaborn, and Plotly, and present data insights through storytelling.	CO2, CO5

S.N	Experiment Title	Mapped CO/COs
P5	Project Title: Linear Regression Model Problem Statement: Implement and evaluate a linear regression model on a real-world dataset to predict outcomes and analyze feature importance.	CO3
P6	Project Title: Classification Model for Binary Data Problem Statement: Develop and test a classification model (e.g., logistic regression) to classify data into two categories, and evaluate its performance.	CO3
P7	Project Title: K-means Clustering for Market Segmentation Problem Statement: Apply unsupervised learning (K-means clustering) to segment customers into groups based on their purchasing behavior.	CO3
P8	Project Title: Data Science Project Life Cycle Problem Statement: Work on a full-fledged data science project, from problem definition to model deployment, applying all steps of the data science life cycle.	CO5
P9	Project Title: Time Series Analysis Problem Statement: Analyze and visualize time series data to uncover trends and make forecasts using Python libraries such as Pandas and Statsmodels.	CO3
P10	Project Title: Random Forest for Multi-class Classification Problem Statement: Build a random forest classifier to solve a multi-class classification problem, and tune hyperparameters to improve model performance.	CO3
P11	Project Title: Working with APIs in Python Problem Statement: Collect real-time data from APIs (e.g., Twitter, OpenWeatherMap) and integrate it into a Python workflow for data analysis.	CO1, CO4
P12	Project Title: Case Study on Data Science in Healthcare Problem Statement: Analyze a healthcare dataset to develop predictive models for patient outcomes and recommend data-driven decisions.	CO5
P13	Project Title: Customer Churn Prediction Problem Statement: Develop a machine learning model to predict customer churn based on historical data and suggest retention strategies.	CO3, CO5
P14	Project Title: Natural Language Processing (NLP) Problem Statement: Analyze textual data using Python libraries such as NLTK or spaCy to perform sentiment analysis or keyword extraction.	CO4
P15	Project Title: Automating Data Analysis Tasks Problem Statement: Develop Python scripts to automate repetitive data wrangling and analysis tasks, making use of functions and loops.	CO4

Text Books

- T1: "Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking" by Foster Provost and Tom Fawcett
- T2: "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython" by Wes McKinney

Reference Books

- R1: "The Elements of Statistical Learning: Data Mining, Inference, and Prediction" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman
- R2: "Introduction to Machine Learning with Python: A Guide for Data Scientists" by Andreas C. Müller and Sarah Guido

Online Learning Resources

- **Kaggle:** Online platform with hands-on data science projects and Python tutorials. https://www.kaggle.com/learn/overview
- **Coursera:** Data Science courses by leading universities and institutions. https://www.coursera.org/specializations/jhu-data-science
- **DataCamp:** Interactive platform for learning data science with Python and R. https://www.datacamp.com/
- **GitHub:** Explore and contribute to open-source data science projects. https://github.com/

Basics of Operating Systems Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Basics of Operating Systems Lab	ENBC152	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

COs	Statements
CO 1	Understanding the fundamental concepts and components of operating systems.
CO 2	Implementing process scheduling algorithms and understand process synchronization techniques.
CO 3	Managing memory allocation, including paging and segmentation.
CO 4	Handling device management and understand secondary storage structures.
CO 5	Implementing file system interfaces and basic security measures.

S.N	Lab Task	Mapped CO/COs
1	Install and configure an operating system (e.g., Linux, Windows).	CO1
2	Explore the structure and components of the installed operating system.	CO1
3	Implement a simple process scheduler using different scheduling algorithms (FCFS, SJF, Round Robin).	CO2
4	Simulate process synchronization using semaphores and monitor solutions.	CO2
5	Implement a program to demonstrate the critical section problem.	CO2
6	Develop a program to handle deadlock detection and recovery.	CO2
7	Create a memory management simulation to handle paging and segmentation.	CO3
8	Implement a virtual memory system with page replacement algorithms (FIFO, LRU).	CO3
9	Simulate disk scheduling algorithms (FCFS, SSTF, SCAN, C-SCAN).	CO4
10	Develop a program for file system operations including creation, deletion, and traversal of directories.	CO5
11	Implement file allocation methods (contiguous, linked, indexed).	CO5

S.N	Lab Task	Mapped CO/COs
12	Create a simulation of buffer management in device allocation.	CO4
13	Develop a program for swap space management.	CO4
14	Implement user authentication and access control mechanisms.	CO5
15	Simulate a basic file system with free-space management techniques.	CO5
16	Implement a program to handle system threats and security measures.	CO5
17	Develop a simple thread management program demonstrating multithreading.	CO2
18	Simulate a device management system including buffering and spooling.	CO4
19	Implement a program for inter-process communication using pipes and message queues.	CO2
20	Create a simple command-line interpreter (shell) that can execute basic commands.	CO1
1	**Process Scheduling Project:** Develop a comprehensive scheduler that implements and compares multiple scheduling algorithms, demonstrating their efficiency in different scenarios.	CO2
2	**Memory Management Project:** Create a memory management simulator that handles paging, segmentation, and virtual memory, providing detailed visualization and analysis.	CO3
3	**File System Project:** Design a basic file system that includes file creation, deletion, access control, and directory management with user authentication.	CO5
4	**Device Management Project:** Implement a device management module that handles multiple devices, their allocation, and management using different techniques.	CO4
5	**Security Project:** Develop a security module for an operating system that addresses authentication, access control, and threat detection, implementing various security protocols.	CO5

Online Learning Resources

- **GeeksforGeeks:** Tutorials and articles on operating system concepts and implementations.
  https://www.geeksforgeeks.org/operating-systems/
- **TutorialsPoint:** Comprehensive guides on operating system principles and practices.
  https://www.tutorialspoint.com/operating_system/index.htm

- **NPTEL:** Video lectures and course materials on operating system fundamentals. https://nptel.ac.in/courses/106/106/106106144/
- **Coursera:** Courses on operating systems from leading universities. https://www.coursera.org/courses?query=operating%20systems

Concepts of Object Oriented Programming Using C++ Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Concepts of Object Oriented Programming Using C++ Lab	ENBC154	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

COs	Statements
CO 1	Understanding the fundamentals of object-oriented programming and its basic concepts.
CO 2	Developing programs using classes, objects, and various constructors and destructors.
CO 3	Implementing inheritance and polymorphism in C++ programs.
CO 4	Utilizing advanced C++ features like file handling, templates, and exception handling.

S.N	Lab Task	Mapped CO/COs
1	Write a C++ program to understand the basic syntax and structure of a C++ program.	CO1
2	Implement a program using data types, variables, and control structures.	CO1
3	Develop a program using functions and arrays.	CO1
4	Create a C++ program to demonstrate the use of pointers.	CO1
5	Write a program to implement classes and objects in C++.	CO2
6	Develop a program using constructors and destructors.	CO2
7	Implement a program to demonstrate the use of friend functions and inline functions.	CO2
8	Write a program to use static class data and constant member functions.	CO2
9	Develop a program to demonstrate dynamic memory allocation using new and delete operators.	CO2
10	Implement single and multiple inheritance in C++.	CO3
11	Create a program to demonstrate polymorphism using function overloading.	CO3

S.N	Lab Task	Mapped CO/COs
12	Develop a program to demonstrate operator overloading.	CO3
13	Write a program to use pointers to objects and virtual functions.	CO3
14	Implement a program for string manipulation using C++ string class.	CO4
15	Develop a program for file handling operations (read, write, append).	CO4
16	Create a program to handle exceptions using try, catch, and throw.	CO4
17	Implement a program to use function templates.	CO4
18	Write a program to use class templates.	CO4
19	Develop a program to demonstrate formatted I/O operations.	CO4
20	Create a program to handle errors during file operations.	CO4
1	**Bank Management System:** Develop a bank management system using OOP concepts like classes, objects, inheritance, and polymorphism.	CO2, CO3
2	**Library Management System:** Create a library management system that uses file handling for data storage and retrieval.	CO4
3	**Student Record System:** Design a student record system implementing dynamic memory allocation and exception handling.	CO2, CO4
4	**Inventory Management System:** Develop an inventory management system using templates and polymorphism.	CO3, CO4
5	**Online Shopping System:** Create an online shopping system that demonstrates all learned OOP concepts including inheritance, polymorphism, file handling, and exception handling.	CO2, CO3, CO4

Online Learning Resources

- **GeeksforGeeks:** Tutorials and articles on C++ and object-oriented programming concepts.
  https://www.geeksforgeeks.org/c-plus-plus/
- **TutorialsPoint:** Comprehensive guides on C++ programming and OOP principles.
  https://www.tutorialspoint.com/cplusplus/index.htm
- **NPTEL:** Video lectures and course materials on object-oriented programming using C++.
  https://nptel.ac.in/courses/106/105/106105151/
- **Coursera:** Courses on C++ programming and object-oriented principles from leading universities.
  https://www.coursera.org/courses?query=c++

Minor Project-I

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Minor Project-I	ENSI152	0-0-0	2
Type of Course:	Project		
Pre-requisite(s), if any:	NA		

Course Perspective

The objective of Minor Project-I for the B. Tech (Computer Science and Engineering) program is to provide students with the opportunity to apply theoretical knowledge to real-world societal problems. This course aims to develop students' ability to identify and understand complex societal issues relevant to computer science, engage in critical thinking to formulate and analyze problems, and conduct comprehensive literature reviews to evaluate existing solutions. Through this project, students will enhance their research skills, document their findings in a well-structured manner, and effectively present their analysis and conclusions. The course fosters professional development by encouraging students to approach problems from multiple perspectives, develop innovative solutions, and improve their communication and documentation skills. Ultimately, the Minor Project-I course seeks to prepare students for future professional challenges by integrating academic knowledge with practical problem-solving experiences.

Duration: 6 weeks.

Project must focus on the following aspects:

1. **Understanding of Societal Problems:**
   - Students must have a basic understanding of societal problems, the concerned domain, and relevant issues.
2. **Critical Thinking and Problem Formulation:**
   - Students are expected to think critically about formulated problems and review existing solutions.
3. **Presentation of Findings:**
   - Students must be able to present findings from existing solutions in an appropriate format.
4. **Implementation:**
   - Students are not strictly expected to provide or implement these existing solutions.

Guidelines:

1. **Project Selection:**

- Choose a societal problem relevant to the field of computer science and engineering.
- Ensure the problem is specific and well-defined.

2. **Literature Review:**
   - Conduct a thorough review of existing literature and solutions related to the problem.
   - Identify gaps in existing solutions and potential areas for further investigation.
3. **Analysis and Critical Thinking:**
   - Analyze the problem critically, considering various perspectives and implications.
   - Evaluate the effectiveness and limitations of current solutions.
4. **Documentation:**
   - Document the entire process, including problem identification, literature review, analysis, and findings.
   - Use appropriate formats and standards for documentation.
5. **Presentation:**
   - Prepare a presentation summarizing the problem, existing solutions, analysis, and findings.
   - Ensure the presentation is clear, concise, and well-structured.

Evaluation Criteria for Minor Project (Out of 100 Marks):

1. **Understanding of Societal Problems (20 Marks):**
   - Comprehensive understanding of the problem: 20 marks
   - Good understanding of the problem: 15 marks
   - Basic understanding of the problem: 10 marks
   - Poor understanding of the problem: 5 marks
   - No understanding of the problem: 0 marks
2. **Critical Thinking and Analysis (30 Marks):**
   - Exceptional critical thinking and analysis: 30 marks
   - Good critical thinking and analysis: 25 marks
   - Moderate critical thinking and analysis: 20 marks
   - Basic critical thinking and analysis: 10 marks
   - Poor critical thinking and analysis: 5 marks
   - No critical thinking and analysis: 0 marks
3. **Literature Review (20 Marks):**
   - Comprehensive and detailed literature review: 20 marks

- Good literature review: 15 marks
- Moderate literature review: 10 marks
- Basic literature review: 5 marks
- Poor literature review: 0 marks

4. **Documentation Quality (15 Marks):**
    - Well-structured and detailed documentation: 15 marks
    - Moderately structured documentation: 10 marks
    - Poorly structured documentation: 5 marks
    - No documentation: 0 marks
5. **Presentation (15 Marks):**
    - Clear, concise, and engaging presentation: 15 marks
    - Clear but less engaging presentation: 10 marks
    - Somewhat clear and engaging presentation: 5 marks
    - Unclear and disengaging presentation: 0 marks

Total: 100 Marks

Course Outcomes

By the end of this course, students will be able to:

1. **Understand Societal Issues:**
    - Demonstrating a basic understanding of societal problems and relevant issues within the concerned domain.
2. **Critical Thinking:**
    - Thinking critically about formulated problems and existing solutions.
3. **Literature Review:**
    - Conducting comprehensive literature reviews and identify gaps in existing solutions.
4. **Documentation:**
    - Documenting findings and analysis in a well-structured and appropriate format.
5. **Presentation Skills:**
    - Presenting findings and analysis effectively, using clear and concise communication skills.
6. **Problem Analysis:**
    - Analyzing problems from various perspectives and evaluate the effectiveness of existing solutions.

7. **Professional Development:**

   - Developing skills in research, analysis, documentation, and presentation, contributing to overall professional growth.

Semester: 3

Introduction to Data Structures

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Data Structures	ENBC201	3-1-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of data structures, focusing on arrays, linked lists, stacks, queues, searching, sorting, trees, and graphs. The course is divided into 4 units:

1. Foundations of Data Structures
2. Linear Data Structures
3. Searching and Sorting
4. Trees and Graph Algorithms

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the basic concepts and principles of data structures.
CO 2	Implementing and manipulate linear data structures like arrays, linked lists, stacks, and queues.
CO 3	Applying searching and sorting algorithms to solve problems.
CO 4	Utilizing tree and graph algorithms to manage hierarchical and networked data.

A student is expected to have learned concepts and demonstrated abilities or skills related to data structures at the end of the course.

Course Outline

Unit Number: 1	**Title: Foundations of Data Structures**	**No. of hours: 9**
Content:		
• Introduction: Abstract Data Type, Elementary Data Organization • Measuring efficiency of an Algorithm: Time and Space Complexity Analysis, Asymptotic notations • Arrays: Single and Multidimensional Arrays, Representation of Arrays: Row Major Order, and Column Major Order, Application of arrays		
Unit Number: 2	**Title: Linear Data Structures**	**No. of hours: 11**
Content:		
• Linked lists: Array and Dynamic Implementation of Single Linked Lists, Doubly Linked List, Circularly Linked List, Operations on a Linked List • Stack operations: Push & Pop, Array and Linked list implementation of Stack, Applications: Prefix and Postfix Expressions, Evaluation of postfix expression • Queue operations: Create, Add, Delete, full and empty queues, Array and linked implementation of queues, Circular queues		
Unit Number: 3	**Title: Searching and Sorting**	**No. of hours: 10**
Content:		
• Searching: Sequential search, Binary Search • Sorting: Insertion Sort, Selection Sort, Bubble Sort, Quick Sort, Merge Sort • Hashing: Hash Function, Hash Table, Collision Resolution Strategies		
Unit Number: 4	**Title: Trees and Graph Algorithms**	**No. of hours: 10**
Content:		
• Trees: Basic terminology, Binary Trees, Array and linked list implementation, Types of Binary Tree, Tree Traversal algorithms: Inorder, Preorder and Postorder • Graphs: Representation (Matrix and Linked), Traversals, Shortest path, Minimum Spanning Tree Algorithms		

Learning Experience for Introduction to Data Structures

Classroom Learning Experience

- **Interactive Lectures:** Engage students with the foundational concepts of data structures through interactive lectures that cover topics such as arrays, linked lists, stacks, and queues. Use real-world examples to demonstrate the practical applications of data structures in solving computational problems.
- **Hands-On Programming Labs:** Provide practical lab sessions where students implement and manipulate various data structures in programming assignments. Labs will focus on developing proficiency in using arrays, linked lists, stacks, queues, and applying sorting and searching algorithms.
- **Group Projects:** Facilitate collaborative learning by assigning group projects that require students to design and implement efficient data structures for specific applications. Projects will simulate real-world scenarios where students must choose the appropriate data structures to optimize performance.
- **Immediate Feedback:** Provide in-class coding challenges, quizzes, and problem-solving sessions to offer timely feedback on students' understanding of data structure concepts.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign regular programming assignments and case studies that challenge students to apply data structure concepts to solve complex problems. Case studies will include scenarios that require the use of trees, graphs, and hashing techniques to manage data effectively.
- **Collaborative Projects:** Promote teamwork on larger projects outside the classroom, where students design and implement complex data structures, applying them to real-world problems to optimize performance.
- **Online Discussions:** Facilitate online forums where students can discuss data structure challenges, share solutions, and collaborate on projects.
- **Peer Review:** Organize peer code review sessions where students critique and provide feedback on each other's implementations of data structures, improving code quality and conceptual understanding.
- **Self-Study:** Encourage students to explore advanced data structure concepts and algorithms through additional resources and exercises to deepen their knowledge beyond the classroom material.
- **Practice Problems:** Provide supplementary coding challenges focused on data structure implementations and algorithm optimizations to reinforce key concepts.

Text Books

- "Data Structures Using C" by Reema Thareja
- "Fundamentals of Data Structures in C" by Ellis Horowitz, Sartaj Sahni, and Susan Anderson-Freed

Reference Books

- "Data Structures and Algorithms Made Easy" by Narasimha Karumanchi
- "Data Structures Using C and C++" by Yedidyah Langsam, Moshe Augenstein, and Aaron M. Tenenbaum

Additional Readings

Self-Learning Components:

1. Link to Data Structures course on NPTEL: https://nptel.ac.in/courses/106/106/106106127/
2. Link to Data Structures on Coursera: https://www.coursera.org/courses?query=data%20structures
3. Link to Data Structures resources: https://www.geeksforgeeks.org/data-structures/
4. Link to Data Structures tutorials: https://www.tutorialspoint.com/data_structures_algorithms/index.htm
5. Link to Data Structures lectures: https://ocw.mit.edu/courses/electrical-engineering-an 6-006-introduction-to-algorithms-fall-2011/

Fundamentals of Machine Learning

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Fundamentals of Machine Learning	ENSP205	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of machine learning, focusing on supervised and unsupervised learning algorithms. The course is divided into 4 units:

1. Introduction to Machine Learning
2. Supervised Learning - I
3. Supervised Learning - II
4. Ensemble Learning & Unsupervised Algorithms

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the basic concepts and workflow of machine learning.
CO 2	Implementing and evaluate linear and non-linear regression models.
CO 3	Applying various classification algorithms to solve problems.
CO 4	Understanding and apply ensemble learning and basic unsupervised learning algorithms.

A student is expected to have learned concepts and demonstrated abilities or skills related to machine learning at the end of the course.

Course Outline

<table>
<tr><td><b>Unit Number: 1</b></td><td><b>Title: Introduction to Machine Learning</b></td><td><b>No. of hours: 8</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• Introduction: Introduction to ML, Conventional vs. ML approach, Types of Machine Learning, Designing a Learning System, Challenges in Machine Learning, Applications
• Machine Learning Workflow: Role of Data, Data Preprocessing, Data wrangling, Data skewness removal (sampling), Model Training, Model Testing, Performance metrics</td></tr>
<tr><td><b>Unit Number: 2</b></td><td><b>Title: Supervised Learning - I</b></td><td><b>No. of hours: 14</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• Linear Models for Regression: Simple Linear Regression, Multiple Linear Regression, Assumptions of Linear Regression, Least Squares Estimation, Gradient estimation, Coefficient Interpretation, Goodness-of-Fit Measures, Regularization Techniques, Model Validation, Applications
• Non-Linear Regression Models: Polynomial Regression, Lasso & Ridge Regression, Evaluation metrics
• Logistic Regression: Definition and comparison with linear regression, Sigmoid Function, Model Estimation, Interpretation of Coefficients, Model Evaluation, Applications</td></tr>
<tr><td><b>Unit Number: 3</b></td><td><b>Title: Supervised Learning - II</b></td><td><b>No. of hours: 8</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• k-Nearest Neighbors (k-NN) Algorithm: Introduction to k-NN, Choosing the 'k' Value, Distance Metrics, Feature Scaling, Handling Missing Values, Cross-Validation, Applications of k-NN
• Decision Tree Classification Algorithm: Introduction to Decision Trees, Building a Decision Tree, Splitting Criteria, Tree Pruning, Handling Missing Data, Overfitting in Decision Trees, Advantages and Disadvantages, Applications
• Naive Bayes Algorithm: Introduction to Naive Bayes, Bayes' Theorem Application, Assumptions of Naive Bayes, Types of Naive Bayes Models, Model Training and Prediction, Model Evaluation Metrics, Applications
• Support Vector Machine (SVM): Introduction to SVM, Linear SVM Classification, Kernel Trick, Model Training and Prediction, Model Evaluation Techniques, Applications</td></tr>
</table>

Unit Number: 4	Title: Ensemble Learning & Unsupervised Algorithms	No. of hours: 10
Content:		
• Ensemble Learning: Introduction to Ensemble Learning, Methods of Combining Models - Bagging (Bootstrap Aggregating), Boosting, Stacking • Bagging Algorithms: Random Forests • Boosting Algorithms: AdaBoost (Adaptive Boosting), Gradient Boosting • Unsupervised Learning: Introduction, K-Means Clustering, Principal Component Analysis (PCA)		

Learning Experience for Fundamentals of Machine Learning

Classroom Learning Experience

- **Interactive Lectures:** Engage students with the foundational concepts of machine learning through interactive lectures that cover both theoretical aspects and practical applications of supervised and unsupervised learning algorithms. Topics include linear regression, logistic regression, decision trees, k-NN, and clustering methods.

- **Hands-On Coding Sessions:** Provide practical coding sessions where students implement machine learning models in Python or R. Focus on applying algorithms like linear regression, logistic regression, decision trees, and k-NN to real-world datasets, with a step-by-step approach to model building and evaluation.

- **Group Projects:** Encourage collaborative learning by assigning group projects that involve building and evaluating machine learning models. Projects will require students to preprocess data, select appropriate models, and assess model performance using relevant metrics such as accuracy, precision, recall, and F1-score.

- **Immediate Feedback:** Provide in-class coding challenges, quizzes, and problem-solving sessions to offer real-time feedback on students' understanding of machine learning concepts and model implementation.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign regular programming assignments and case studies that challenge students to apply machine learning techniques to solve complex problems. Case studies will include scenarios that require the application of ensemble methods, unsupervised learning algorithms like clustering and dimensionality reduction, and deep learning basics.

- **Collaborative Projects:** Promote teamwork on larger machine learning projects outside the classroom, where students work together to build, evaluate, and optimize models using various datasets and techniques.

- **Online Discussions:** Facilitate online forums where students can discuss machine learning challenges, share solutions, and troubleshoot coding issues collaboratively.
- **Peer Review:** Organize peer review sessions where students critique and provide feedback on each other's machine learning models, improving model performance and deepening their understanding of key concepts.
- **Self-Study:** Encourage students to explore advanced machine learning topics such as neural networks, reinforcement learning, or time-series forecasting through self-paced study and additional resources.
- **Practice Problems:** Provide supplementary problem sets and coding challenges focused on model tuning, hyperparameter optimization, and feature engineering to reinforce core machine learning concepts.

Text Books

- "Machine Learning" by Tom M. Mitchell
- "Introduction to Machine Learning with Python" by Andreas C. Müller and Sarah Guido

Reference Books

- "Pattern Recognition and Machine Learning" by Christopher M. Bishop
- "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy

Additional Readings

Self-Learning Components:

1. Link to Machine Learning course on NPTEL: https://nptel.ac.in/courses/106/106/106106139/
2. Link to Machine Learning on Coursera: https://www.coursera.org/learn/machine-learning
3. Link to Machine Learning tutorials on GeeksforGeeks: https://www.geeksforgeeks.org/machine-learning/
4. Link to Machine Learning lectures: https://ocw.mit.edu/courses/electrical-engineering-6-036-introduction-to-machine-learning-fall-2020/
5. Link to Machine Learning and AI on edX: https://www.edx.org/learn/machine-learning

Basics of Probability & Statistics

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Basics of Probability & Statistics	ENBC203	4-0-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of probability and statistics, focusing on basic probability, probability distributions, descriptive statistics, and inferential statistics. The course is divided into 4 units:

1. Foundations of Probability
2. Engineering Applications of Probability Distributions
3. Descriptive Statistics and Regression Analysis
4. Inferential Statistics for Engineers

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	**Statements**
CO 1	Understanding basic probability concepts and calculate probabilities for different events.
CO 2	Analyzing and apply different probability distributions in various scenarios.
CO 3	Using descriptive statistics and regression analysis to summarize and interpret data.
CO 4	Applying inferential statistics techniques to make data-driven decisions.

A student is expected to have learned concepts and demonstrated abilities or skills related to probability and statistics at the end of the course.

Course Outline

Unit Number: 1	**Title: Foundations of Probability**	**No. of hours: 8**
Content:		
• Basic notions of probability, events, and set operations • Conditional probability and independence of events • Applications of Bayes' theorem • Random variables: Discrete and continuous types • Cumulative distribution functions (CDF) and probability mass/density functions (PMF/PDF) • Mathematical expectation and moments		
Unit Number: 2	**Title: Engineering Applications of Probability Distributions**	**No. of hours: 8**
Content:		
• Joint and marginal distributions • Discrete distributions: Bernoulli, Binomial, Geometric, and Poisson distributions • Continuous distributions: Uniform, Exponential, and Normal distributions • Central Limit Theorem • Law of Large Numbers		
Unit Number: 3	**Title: Descriptive Statistics and Regression Analysis**	**No. of hours: 8**
Content:		
• Descriptive statistics: Measures of central tendency (mean, median, mode) and variability (variance, standard deviation) • Visualization techniques: Histograms, scatter plots • Correlation coefficient and covariance • Linear regression: Modeling relationships between variables • Least squares method for fitting regression models		
Unit Number: 4	**Title: Inferential Statistics for Engineers**	**No. of hours: 8**
Content:		

- Introduction to statistical inference
- Sampling distributions of mean and variance
- Estimation techniques: Point estimation and confidence intervals
- Hypothesis testing: Parametric tests (Z-test, T-test) and non-parametric tests

Learning Experience for Basics of Probability & Statistics

Classroom Learning Experience

- **Interactive Lectures:** Utilize visual aids and real-life examples to explain fundamental concepts such as probability, distributions, and statistical inference, ensuring that students can relate these concepts to practical applications.
- **Hands-On Problem Solving:** Engage students in solving a variety of probability and statistics problems through guided practice sessions. Encourage the use of statistical software for data analysis and visualization, providing practical experience with tools like R or Excel.
- **Group Projects:** Foster collaborative learning by assigning group projects that involve collecting, analyzing, and interpreting data. Projects may include surveys, experiments, or analysis of existing datasets to apply statistical techniques learned in class.
- **Immediate Feedback:** Provide in-class exercises and quizzes to offer real-time feedback on students' understanding of probability and statistics concepts.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Provide assignments and case studies that require students to apply probability and statistical methods to real-world scenarios. These tasks will emphasize critical thinking and the application of statistical tools for decision-making in fields like economics, engineering, and social sciences.
- **Collaborative Projects:** Promote teamwork on larger statistical analysis projects outside the classroom, where students collect and interpret data, apply statistical methods, and present their findings.
- **Online Discussions:** Facilitate online forums where students can discuss statistical problems, share insights, and collaborate on project ideas, promoting peer learning.
- **Self-Study:** Encourage students to explore additional topics in probability and statistics through supplementary reading materials and practice exercises that deepen their understanding.

- **Practice Problems:** Provide additional problem sets for independent study to reinforce the key concepts of probability, statistical distributions, and data analysis techniques.

- **Peer Review:** Organize peer review sessions where students critique each other's data analyses, enhancing their ability to interpret and present statistical data effectively.

Text Books

- "Probability and Statistics for Engineers" by Richard A. Johnson

- "Probability & Statistics with R for Engineers and Scientists" by Michael Baron

Reference Books

- "Introduction to Probability and Statistics for Engineers and Scientists" by Sheldon M. Ross

- "Probability and Statistics for Engineering and the Sciences" by Jay L. Devore

Additional Readings

Self-Learning Components:

1. Link to Probability and Statistics course on NPTEL: https://nptel.ac.in/courses/111/106/111106112/

2. Link to Probability and Statistics on Coursera: https://www.coursera.org/courses?query=probability%20and%20statistics

3. Link to Probability and Statistics resources: https://www.khanacademy.org/math/statistics-probability

4. Link to Probability and Statistics tutorials: https://www.tutorialspoint.com/probability_and_statistics/index.htm

5. Link to Probability and Statistics lectures: https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/

Introduction to Java Programming

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Java Programming	ENBC205	3-1-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of Java programming, focusing on object-oriented programming (OOP), inheritance, polymorphism, exception handling, multithreading, and file handling. The course is divided into 4 units:

1. Introduction to Java and OOP
2. Inheritance and Polymorphism
3. Exception Handling and Multithreading
4. I/O Stream and Collections

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the basics of Java programming and OOP concepts.
CO 2	Implementing inheritance and polymorphism in Java programs.
CO 3	Handling exceptions and manage multithreading in Java.
CO 4	Performing file handling and utilize collections in Java.

A student is expected to have learned concepts and demonstrated abilities or skills related to Java programming at the end of the course.

Course Outline

<table>
<tr><td><b>Unit Number: 1</b></td><td><b>Title: Introduction to Java and OOP</b></td><td><b>No. of hours: 10</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• Introduction to Java: Features, Importance, Java Virtual Machine, Byte Code
• Keywords, constants, variables, and Data Types, Operators and Expressions, Type casting and conversion
• Java Control Structure: Decision making (if, if-else, switch-case), Loop (do, while, for), jump statements (break and continue)
• Simple Input and Output: Scanner Class
• Arrays Handling: Single and Multi-dimensional, Referencing Arrays Dynamically
• Java Strings: String class, Creating & Using String Objects, Manipulating Strings, String Immutability & Equality
• OOP Paradigm: Features of OOP, Class and Object in Java, Overloading Member Methods, Static Members, this Keyword
• Constructors: default, parameterized, and copy constructors</td></tr>
<tr><td><b>Unit Number: 2</b></td><td><b>Title: Inheritance and Polymorphism</b></td><td><b>No. of hours: 10</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• Access Specifiers, Introduction to Inheritance: Derived Class and Super class, super Keyword
• Types of inheritance: simple, multilevel, hierarchical
• Polymorphism: Static (Method overloading), Dynamic (Method Overriding)
• Abstract Method and Abstract Class
• Interfaces: Defining and Implementing an Interface
• Packages: Creating, Naming, Using Package Members</td></tr>
<tr><td><b>Unit Number: 3</b></td><td><b>Title: Exception Handling and Multithreading</b></td><td><b>No. of hours: 10</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
</table>

• Exception Handling: Dealing with Errors, Classification of Exceptions, Declaring and Throwing Exceptions, Catching Exceptions, finally clause • Multithreaded Programming: Fundamentals, Java thread model, priorities, synchronization, thread classes, Runnable interface, inter-thread Communication • Wrapper Classes: Autoboxing/Unboxing, Enumerations		
Unit Number: 4	**Title: I/O Stream and Collections**	**No. of hours: 10**
Content:		
• File Handling: File Class Methods, Reading from a File, Writing to a File, Buffered I/O, Character Streams, Byte Streams, File Input/Output Stream • Java Collections Framework: Introduction, Collection Interfaces: List (ArrayList, LinkedList), Set (HashSet, LinkedHashSet), Map (HashMap) • Working with Collections: Adding, Removing, Searching Elements, Iterating Elements		

Learning Experience for Introduction to Java Programming

Classroom Learning Experience

- **Interactive Lectures:** Leverage visual aids, code demonstrations, and live coding sessions to explain Java concepts such as object-oriented programming (OOP), inheritance, and polymorphism, making abstract concepts more concrete and relatable.
- **Hands-On Labs:** Provide students with lab sessions where they can practice writing and debugging Java code. These labs will focus on implementing Java programs that use OOP principles, exception handling, and multithreading.
- **Group Projects:** Encourage students to work in groups on projects that require them to build small-scale Java applications. These projects will emphasize the practical application of Java concepts like file handling, collections, and GUI development.
- **Immediate Feedback:** Offer real-time feedback during quizzes, coding challenges, and in-class problem-solving activities to ensure students understand core Java concepts and their applications.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign tasks that require students to solve real-world problems using Java. These assignments will cover various topics such as inheritance, polymorphism, and data structures within Java, reinforcing practical knowledge.

- **Collaborative Projects:** Promote teamwork on larger projects outside the classroom, where students design and implement Java applications, applying concepts learned in class to create functional software solutions.

- **Online Discussions:** Facilitate online discussion boards where students can collaborate, ask questions, and share coding strategies for solving complex Java programming problems.

- **Peer Review:** Organize peer review sessions where students evaluate each other's Java code, providing constructive feedback on coding style, efficiency, and use of OOP principles.

- **Self-Study:** Encourage students to explore advanced Java topics such as JavaFX, streams, and design patterns through additional resources and practice exercises.

- **Practice Problems:** Provide supplementary coding challenges and problem sets for students to complete independently, reinforcing key Java programming concepts like exception handling, collections, and multithreading.

Text Books

- "Java: The Complete Reference" by Herbert Schildt

- "Head First Java" by Kathy Sierra and Bert Bates

Reference Books

- "Effective Java" by Joshua Bloch

- "Core Java Volume I–Fundamentals" by Cay S. Horstmann

Additional Readings

Self-Learning Components:

1. Link to Java Programming course on NPTEL: https://nptel.ac.in/courses/106/106/106106147/

2. Link to Java Programming on Coursera: https://www.coursera.org/courses?query=java%20programming

3. Link to Java Programming resources: https://www.geeksforgeeks.org/java/

4. Link to Java Programming tutorials: https://www.tutorialspoint.com/java/index.htm

5. Link to Java Programming lectures: https://ocw.mit.edu/courses/electrical-engineering-6-092-java-preparation-for-6-170-january-iap-2010/

Life Skills for Professionals-I

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Life Skills for Professionals-I	AEC011	3-0-0	3
Type of Course:	AEC		
Pre-requisite(s):	None		

Course Perspective: This course aims to develop essential life skills for professionals, focusing on communication, non-verbal communication, basic number system, and time management. The course is divided into 5 units:

1. Communication: An Introduction
2. Non-Verbal Communication
3. Basic Number System
4. Advanced Number System
5. Time Management

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the fundamentals of communication and its importance in professional settings.
CO 2	Improving non-verbal communication skills for better interpersonal interactions.
CO 3	Appling basic number system concepts in various scenarios.
CO 4	Utilizing time management strategies to enhance productivity and efficiency.

A student is expected to have learned concepts and demonstrated abilities or skills related to life skills for professionals at the end of the course.

Course Outline

Unit Number: 1	**Title: Communication: An Introduction**	**No. of hours: 6**
Content:		
• 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	**Title: Non-Verbal Communication**	**No. of hours: 6**
Content:		
• 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:		
• Divisibility, Unit Digit, Last Two-Digit • Remainder, Number of Zero, Factor • LCM & HCF, Simplification • Mixture, Average, Ratio, and Partnership		
Unit Number: 4	**Title: Advanced Number System**	**No. of hours: 6**
Content:		
• Factor, LCM & HCF, Simplification • Mixture, Average, Ratio, and Partnership		

Unit Number: 5	Title: Time Management	No. of hours: 6
Content:		
• Time management strategies • Setting goals, organizing, and planning ahead • Making the most of your time • Dealing with distractions, Procrastination, and Avoiding distractions		

Learning Experience for Life Skills for Professionals-I

Classroom Learning Experience

- **Interactive Sessions:** Engage students through interactive discussions on the fundamentals of communication, non-verbal cues, and time management. These sessions will include role-playing exercises to help students practice and refine their communication skills.

- **Workshops:** Conduct workshops focused on non-verbal communication, where students can learn about body language, facial expressions, and other non-verbal cues that enhance interpersonal communication.

- **Hands-On Activities:** Provide practical exercises in basic and advanced number systems, allowing students to solve real-life problems and apply mathematical concepts in a professional context.

- **Group Discussions:** Facilitate group discussions on time management strategies, enabling students to share their experiences, challenges, and solutions for managing time effectively.

- **Immediate Feedback:** Offer real-time feedback during workshops and discussions, helping students improve their communication techniques and time management strategies through active participation.

Outside Classroom Learning Experience

- **Assignments & Case Studies:** Assign tasks and case studies related to communication barriers, time management issues, and number system applications, encouraging students to think critically and apply the skills learned in class to real-world situations.

- **Collaborative Projects:** Encourage students to work on group projects outside the classroom, focusing on practical applications of communication skills, problem-solving, and time management in professional settings.

- **Online Discussions:** Facilitate online forums where students can share their experiences, ask questions, and collaborate on life skills challenges, enhancing peer learning.

- **Peer Review:** Organize peer review sessions where students provide feedback on each other's presentations and reflective journals, helping to develop a deeper understanding of communication and professional skills.
- **Self-Study:** Encourage students to engage in self-reflection and self-study on topics like stress management, teamwork, and leadership, using additional resources such as articles, books, and videos.
- **Practice Problems:** Provide scenarios and practice exercises for students to work through independently, reinforcing concepts related to time management, communication strategies, and problem-solving in professional environments.

Text Books

- "Communication Skills" by Sanjay Kumar and Pushp Lata
- "Business Communication" by Meenakshi Raman and Prakash Singh

Reference Books

- "Essential Communication Skills" by Shalini Aggarwal
- "Developing Communication Skills" by Krishna Mohan and Meera Banerji

Additional Readings

Self-Learning Components:

1. Link to Communication Skills course on NPTEL: https://nptel.ac.in/courses/109/104/109104031/
2. Link to Communication Skills on Coursera: https://www.coursera.org/courses?query=communication%20skills
3. Link to Time Management resources: https://www.mindtools.com/pages/main/newMN_HTE.htm
4. Link to Non-Verbal Communication tutorials: https://www.skillsyouneed.com/ips/nonverbal-communication.html
5. Link to Number System tutorials: https://www.tutorialspoint.com/number_system/index.htm

Introduction to Java Programming Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Java Programming Lab	ENBC251	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

COs	Statements
CO 1	Understanding the basic syntax, features, and structure of Java programming language.
CO 2	Developing Java applications using OOP concepts such as classes, objects, inheritance, and polymorphism.
CO 3	Handling exceptions and implement multithreading in Java programs.
CO 4	Utilizing Java I/O streams and collections framework to handle data and perform file operations.

S.N	Lab Task	Mapped CO/COs
1	Write a Java program to understand the basic syntax and structure of a Java program.	CO1
2	Develop a program using data types, variables, and control structures.	CO1
3	Implement arrays handling (single and multi-dimensional) in Java.	CO1
4	Write a program to manipulate strings using Java String class.	CO1
5	Develop a program to demonstrate OOP features: classes, objects, and constructors.	CO2
6	Implement a program using static members and the ‘this‘ keyword.	CO2
7	Write a program to demonstrate method overloading and overriding.	CO2
8	Develop a program to implement inheritance (simple, multilevel, hierarchical).	CO2
9	Implement a program to demonstrate polymorphism in Java.	CO2
10	Create a program using abstract classes and interfaces.	CO2
11	Develop a program to handle exceptions using try, catch, throw, and finally.	CO3

S.N	Lab Task	Mapped CO/COs
12	Implement a multithreaded program demonstrating thread creation and synchronization.	CO3
13	Write a program to demonstrate autoboxing and unboxing using wrapper classes.	CO3
14	Develop a program for file handling operations: reading and writing to a file.	CO4
15	Implement a program to demonstrate the use of byte streams and character streams.	CO4
16	Create a program using Java collections framework: List, Set, and Map interfaces.	CO4
17	Develop a program to add, remove, search, and iterate elements in collections.	CO4
18	Implement a program to use function templates.	CO4
19	Write a program to use class templates.	CO4
20	Create a program to handle errors during file operations.	CO4
1	**Student Management System:** Develop a student management system using OOP concepts like classes, objects, inheritance, and polymorphism.	CO2, CO3
2	**Library Management System:** Create a library management system that uses file handling for data storage and retrieval.	CO4
3	**Banking System:** Design a banking system implementing dynamic memory allocation and exception handling.	CO2, CO4
4	**Inventory Management System:** Develop an inventory management system using templates and collections.	CO3, CO4
5	**Online Shopping System:** Create an online shopping system that demonstrates all learned OOP concepts including inheritance, polymorphism, file handling, and exception handling.	CO2, CO3, CO4

Online Learning Resources

- **GeeksforGeeks:** Tutorials and articles on Java programming and object-oriented programming concepts.
  https://www.geeksforgeeks.org/java/
- **TutorialsPoint:** Comprehensive guides on Java programming and OOP principles.
  https://www.tutorialspoint.com/java/index.htm
- **NPTEL:** Video lectures and course materials on Java programming.
  https://nptel.ac.in/courses/106/106/106106147/
- **Coursera:** Courses on Java programming and object-oriented principles from leading universities.

https://www.coursera.org/courses?query=java

Introduction to Data Structures Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Data Structures Lab	ENBC253	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

COs	Statements
CO 1	Understanding the fundamentals of data structures, including arrays and their applications.
CO 2	Implementing linear data structures such as linked lists, stacks, and queues.
CO 3	Applying sorting and searching algorithms to various data structures.
CO 4	Implementing tree and graph algorithms and understand their applications.

S.N	Lab Task	Mapped CO/COs
1	Write a program to understand the basic concepts of arrays and their applications.	CO1
2	Implement a program to measure the time and space complexity of an algorithm.	CO1
3	Develop a program to demonstrate single and multi-dimensional arrays.	CO1
4	Implement a program to demonstrate row major and column major order representation.	CO1
5	Write a program to implement single linked lists and perform various operations on them.	CO2
6	Develop a program to implement doubly linked lists and perform various operations on them.	CO2
7	Implement a program to demonstrate circular linked lists and perform operations.	CO2
8	Create a program to perform stack operations using arrays and linked lists.	CO2
9	Write a program to evaluate postfix expressions using stack.	CO2
10	Develop a program to perform queue operations using arrays and linked lists.	CO2
11	Implement a program to demonstrate circular queues.	CO2

S.N	Lab Task	Mapped CO/COs
12	Write a program to perform sequential and binary search on an array.	CO3
13	Develop a program to implement insertion sort on an array.	CO3
14	Implement a program to perform selection sort on an array.	CO3
15	Write a program to implement bubble sort on an array.	CO3
16	Develop a program to perform quick sort on an array.	CO3
17	Implement a program to perform merge sort on an array.	CO3
18	Write a program to demonstrate hash table and collision resolution strategies.	CO3
19	Develop a program to implement binary tree and perform various tree traversal algorithms.	CO4
20	Implement a program to demonstrate graph representation and perform graph traversal algorithms.	CO4
1	**Library Management System:** Develop a library management system using data structures like linked lists, stacks, and queues for various operations.	CO2, CO3
2	**Hospital Management System:** Create a hospital management system to manage patient records using arrays and linked lists.	CO2, CO3
3	**Social Network Analysis:** Implement a social network analysis tool using graph algorithms to find shortest paths and minimum spanning trees.	CO4
4	**Inventory Management System:** Develop an inventory management system using sorting and searching algorithms for efficient data retrieval.	CO3
5	**Pathfinding Algorithm:** Create a pathfinding algorithm for a maze using tree and graph traversal algorithms.	CO4

Online Learning Resources

- **GeeksforGeeks:** Tutorials and articles on data structures and algorithms. https://www.geeksforgeeks.org/data-structures/
- **TutorialsPoint:** Comprehensive guides on data structures and their implementations. https://www.tutorialspoint.com/data_structures_algorithms/index.htm
- **NPTEL:** Video lectures and course materials on data structures and algorithms. https://nptel.ac.in/courses/106/106/106106127/
- **Coursera:** Courses on data structures and algorithms from leading universities. https://www.coursera.org/courses?query=data%20structures

Machine Learning Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Machine Learning Lab	ENSP257	0-0-2	1
Type of Course:	SEC		

Defined Course Outcomes

COs	**Statements**
CO 1	Understanding the fundamental concepts and challenges of machine learning.
CO 2	Implementing supervised learning algorithms for regression and classification.
CO 3	Applying ensemble learning methods and unsupervised learning algorithms.
CO 4	Evaluating the performance of machine learning models using appropriate metrics.

S.N	**Lab Task**	**Mapped CO/COs**
1	Write a program to understand the basic concepts and challenges of machine learning.	CO1
2	Develop a program for data preprocessing including handling missing values, data wrangling, and sampling.	CO1
3	Implement a simple linear regression model to predict continuous outcomes.	CO2
4	Develop a multiple linear regression model and evaluate its performance.	CO2
5	Implement polynomial regression and compare it with linear regression.	CO2
6	Write a program for logistic regression to classify binary outcomes.	CO2
7	Develop a k-nearest neighbors (k-NN) algorithm for classification and regression tasks.	CO2
8	Implement a decision tree classifier and visualize the tree structure.	CO2
9	Develop a Naive Bayes classifier and evaluate its performance.	CO2
10	Implement a support vector machine (SVM) for classification tasks.	CO2
11	Write a program to demonstrate the use of ensemble learning methods: Bagging, Boosting, and Stacking.	CO3

S.N	Lab Task	Mapped CO/COs
12	Develop a random forest classifier and compare it with a decision tree.	CO3
13	Implement AdaBoost algorithm and evaluate its performance on a dataset.	CO3
14	Write a program for gradient boosting and compare it with AdaBoost.	CO3
15	Implement k-means clustering for a given dataset and visualize the clusters.	CO3
16	Develop a program for principal component analysis (PCA) to reduce the dimensionality of a dataset.	CO3
17	Write a program to evaluate machine learning models using metrics like accuracy, precision, recall, and F1 score.	CO4
18	Develop a program to create a confusion matrix and interpret the results.	CO4
19	Implement cross-validation techniques to evaluate model performance.	CO4
20	Write a program to demonstrate the use of ROC curves and AUC for model evaluation.	CO4
1	**House Price Prediction:** Develop a machine learning model to predict house prices using linear and polynomial regression.	CO2, CO4
2	**Spam Email Detection:** Create a spam email detection system using logistic regression and Naive Bayes classifier.	CO2, CO4
3	**Customer Segmentation:** Implement customer segmentation using k-means clustering and PCA.	CO3, CO4
4	**Sentiment Analysis:** Develop a sentiment analysis model using support vector machine (SVM) and ensemble learning methods.	CO2, CO3, CO4
5	**Handwritten Digit Recognition:** Create a handwritten digit recognition system using decision tree, random forest, and gradient boosting.	CO2, CO3, CO4

Online Learning Resources

- **GeeksforGeeks:** Tutorials and articles on machine learning algorithms and concepts.
  https://www.geeksforgeeks.org/machine-learning/
- **Coursera:** Courses on machine learning from leading universities.
  https://www.coursera.org/courses?query=machine%20learning
- **Kaggle:** Datasets and notebooks for machine learning projects.
  https://www.kaggle.com/

- **scikit-learn Documentation:** Comprehensive guide on using scikit-learn for machine learning in Python.
  https://scikit-learn.org/stable/documentation.html

Summer Internship-I

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Summer Internship-I	SIBC251	0-0-0-	2
Type of Course:	INT		

Duration

The internship will last for six weeks. It will take place after the completion of the 2nd semester and before the commencement of the 3rd semester.

Internship Options

Students can choose from the following options:

1. **Industry Internship (Offline):**
   - Students must produce a joining letter at the start and a relieving letter upon completion.
2. **Global Certifications:**
   - Students can opt for globally recognized certification programs relevant to their field of study.
3. **Research Internship:**
   - Students can engage in a research internship under the mentorship of a faculty member for six weeks.
4. **On-Campus Industry Internship Programs:**
   - The university will offer on-campus internships in collaboration with industry partners.
5. **Internships at Renowned Institutions:**
   - Students can pursue summer internships at esteemed institutions such as IITs, NITs, Central Universities, etc.

Report Submission and Evaluation

1. **Report Preparation:**
   - Students must prepare a detailed report documenting their internship experience and submit it to the department. A copy of the report will be kept for departmental records.

2. **Case Study/Project/Research Paper:**
    - Each student must complete one of the following as part of their internship outcome:
        - A case study
        - A project
        - A research paper suitable for publication
3. **Presentation:**
    - Students are required to present their learning outcomes and results from their summer internship as part of the evaluation process.

Evaluation Criteria for Summer Internship (Out of 100 Marks)

1. **Relevance to Learning Outcomes (30 Marks)**
    - **Case Study/Project/Research Paper Relevance (15 Marks):**
        - Directly relates to core subjects: 15 marks
        - Partially relates to core subjects: 10 marks
        - Minimally relates to core subjects: 5 marks
        - Not relevant: 0 marks
    - **Application of Theoretical Knowledge (15 Marks):**
        - Extensive application of theoretical knowledge: 15 marks
        - Moderate application of theoretical knowledge: 10 marks
        - Minimal application of theoretical knowledge: 5 marks
        - No application of theoretical knowledge: 0 marks
2. **Skill Acquisition (30 Marks)**
    - **New Technical Skills Acquired (15 Marks):**
        - Highly relevant and advanced technical skills: 15 marks
        - Moderately relevant technical skills: 10 marks
        - Basic technical skills: 5 marks
        - No new skills acquired: 0 marks
    - **Professional and Soft Skills Development (15 Marks):**
        - Significant improvement in professional and soft skills: 15 marks
        - Moderate improvement in professional and soft skills: 10 marks
        - Basic improvement in professional and soft skills: 5 marks
        - No improvement: 0 marks
3. **Report Quality (20 Marks)**
    - **Structure and Organization (10 Marks):**
        - Well-structured and organized report: 10 marks
        - Moderately structured report: 7 marks

  - Poorly structured report: 3 marks
  - No structure: 0 marks
- **Clarity and Comprehensiveness (10 Marks):**
  - Clear and comprehensive report: 10 marks
  - Moderately clear and comprehensive report: 7 marks
  - Vague and incomplete report: 3 marks
  - Incomprehensible report: 0 marks

4. **Presentation (20 Marks)**
   - **Content Delivery (10 Marks):**
     - Clear, engaging, and thorough delivery: 10 marks
     - Clear but less engaging delivery: 7 marks
     - Somewhat clear and engaging delivery: 3 marks
     - Unclear and disengaging delivery: 0 marks
   - **Visual Aids and Communication Skills (10 Marks):**
     - Effective use of visual aids and excellent communication skills: 10 marks
     - Moderate use of visual aids and good communication skills: 7 marks
     - Basic use of visual aids and fair communication skills: 3 marks
     - No use of visual aids and poor communication skills: 0 marks

Total: 100 Marks

Course Outcomes

By the end of this course, students will be able to:

- **Apply Theoretical Knowledge:**
  - Integrating and apply theoretical knowledge gained during coursework to real-world industry or research problems.
- **Develop Technical Skills:**
  - Acquiring and demonstrate advanced technical skills relevant to the field of computer science and engineering through practical experience.
- **Conduct Independent Research:**
  - Executing independent research projects, including problem identification, literature review, methodology design, data collection, and analysis.
- **Prepare Professional Reports:**
  - Compiling comprehensive and well-structured reports that document the internship experience, project details, research findings, and conclusions.
- **Enhance Problem-Solving Abilities:**
  - Developing enhanced problem-solving and critical thinking skills by tackling practical challenges encountered during the internship.

- **Improve Professional and Soft Skills:**
  - Exhibiting improved professional and soft skills, including communication, teamwork, time management, and adaptability in a professional setting.
- **Present Findings Effectively:**
  - Delivering clear and engaging presentations to effectively communicate project outcomes, research findings, and acquired knowledge to peers and faculty members.
- **Pursue Lifelong Learning:**
  - Demonstrating a commitment to lifelong learning by engaging in continuous skill development and staying updated with emerging trends and technologies in the field.

Competitive Coding Bootcamp- I

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Competitive Coding Bootcamp- I		2-0-0-	0
Type of Course:	AUDIT		

Course Outcomes (COs):

- **CO1:** Understanding and apply problem-solving strategies and techniques relevant to competitive programming.
- **CO2:** Analyzing the efficiency of algorithms in terms of time and space complexity using asymptotic notations.
- **CO3:** Applying core programming concepts such as functions, recursion, and dynamic memory allocation to solve computational problems.
- **CO4:** Implementing and analyze solutions for problems involving arrays and strings, utilizing efficient operations and algorithms.

Course Outline

Unit No.	**Title**	**No. of hours**
1	**Foundations of Competitive Programming** **Content:** • Introduction to Competitive Programming Platforms: Overview of major platforms like Codeforces, LeetCode, HackerRank, etc. • Setting up accounts and environment for competitive programming. • Solving introductory problems to get familiar with the platforms. • Problem-Solving Strategies: Techniques for solving problems, Greedy Algorithms, Divide and Conquer, Brute Force methods.	8

Unit No.	Title	No. of hours
2	**Time and Space Complexity of Algorithms** **Content:** • Big O Notation: Definition, examples, and practical importance. • Common Complexities: O(1), O(log n), O(n), O(n log n), O(n2̂), etc. • Impact of time and space complexity on algorithm performance. • Asymptotic notations, Best, Average, and worst-case analysis of Algorithms.	8
3	**Core Programming Concepts** **Content:** • Functions: Definition and Declaration, Function Overloading, Recursion and Backtracking. • Pointers: Basics of Pointers and References, Pointer Arithmetic, Dynamic Memory Allocation (malloc, free, new, delete). • Files: File I/O Operations (Reading/Writing), File Handling in C++/Java/Python, Vectors (in C++/ArrayLists in Java): Declaration, Initialization, and Operations, Dynamic Resizing.	8
4	**Arrays and Strings** **Content:** • Arrays: Operations, Manipulations. • Strings: Operations, Substrings, Pattern Matching. • Operations on arrays: Insertion, deletion, and traversal. • String operations: Concatenation, substring search. • Key Problems: Rotating arrays, reversing strings, finding longest substrings without repeating characters.	6

Experiment List

Problem Statement	**Mapped COs**
Two Sum: Find two numbers that add up to a specific target.	CO1
Best Time to Buy and Sell Stock: Maximize profit from stock prices.	CO1
Valid Parentheses: Check if a string contains valid parentheses.	CO1
Greedy Algorithm: Jump Game - Can you reach the end of the array?	CO1
Divide and Conquer: Merge Sort implementation to sort an array.	CO1
Brute Force: Find all subsets of a given set.	CO1
Greedy Algorithm: Minimum Number of Platforms Required for Trains	CO1
Divide and Conquer: Maximum Subarray (Kadane's Algorithm)	CO1
Brute Force: Count number of occurrences of a substring in a string.	CO1
Greedy Algorithm: Coin Change Problem (Minimum Coins)	CO1
Time Complexity: Check if a number is prime using $O(\sqrt{n})$ complexity.	CO2
Sorting: QuickSort algorithm with O(n log n) complexity.	CO2
Big O Notation: Analyze time complexity of an algorithm.	CO2
Space Complexity: Fibonacci with O(n) space complexity.	CO2
Time Complexity: Find first duplicate element in an array with O(n) time.	CO2
Time Complexity: Search an element in a rotated sorted array in O(log n) time.	CO2
Complexity Analysis: Binary Search Tree operations with complexity O(log n).	CO2
Analyze best, average, and worst case for Insertion Sort.	CO2
Time and Space Complexity: Check the complexity of an algorithm (recurrences).	CO2
Time Complexity: Compute factorial recursively with complexity analysis.	CO2
Recursion: Generate all permutations of a string.	CO3
Dynamic Memory Allocation: Implement a dynamic array (vector) from scratch.	CO3
Backtracking: Solve the N-Queens problem using recursion.	CO3
Pointers: Swap two numbers using pointers in C++.	CO3
File Handling: Read and write data to a file in Python/C++/Java.	CO3
Function Overloading: Implement overloaded functions for adding integers and floats.	CO3
Dynamic Memory Allocation: Use malloc and free to manage memory in C.	CO3
Recursion: Solve Tower of Hanoi using recursion.	CO3
Arrays: Rotate an array to the right by k steps.	CO4
Strings: Find the longest substring without repeating characters.	CO4

Learning Experiences

- Understanding Memory Management: Students grasp the concept of memory allocation and deallocation through pointers, gaining insights into how data is stored and accessed in memory.

- Pointer Arithmetic: Learners practice pointer arithmetic to navigate arrays and structures, enhancing their ability to perform low-level data manipulations efficiently.
- Dynamic Memory Allocation: Students experience dynamic memory allocation with functions like malloc, calloc, and free, learning to manage memory dynamically during runtime.
- Pointer and Function Interactions: Students explore how pointers are used to pass arguments by reference, leading to more efficient function calls and manipulation of data within functions.
- Pointer to Pointer Concepts: Learners work with pointer to pointer (double pointers) to understand multi-level indirection and its applications in complex data structures and dynamic memory management.
- Debugging with Pointers: Students enhance their debugging skills by identifying and fixing pointer-related issues such as memory leaks, dangling pointers, and segmentation faults.

Textbooks

- "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein.
- "Algorithm Design" by Jon Kleinberg and Éva Tardos.

Online Resources

- LeetCode (https://leetcode.com/)
- HackerRank (https://www.hackerrank.com/)
- GeeksforGeeks (https://www.geeksforgeeks.org/)

List of Suggested Competitive Programming Courses

- Algorithms and Data Structures by MIT OpenCourseWare
- Introduction to Competitive Programming by NPTEL
- Competitive Programming by HackerRank
- The Bible of Competitive Programming & Coding Interviews

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

Web References

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

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

VAC-III

Design Thinking & Innovations for Engineers

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Design Thinking & Innovations for Engineers	VAC170	0-0-0-	2
Type of Course:	VAC		

Course Perspective: This course aims to cultivate an innovative mindset and enhance creative problem-solving skills through practical experience in design thinking processes and innovation methodologies. It guides students from the inception of an idea to the execution of a startup.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding and apply the principles of design thinking to solve engineering problems.
CO 2	Developing innovative ideas through ideation and prototyping techniques.
CO 3	Implementing innovation strategies in engineering projects.
CO 4	Integrating design thinking methodologies in real-world engineering applications, ensuring sustainable and user-centric solutions.

A student is expected to have learned concepts and demonstrated abilities or skills related to strategic management at the end of the course.

Course Outline

Unit Number: 1	Title: Introduction to Design Thinking	No. of hours: NA
Content:		

• Overview of Design Thinking: History, principles, and importance. • Key Stages of Design Thinking: Empathize, Define, Ideate, Prototype, and Test. • Innovation Types: Incremental vs. Disruptive Innovation. • Tools and Techniques for Design Thinking: Brainstorming, Mind Mapping, Sketching. • Practical Exercise: Identify and Define a Problem Statement.		
Unit Number: 2	**Title: Ideation and Prototyping**	**No. of hours: NA**
Content:		
• Idea Generation Techniques: Brainstorming, SCAMPER, Reverse Engineering. • Prototyping: Importance, Methods, and Tools. • User-Centered Design: Conducting User Research and Testing. • Practical Exercise: Develop and Prototype a Solution for the Identified Problem. • Evaluation and Feedback: Iterative Process for Refinement.		
Unit Number: 3	**Title: Innovation Strategies and Entrepreneurship Life Cycle**	**No. of hours: NA**
Content:		
• Types of innovation: Incremental, Disruptive, Radical. • Innovation frameworks and models. • Introduction to Entrepreneurship: Definition, Characteristics, and Importance. • Stages of Entrepreneurship Life Cycle: Ideation, Validation, Scaling, and Exit. • Business Model Canvas: Value Proposition, Customer Segments, Channels, Revenue Streams. • Funding and Investment: Sources of Funding, Pitching to Investors. • Practical Exercise: Create a Business Model Canvas for the Prototype.		
Unit Number: 4	**Title: Application of Design Thinking in Engineering**	**No. of hours: NA**
Content:		
• Applying design thinking in engineering projects. • Case studies: IDEO's Shopping Cart, Airbnb, Tesla, Google's Design Sprint, and a local startup success story.		

Learning Experience for Design Thinking & Innovations for Engineers

Classroom Learning Experience

- **Collaborative Workshops:** Facilitate hands-on workshops where students collaborate in teams to apply design thinking methodologies, encouraging diverse perspectives and interdisciplinary approaches to problem-solving.
- **Ideation Sessions:** Conduct brainstorming and ideation sessions using techniques like SCAMPER and Reverse Engineering, enabling students to generate innovative ideas and explore creative solutions to real-world problems.
- **Prototyping Activities:** Engage students in rapid prototyping exercises, allowing them to transform their ideas into tangible models. These activities will emphasize the importance of user feedback and iterative improvement.
- **Case Studies and Industry Examples:** Analyze case studies of successful innovations and startups, such as IDEO's Shopping Cart, Airbnb, and Tesla, to illustrate the practical application of design thinking in engineering and entrepreneurship.
- **Feedback and Iteration:** Provide continuous feedback during workshops and prototyping sessions, encouraging students to iterate and refine their ideas based on peer and instructor input.

Outside Classroom Learning Experience

- **User-Centered Design Projects:** Assign projects where students must conduct user research, develop prototypes, and test their designs with real users, ensuring that the solutions are practical, sustainable, and user-centric.
- **Business Model Development:** Guide students through the process of creating a Business Model Canvas for their prototypes, focusing on value proposition, customer segments, and revenue streams, preparing them for the entrepreneurial aspects of engineering innovation.
- **Pitching and Presentation Skills:** Train students in pitching their innovative ideas to potential investors or stakeholders, enhancing their communication and presentation skills.
- **Self-Study and Case Analysis:** Encourage students to explore additional case studies of innovative products and services, reinforcing the application of design thinking principles in different industries.
- **Practice Problems:** Provide practice scenarios where students can apply design thinking frameworks to develop solutions to hypothetical engineering challenges.

Reference Books

- "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation" by Tim Brown

- "Creative Confidence: Unleashing the Creative Potential Within Us All" by Tom Kelley and David Kelley
- "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School" by Idris Mootee
- "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail" by Clayton M. Christensen
- "Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days" by Jake Knapp, John Zeratsky, and Braden Kowitz
- "The Design of Everyday Things" by Don Norman
- "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries
- "Making Ideas Happen: Overcoming the Obstacles Between Vision and Reality" by Scott Belsky
- "Innovation and Entrepreneurship" by Peter F. Drucker

AWS Cloud Fundamentals

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
AWS Cloud Fundamentals	VAC171	0-0-0-	2
Type of Course:	VAC		

Course Perspective: This course provides a foundational understanding of Amazon Web Services (AWS), focusing on its core services, architecture, security measures, and best practices. It prepares students to effectively deploy and manage applications on the AWS platform.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the fundamentals of cloud computing and the benefits of using AWS.
CO 2	Identifying and utilize core AWS services for computing, storage, and networking.
CO 3	Implementing security measures and best practices on AWS.
CO 4	Deploying, monitoring, and managing applications on the AWS platform.

A student is expected to have learned concepts and demonstrated abilities or skills related to strategic management at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to Cloud Computing and AWS**	**No. of hours: 7**
Content:		

• Overview of cloud computing models (IaaS, PaaS, SaaS) • Introduction to AWS and its global infrastructure • AWS Management Console and key concepts • Amazon EC2 instances • Billing, pricing models, and account management • Introduction to AWS Free Tier and hands-on lab setup		
Unit Number: 2	**Title: Core AWS Services**	**No. of hours: 7**
Content:		
• Amazon EC2: Virtual servers in the cloud • Amazon S3: Scalable storage in the cloud, Creation of S3 Bucket, S3 versioning, S3 cross region replication • Amazon RDS: Managed relational database service, AWS DynamoDB • Amazon VPC: Virtual Private Cloud: Creation VPC, Subnet, Net gateway, and Route Table • AWS Route 53, Creation of Route 53 in AWS. • AWS Simple Notification Service (SNS), How to send email and SMS from SNS • AMI: Creation of AMI, Copy AMI into another AWS Account, Attaching root volume with another EC2 instance		
Unit Number: 3	**Title: AWS Security and Compliance**	**No. of hours: 7**
Content:		

• AWS Lambda: Serverless computing, Trigger, Downstream Resources and Runtime • Amazon CloudFront: Content delivery network simulation • Identity and Access Management (IAM), Cross account access using IAM Role, how to connect Windows AD server to AWS. • Creation of Security groups, network ACLs, and VPC security • Elastic Block Storage • AWS Auto scaling • AWS compliance programs and certifications • Monitoring and logging with AWS CloudTrail and CloudWatch • Data encryption and security best practices		
Unit Number: 4	**Title: Deploying and Managing Applications on AWS**	**No. of hours: 7**
Content:		
• Deploying web applications and portfolio of students using AWS EC2 instance on cloud • Deploying Web services on different servers i.e. Microsoft servers, Linux, and AWS servers • Hosting Static Website on S3 Bucket • Load Balancer: Creation of Load Balancer on VPC or among VPC • Monitoring and troubleshooting applications • Backup and disaster recovery strategies • Case studies and real-world applications		

Learning Experience for AWS Cloud Fundamentals

Classroom Learning Experience

- **Hands-On Labs:** Engage students in practical, hands-on lab exercises using the AWS Free Tier. These labs will cover the setup and management of core AWS services like EC2, S3, and VPC, providing real-world experience in cloud computing.

- **Interactive Demonstrations:** Utilize live demonstrations to show the deployment of applications on AWS, including the creation and configuration of instances, setting up virtual networks, and managing databases.

- **Case Studies:** Analyze real-world case studies where AWS is used to solve complex business problems, helping students understand the practical applications and benefits of cloud computing.

- **Collaborative Projects:** Encourage students to work in teams to design, deploy, and manage a cloud-based solution. This project will cover the complete lifecycle, from architecture design to deployment and monitoring.
- **Guest Lectures:** Invite industry experts to deliver guest lectures on advanced AWS topics and emerging trends in cloud computing, providing students with insights into current industry practices.
- **Quizzes and Assessments:** Implement periodic quizzes and assessments to reinforce understanding of key concepts like cloud architecture, security, and best practices.

Outside Classroom Learning Experience

- **Discussion Forums:** Facilitate online discussion forums where students can share experiences, discuss challenges, and exchange solutions related to AWS services.
- **Certification Preparation:** Provide resources and guidance for students interested in pursuing AWS certifications, including practice exams, study materials, and certification roadmaps.
- **Self-Study:** Encourage students to explore additional AWS services such as Lambda, CloudFront, and RDS by accessing AWS documentation, tutorials, and online courses.
- **Practice Projects:** Assign individual practice projects where students can experiment with advanced AWS services and architectures, reinforcing concepts learned in class.
- **Collaborative Work:** Encourage students to work in teams on larger cloud-based projects, applying their knowledge to solve complex problems and optimize cloud infrastructure.

Reference Books

- "AWS Certified Solutions Architect Official Study Guide" by Joe Baron, Hisham Baz, Tim Bixler, Biff Gaut, Kevin E. Kelly, Sean Senior, John Stamper
- "AWS Certified Developer Official Study Guide" by Nick Alteen, Jennifer Fisher, Jason Leznek, John Stamper
- "Amazon Web Services in Action" by Andreas Wittig and Michael Wittig
- "AWS for Solutions Architects" by Alberto Artasanchez
- "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Zaigham Mahmood, Ricardo Puttini

Additional Readings

1. "AWS Lambda in Action" by Danilo Poccia
2. "Serverless Architectures on AWS" by Peter Sbarski
3. "Cloud Native Transformation" by Pini Reznik, Jamie Dobson, Michelle Gienow
4. "The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win" by Gene Kim, Kevin Behr, George Spafford

Web Development with Open Source Frameworks

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Web Development with Open Source Frameworks	VAC172	0-0-2	2
Type of Course:	VAC		
Pre-requisite(s):	None		

Course Perspective: This course provides hands-on experience in web development using various open-source frameworks, focusing on practical application to create functional web applications.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding and setting up web development environments using open source tools.
CO 2	Developing and styling web pages using HTML, CSS, and JavaScript frameworks.
CO 3	Building dynamic web applications using open-source backend frameworks.
CO 4	Deploying and managing web applications using open-source deployment tools.

A student is expected to have learned concepts and demonstrated abilities or skills related to strategic management at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to Web Development and Setup**	**No. of hours: 7**
Content:		
• Overview of Web Development: Client-Server Architecture • Introduction to Open-Source Tools: Git, VSCode, Browser Developer Tools • Setting Up Development Environment: Installing and Configuring Tools • Version Control with Git and GitHub • Hands-on Project: Set up a basic web development environment and create a simple HTML page.		
Unit Number: 2	**Title: Frontend Development with Open-Source Frameworks**	**No. of hours: 7**
Content:		
• HTML5 and CSS3: Structure and Styling • Responsive Design with Bootstrap • Introduction to JavaScript: Basics and DOM Manipulation • JavaScript Frameworks: Overview of React.js and Vue.js • Hands-on Project: Create a responsive webpage with dynamic content using Bootstrap and JavaScript.		
Unit Number: 3	**Title: Backend Development with Open Source Frameworks**	**No. of hours: 5**
Content:		
• Introduction to Backend Development: Server-Side Scripting • Overview of Backend Frameworks: Node.js with Express.js and Django • RESTful APIs: Creation and Consumption • Database Integration: MongoDB (with Node.js) and SQLite (with Django) • Hands-on Project: Build a basic web application with user authentication and data storage using Node.js and Express.js or Django.		
Unit Number: 4	**Title: Deployment and Real-World Projects**	**No. of hours: 5**
Content:		

- Overview of Deployment Tools: Docker, Heroku, Netlify
- Continuous Integration and Deployment (CI/CD) with GitHub Actions
- Real-World Project 1: Develop and Deploy a Blog Website
- Real-World Project 2: Develop and Deploy a To-Do List Application
- Final Project: Students develop and deploy their own web application.

Learning Experience for Web Development with Open Source Frameworks

Classroom Learning Experience

- **Project-Based Learning:** Engage students in real-world projects that require them to build functional web applications using open-source frameworks. This hands-on approach ensures they apply theoretical knowledge to practical tasks.
- **Interactive Labs:** Conduct interactive lab sessions where students can experiment with different web development tools and frameworks like React.js, Vue.js, Node.js, Express.js, and Django. These labs will provide step-by-step guidance to help students understand the nuances of each tool.
- **Version Control Practice:** Implement version control with Git and GitHub throughout the course, encouraging students to track changes, collaborate on projects, and manage code repositories effectively.
- **Responsive Design Techniques:** Focus on creating responsive web designs that adapt to different screen sizes using frameworks like Bootstrap. Students will learn to ensure their applications are user-friendly across devices.
- **Collaborative Development:** Promote teamwork by assigning group projects where students can collaborate on the frontend and backend of web applications, simulating a real-world development environment.
- **Guest Lectures and Webinars:** Invite industry experts to discuss emerging trends in web development and the latest open-source tools, providing students with insights into the current state of the industry.

Outside Classroom Learning Experience

- **Continuous Integration and Deployment (CI/CD):** Introduce students to CI/CD practices using tools like GitHub Actions, Docker, and Heroku. They will learn to automate testing, deployment, and scaling of their applications.
- **Final Capstone Project:** At the end of the course, students will develop and deploy their own web application using the frameworks and tools they have learned. This capstone project will demonstrate their understanding and ability to create a complete, functional web application from scratch.

- **Self-Study:** Encourage students to explore additional features of open-source frameworks and tools, such as serverless architecture and advanced frontend optimization techniques, to enhance their web development skills.
- **Peer Code Review:** Organize peer code review sessions where students critique and provide feedback on each other's projects, improving code quality and collaboration.
- **Online Discussion Forums:** Facilitate online forums where students can ask questions, share their experiences with frameworks, and collaborate on solving challenges.

Text Books and Online Resources

- "Eloquent JavaScript" by Marijn Haverbeke
- "Learning Web Design" by Jennifer Robbins
- MDN Web Docs (https://developer.mozilla.org/)
- freeCodeCamp (https://www.freecodecamp.org/)
- W3Schools (https://www.w3schools.com/)

Tools Used

- VSCode (https://code.visualstudio.com/)
- Git and GitHub (https://github.com/)
- Bootstrap (https://getbootstrap.com/)
- React.js (https://reactjs.org/)
- Node.js (https://nodejs.org/)
- Express.js (https://expressjs.com/)
- Django (https://www.djangoproject.com/)
- MongoDB (https://www.mongodb.com/)
- Heroku (https://www.heroku.com/)

Google Data Analytics

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Google Data Analytics	VAC173	0-0-2	2
Type of Course:	Value Added Course (VAC)		
Pre-requisite(s):	None		

Course Perspective: This course provides hands-on experience in data analytics using Google's tools. Students will learn to effectively utilize Google Analytics, Google Data Studio, Google Sheets, and BigQuery for comprehensive data analyses and visualizations.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding and utilize Google Analytics for tracking and reporting website traffic.
CO 2	Performing data manipulation and analysis using Google Sheets.
CO 3	Creating interactive data visualizations using Google Data Studio.
CO 4	Conducting advanced data analysis and querying using Google BigQuery.

Course Outline

Unit Number: 1	**Title: Google Analytics Overview**	**No. of hours: 7**
Content:		
• Setting up Google Analytics account and properties • Understanding Key Metrics and Dimensions • Analyzing Traffic Sources • Tracking Goals and Conversions • Hands-on Project: Implementing Google Analytics for a website		
Unit Number: 2	**Title: Data Manipulation with Google Sheets**	**No. of hours: 7**
Content:		

• Basics of Google Sheets interface • Techniques for Data Cleaning and Analysis • Creating and Analyzing Pivot Tables • Hands-on Project: Data analysis with Google Sheets		
Unit Number: 3	**Title: Visualizations with Google Data Studio**	**No. of hours: 7**
Content:		
• Introduction to Google Data Studio • Connecting Data Sources and Creating Reports • Advanced Visualization Techniques • Hands-on Project: Developing an interactive dashboard		
Unit Number: 4	**Title: Advanced Analytics with Google BigQuery**	**No. of hours: 7**
Content:		
• Overview of Google BigQuery • Writing and Executing SQL Queries • Data Import and Export Functions • Integration with Google Data Studio • Hands-on Project: Comprehensive data analysis using BigQuery		

Learning Experience for Google Data Analytics

Classroom Learning Experience

- **Hands-On Training:** Engage students in practical exercises using Google Analytics, Google Sheets, Google Data Studio, and Google BigQuery. The hands-on approach ensures that students can apply their learning to real-world data analysis tasks.

- **Interactive Labs:** Conduct lab sessions where students can explore and experiment with Google's tools under guided supervision. These labs provide a platform for students to deepen their understanding through experimentation.

- **Case Studies and Real-World Applications:** Incorporate case studies from industry to illustrate how data analytics with Google tools is applied in various sectors, such as e-commerce, marketing, and finance.

- **Collaborative Learning:** Encourage group projects where students collaborate on data analysis tasks, share insights, and critique each other's work, simulating a team-based work environment.
- **Guest Lectures and Webinars:** Invite industry professionals to share their experiences and best practices in data analytics using Google tools, offering students a glimpse into current trends and techniques.
- **Continuous Feedback:** Provide real-time feedback during lab sessions and project work, allowing students to improve their data analysis skills through iteration.

Outside Classroom Learning Experience

- **Project-Based Learning:** Throughout the course, students will work on projects that simulate real-life data analytics scenarios, such as setting up Google Analytics for a website, performing data cleaning and analysis in Google Sheets, and creating interactive dashboards in Google Data Studio.
- **Capstone Project:** The course will culminate in a comprehensive capstone project where students apply all the tools and techniques they've learned to analyze a large dataset and present their findings using Google Data Studio.
- **Self-Study:** Encourage students to explore advanced features of Google tools, such as API integration, advanced queries in BigQuery, and custom report creation in Google Analytics.
- **Peer Review:** Organize peer review sessions where students critique and provide feedback on each other's data analysis projects, helping to improve their skills in presenting and interpreting data.
- **Online Discussion Forums:** Facilitate online discussions where students can ask questions, share their experiences with Google tools, and troubleshoot challenges collaboratively.

Text Books and Online Resources

- "Google Analytics Breakthrough" by Feras Alhlou, Shiraz Asif, Eric Fettman
- "Learning Google Data Studio" by Mina Ozgen
- Google Analytics Academy (https://analytics.google.com/analytics/academy/)
- Google Data Studio Help (https://support.google.com/datastudio/)
- BigQuery Documentation (https://cloud.google.com/bigquery/docs)

Tools Used

- Google Analytics (https://analytics.google.com/)
- Google Sheets (https://www.google.com/sheets/about/)
- Google Data Studio (https://datastudio.google.com/)
- Google BigQuery (https://cloud.google.com/bigquery)

Software Testing using Open Source Frameworks

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Software Testing using Open Source Frameworks	VAC174	0-0-2	2
Type of Course:	Value Added Course (VAC)		
Pre-requisite(s):	None		

Course Perspective: This course provides hands-on experience in software testing using various open-source frameworks. Students will learn to set up a testing environment, develop automated test scripts, implement unit and integration tests, and integrate automated testing into CI/CD pipelines.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding and setting up a software testing environment using open source tools.
CO 2	Developing and execute automated test scripts using Selenium.
CO 3	Implementing unit and integration testing using JUnit and TestNG.
CO 4	Integrating automated testing into CI/CD pipelines using Jenkins.

Course Outline

Unit Number: 1	**Title: Overview of Software Testing**	**No. of hours: 7**
Content:		

• Importance, types, and life cycle of software testing • Introduction to Open-Source Testing Tools: Selenium, JUnit, TestNG, Jenkins • Setting Up the Testing Environment: Installing and configuring tools • Version Control with Git and GitHub • Hands-on Project: Set up a software testing environment and create a simple test script using Selenium		
Unit Number: 2	**Title: Introduction to Selenium**	**No. of hours: 7**
Content:		
• WebDriver, IDE, and Grid • Writing Test Scripts: Locators, actions, and assertions • Handling Web Elements: Forms, alerts, frames, and windows • Test Execution: Running tests on different browsers and platforms • Hands-on Project: Develop and execute automated test scripts for a sample web application using Selenium WebDriver		
Unit Number: 3	**Title: Unit and Integration Testing with JUnit and TestNG**	**No. of hours: 7**
Content:		
• Introduction to JUnit: Annotations, assertions, and test suites • Writing Unit Tests: Best practices and patterns • Introduction to TestNG: Annotations, groups, and data providers • Integration Testing: Writing and executing integration tests • Hands-on Project: Implement unit and integration tests for a sample application using JUnit and TestNG		
Unit Number: 4	**Title: Continuous Testing with Jenkins**	**No. of hours: 7**
Content:		

- Introduction to Jenkins: Setup and configuration
- Creating Jenkins Pipelines: Declarative and scripted pipelines
- Integrating Selenium, JUnit, and TestNG with Jenkins
- Continuous Testing: Running automated tests in CI/CD pipelines
- Hands-on Project: Set up a Jenkins pipeline to automate the testing process for a sample project, integrating Selenium, JUnit, and TestNG tests

Learning Experience for Software Testing using Open Source Frameworks

Classroom Learning Experience

- **Hands-On Learning:** Engage students in practical exercises that involve setting up testing environments, writing automated test scripts, and implementing unit and integration tests. The hands-on approach ensures that students gain real-world experience in software testing using open-source frameworks.
- **Interactive Labs:** Conduct lab sessions where students can explore different testing tools like Selenium, JUnit, TestNG, and Jenkins under guided supervision. These labs provide an opportunity for students to deepen their understanding through experimentation and practice.
- **Collaborative Learning:** Encourage group projects where students collaborate on testing tasks, share insights, and critique each other's work, simulating a team-based work environment often found in software development.
- **Case Studies and Real-World Applications:** Incorporate case studies from the industry to illustrate how software testing with open-source tools is applied in various sectors, such as e-commerce, finance, and enterprise software development.
- **Guest Lectures and Webinars:** Invite industry professionals to share their experiences and best practices in software testing using open-source frameworks, offering students a glimpse into current trends and techniques.
- **Continuous Feedback:** Provide real-time feedback during labs and projects, helping students improve their testing strategies through iteration and refinement.

Outside Classroom Learning Experience

- **Project-Based Approach:** Throughout the course, students will work on projects that simulate real-life testing scenarios, such as developing and executing automated tests for web applications, setting up CI/CD pipelines, and integrating testing tools.
- **Capstone Project:** The course will culminate in a comprehensive capstone project where students apply all the tools and techniques they've learned to develop a complete testing strategy for a real or simulated software project.

- **Self-Study:** Encourage students to explore additional open-source testing tools, advanced test automation strategies, and the integration of testing into DevOps workflows through online resources and tutorials.
- **Peer Review:** Organize peer review sessions where students evaluate each other's testing frameworks and approaches, providing constructive feedback to improve testing methodologies.
- **Online Discussion Forums:** Facilitate online forums where students can discuss challenges, share solutions, and collaborate on testing strategies, promoting peer learning and community engagement.

Books and Online Resources

- "Selenium Testing Tools Cookbook" by Unmesh Gundecha
- "JUnit in Action" by Petar Tahchiev, Felipe Leme, Vincent Massol, Gary Gregory
- "Continuous Integration: Improving Software Quality and Reducing Risk" by Paul M. Duvall, Steve Matyas, Andrew Glover
- Selenium Documentation (https://www.selenium.dev/documentation/)
- JUnit 5 User Guide (https://junit.org/junit5/docs/current/user-guide/)
- TestNG Documentation (https://testng.org/doc/)
- Jenkins User Documentation (https://www.jenkins.io/doc/)

Database Management with Open Source Frameworks

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Database Management with Open Source Frameworks	VAC175	0-0-2	2
Type of Course:	Value Added Course (VAC)		
Pre-requisite(s):	None		

Course Perspective: This course covers the fundamental concepts of database management systems (DBMS). Topics include data models, relational database design, SQL, transaction management, and database security. Students will learn to design and implement a relational database, write SQL queries, and understand the principles of database management.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding and designing databases using Entity-Relationship (ER) diagrams.
CO 2	Applying SQL queries for data extraction, manipulation, and management.
CO 3	Utilizing MySQL and PostgreSQL for backend application development.
CO 4	Integrating databases with Python for data-driven applications.

Course Outline

Unit Number: 1	**Title: Introduction to Database Design**	**No. of hours: 7**
Content:		

<table>
<tr><td colspan="3">• Overview of Database Management Systems (DBMS): Concepts and benefits
• Introduction to Open-Source RDBMS: MySQL, PostgreSQL
• Database Design: Principles and best practices
• Entity-Relationship (ER) Diagrams: Entities, relationships, attributes, and cardinality
• Hands-on Project: Design an ER diagram for a sample application (e.g., a library management system)</td></tr>
<tr><td><b>Unit Number: 2</b></td><td><b>Title: SQL for Data Extraction and Manipulation</b></td><td><b>No. of hours: 7</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• Introduction to SQL: Basic syntax and structure
• Data Definition Language (DDL): CREATE, ALTER, DROP
• Data Manipulation Language (DML): SELECT, INSERT, UPDATE, DELETE
• SQL Joins: INNER JOIN, LEFT JOIN, RIGHT JOIN, FULL JOIN
• Hands-on Project: Write SQL queries to create and manipulate tables based on the ER diagram from Unit 1</td></tr>
<tr><td><b>Unit Number: 3</b></td><td><b>Title: Advanced SQL and Database Operations</b></td><td><b>No. of hours: 7</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• Advanced SQL Queries: Subqueries, nested queries, and set operations
• Indexing and Optimization: Improving query performance
• Transactions and Concurrency: COMMIT, ROLLBACK, and transaction isolation levels
• Stored Procedures and Triggers: Creating and using stored procedures and triggers
• Hands-on Project: Develop complex SQL queries and procedures for the sample application, including indexing and optimization strategies</td></tr>
<tr><td><b>Unit Number: 4</b></td><td><b>Title: Database Integration with Python</b></td><td><b>No. of hours: 7</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
</table>

- Introduction to Python Database Connectivity: Using libraries like SQLAlchemy, Psycopg2, and MySQL Connector
- CRUD Operations with Python: Implementing create, read, update, and delete operations
- Data Analysis with Pandas: Loading and manipulating data from databases
- Real-World Project 1: Develop a Python application to interact with the MySQL/PostgreSQL database created in previous units
- Real-World Project 2: Perform data analysis on database data using Python and Pandas, creating visualizations of the results

Learning Experience for Database Management with Open Source Frameworks

Classroom Learning Experience

- **Hands-On Learning:** Engage students in practical exercises where they design databases, write SQL queries, and integrate databases with Python applications. This hands-on approach ensures that students gain real-world experience in database management using open-source frameworks.
- **Interactive Labs:** Conduct lab sessions where students can explore MySQL, PostgreSQL, and Python database integration under guided supervision. These labs provide an opportunity for students to deepen their understanding through experimentation and practice.
- **Collaborative Learning:** Encourage group projects where students collaborate on database design and management tasks, share insights, and critique each other's work, simulating a team-based work environment often found in software development.
- **Case Studies and Real-World Applications:** Incorporate case studies from the industry to illustrate how database management using open-source tools is applied in various sectors, such as finance, e-commerce, and healthcare.
- **Guest Lectures and Webinars:** Invite industry professionals to share their experiences and best practices in database management using open-source frameworks, offering students a glimpse into current trends and techniques.

Outside Classroom Learning Experience

- **Project-Based Approach:** Throughout the course, students will work on projects that simulate real-life scenarios, such as designing and implementing a relational database, developing complex SQL queries, and creating Python applications that interact with databases.

- **Capstone Project:** The course will culminate in a comprehensive capstone project where students apply all the tools and techniques they've learned to design, implement, and manage a complete database system for a real or simulated application.
- **Self-Study:** Encourage students to explore advanced database management concepts like normalization, indexing, and database optimization through additional resources, such as documentation, tutorials, and online courses.
- **Peer Review:** Organize peer review sessions where students evaluate each other's database designs and implementations, providing constructive feedback on database structure and query optimization.
- **Online Discussion Forums:** Facilitate online forums where students can discuss challenges, share solutions, and collaborate on database management projects, promoting a peer-learning environment.

Books and Online Resources

- "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, S. Sudarshan
- "Learning SQL" by Alan Beaulieu
- "SQL for Data Scientists: A Beginner's Guide for Building Datasets for Analysis" by Renee M. P. Teate
- MySQL Documentation (https://dev.mysql.com/doc/)
- PostgreSQL Documentation (https://www.postgresql.org/docs/)
- W3Schools SQL Tutorial (https://www.w3schools.com/sql/)

Tools Used

- MySQL (https://www.mysql.com/)
- PostgreSQL (https://www.postgresql.org/)
- SQLAlchemy (https://www.sqlalchemy.org/)
- Pandas (https://pandas.pydata.org/)

Cyber Security with Open Source Frameworks

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Cyber Security with Open Source Frameworks	VAC176	0-0-2	2
Type of Course:	Value Added Course (VAC)		
Pre-requisite(s):	None		

Course Perspective: This course is designed to provide hands-on experience in cyber security using various open-source tools and frameworks. Students will learn to identify, analyze, and mitigate security threats, implement security measures, and use open-source tools for network security, application security, and incident response. By the end of the course, students will be capable of securing systems and networks and conducting effective security assessments.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the fundamentals of cyber security and the importance of using open-source tools.
CO 2	Implementing network security measures using open-source frameworks.
CO 3	Conducting application security assessments and vulnerability testing.
CO 4	Performing incident response and digital forensics using open-source tools.

Course Outline

Unit Number: 1	**Title: Introduction to Cybersecurity**	**No. of hours: 5**
Content:		

• Overview of Cyber Security: Concepts, importance, and threat landscape • Introduction to Open-Source Security Tools: Kali Linux, Wireshark, Metasploit, Nmap • Setting Up a Cyber Security Lab: Installing and configuring Kali Linux • Basic Network Security: Understanding firewalls, VPNs, and IDS/IPS • Hands-on Project: Setting up a cyber security lab environment and performing basic network scanning using Nmap		
Unit Number: 2	**Title: Open Source Security Tools**	**No. of hours: 5**
Content:		
• Introduction to open-source software and its benefits in cybersecurity • Overview of key open-source security tools (Wireshark, Metasploit, Nmap, OpenVAS, Snort) • Installation and configuration of security tools • Use cases and practical applications of each tool		
Unit Number: 3	**Title: Implementing Security with Open Source Frameworks**	**No. of hours: 5**
Content:		
• Using OpenSSL for encryption and securing communications • Implementing firewalls with pfSense • Intrusion detection and prevention with Snort • Vulnerability assessment with OpenVAS • Network security monitoring with Zeek (formerly Bro) • Security information and event management (SIEM) with ELK Stack (Elasticsearch, Logstash, Kibana)		
Unit Number: 4	**Title: Advanced Topics and Case Studies**	**No. of hours: 5**
Content:		

- Incident response and forensic analysis with open-source tools
- Penetration testing methodologies and tools
- Case studies of real-world cyber attacks and defenses
- Ethical hacking and legal considerations
- Project-based learning: securing a sample network
- Future trends in cybersecurity and open-source development

Learning Experience for Cyber Security with Open Source Frameworks

Classroom Learning Experience

- **Hands-On Lab Environment:** Engage students in a practical, hands-on lab environment using Kali Linux and other open-source security tools. This experience helps students to familiarize themselves with real-world cybersecurity scenarios.
- **Interactive Learning:** Conduct interactive sessions where students actively participate in live demonstrations of security attacks and defenses, followed by group discussions on the implications and countermeasures.
- **Collaborative Projects:** Encourage students to collaborate on cybersecurity projects, fostering teamwork and the sharing of knowledge on different tools and techniques for securing systems.
- **Case Studies and Real-World Applications:** Incorporate case studies of major cyber incidents to help students understand the practical application of cybersecurity tools and strategies, as well as to learn from past incidents.
- **Guest Lectures and Industry Insights:** Invite cybersecurity professionals to share their experiences and insights on emerging threats, best practices in the industry, and the role of open-source tools in modern cybersecurity.
- **Continuous Feedback:** Provide ongoing feedback during lab exercises and projects, helping students improve their techniques in real-time and iterate on their approaches.

Outside Classroom Learning Experience

- **Project-Based Learning:** Throughout the course, students will work on projects that simulate cyber threats and defense mechanisms, including setting up firewalls, conducting penetration tests, and performing vulnerability assessments.
- **Capstone Project:** The course will culminate in a capstone project where students apply their skills to secure a simulated network environment, incorporating all the tools and techniques learned during the course.

- **Self-Study:** Encourage students to explore additional open-source cybersecurity tools, advanced penetration testing methods, and ethical hacking practices through independent research and online resources.
- **Peer Review:** Organize peer review sessions where students evaluate each other's cybersecurity defenses and strategies, providing constructive feedback on how to improve network security.
- **Online Discussion Forums:** Facilitate online forums where students can discuss challenges, share solutions, and collaborate on cybersecurity issues, promoting peer-to-peer learning and engagement.

Books and Online Resources

- "The Web Application Hacker's Handbook" by Dafydd Stuttard and Marcus Pinto
- "Metasploit: The Penetration Tester's Guide" by David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni
- "Practical Malware Analysis" by Michael Sikorski and Andrew Honig
- Kali Linux Documentation (https://www.kali.org/docs/)
- OWASP ZAP Documentation (https://www.zaproxy.org/docs/)
- Wireshark Documentation (https://www.wireshark.org/docs/)

Tools Used

- Kali Linux (https://www.kali.org/)
- Nmap (https://nmap.org/)
- Wireshark (https://www.wireshark.org/)
- Metasploit (https://www.metasploit.com/)
- OWASP ZAP (https://www.zaproxy.org/)
- Snort (https://www.snort.org/)
- Autopsy (https://www.sleuthkit.org/autopsy/)
- Volatility (https://www.volatilityfoundation.org/)

Practical Robotics and UAV Applications

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Practical Robotics and UAV Applications	VAC185	0-0-2	2
Type of Course:	Value Added Course (VAC)		
Pre-requisite(s):	None		

Course Preface: This course provides comprehensive hands-on training in the field of robotics and UAV (Unmanned Aerial Vehicles). Students will learn to work with various robotic kits, develop basic robots, understand the working principles of UAVs, and gain practical knowledge of different robotics components and their programming. The course aims to equip students with the skills needed to start developing and working on various robotic applications, fostering innovation and practical problem-solving abilities.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Identifying and describing various types and components of robots.
CO 2	Developing and debugging basic Arduino programs for robotic applications.
CO 3	Explaining and implementing key components and control algorithms for UAVs.
CO 4	Designing and create simple robotic and UAV applications.

Course Outline

Unit Number: 1	**Title: Introduction to Robotics and Basic Components**	**No. of hours: 8**
Content:		

- Overview of Robotics: Types and applications of robots
- Mechanical Components
- Sensors
- Actuators
- Controllers and Microcontrollers
- Power Supply Components
- Communication Modules
- PCBs and Breadboards

Unit Number: 2	**Title: Arduino Programming and Development of Basic Robotic Applications**	**No. of hours: 8**
Content:		

- Introduction to Arduino
- Basic Arduino Programming
- Controlling LEDs
- Motor Control
- Sensor Interfacing
- Communication Protocols
- Building Simple Robots:
  - Assembling robotic kits into functional robots
  - Calibrating and testing sensors and actuators
- Robot Programming:
  - Writing and debugging basic programs for robot control
  - Implementing basic navigation and obstacle avoidance algorithms
- Hands-On Projects:
  - Building and programming a line-following robot
  - Developing a simple robotic arm

Unit Number: 3	**Title: UAVs and Advanced Robotic Components**	**No. of hours: 8**
Content:		

- Introduction to UAVs:
  - Types and applications of UAVs
  - Key components of UAVs (e.g., frame, motors, propellers, flight controllers)
- Advanced Robotics Components:
  - Working with advanced sensors (e.g., IMUs, GPS, LIDAR)
  - Communication modules (e.g., Bluetooth, Wi-Fi, ZigBee)
- UAV Programming and Control:
  - Basic flight control and stabilization algorithms
  - Mission planning and autonomous navigation

Unit Number: 4	**Title: Robotic Applications and Projects**	**No. of hours: 6**
Content:		

- Simple Robotic Applications:
  - Developing a home automation system using robotics
  - Implementing a surveillance robot
- UAV Applications:
  - Creating a UAV for aerial photography
  - Developing a UAV for environmental monitoring (e.g., monitoring crops, water, and air quality)

Learning Experience for Practical Robotics and UAV Applications

Classroom Learning Experience

- **Hands-On Learning:** Students will engage in extensive hands-on activities, assembling, programming, and testing various robotic kits and UAV components. This approach ensures that students gain practical experience and confidence in working with robotics and UAV technology.

- **Interactive Sessions:** Interactive workshops and sessions will be held to demonstrate the real-world applications of robotics and UAVs. Students will participate in live demonstrations, followed by hands-on replication of the projects.

- **Collaborative Learning:** Students will work in teams to complete complex projects, fostering collaboration and teamwork. This will also allow them to share different perspectives and solutions to common challenges in robotics and UAV development.

- **Problem-Solving Focus:** The course is designed to enhance problem-solving skills by challenging students to design and debug robotic systems, implement control algorithms, and troubleshoot issues in real-time.

- **Guest Lectures and Field Visits:** The course will include guest lectures from industry experts in robotics and UAVs, as well as potential field visits to relevant industries, providing students with insights into the latest trends and technologies.

Outside Classroom Learning Experience

- **Project-Based Approach:** The course emphasizes project-based learning, where students apply their knowledge to build functional robots and UAVs. This includes tasks such as developing a line-following robot, constructing a robotic arm, and programming UAVs for specific missions.

- **Capstone Project:** The course will culminate in a capstone project where students will integrate the skills they have learned to design and develop a complete robotic or UAV system. This project will demonstrate their ability to apply theoretical knowledge to practical, real-world problems.

- **Self-Study and Research:** Encourage students to explore advanced topics like sensor fusion, autonomous navigation, and UAV flight control through self-study and research to deepen their understanding.

- **Peer Review:** Organize peer review sessions where students evaluate each other's designs and code, providing constructive feedback on system performance and improvements.

- **Online Discussions and Collaboration:** Facilitate online forums where students can discuss technical challenges, share solutions, and collaborate on robotics and UAV projects, promoting continuous learning and engagement.

Books and Online Resources

- "Robotics: Modelling, Planning and Control" by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo

- "Introduction to Robotics: Mechanics and Control" by John J. Craig

- "Learning ROS for Robotics Programming" by Enrique Fernández, Luis Sánchez, Anil Mahtani, Aaron Martinez

- "Robotics: Everything You Need to Know About Robotics from Beginner to Expert" by Peter Mckinnon

- "Unmanned Aerial Vehicles: Embedded Control" by Rogelio Lozano

Applied Automotive Engineering: Hands-On Practices and Innovations

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Applied Automotive Engineering: Hands-On Practices and Innovations	VAC186	0-0-2	2
Type of Course:	Value Added Course (VAC)		
Pre-requisite(s):	None		

Course Perspective: The Automotive Engineering course offers a practical, hands-on approach to understanding and applying the fundamentals of automotive technology. Emphasizing real-world applications, this course covers vehicle classification, IC engine mechanics, troubleshooting, and maintenance, alongside the integration of modern technologies. Students will engage in diagnostic testing, incorporate smart technologies, and develop live projects, equipping them with the skills and experiences necessary to excel in the automotive industry and address its evolving challenges. This course ensures that students are industry-ready, capable of innovative thinking and effective problem-solving.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Planing and proposing live automotive projects based on hands-on learning.
CO 2	Developing and executing live projects with practical applications.
CO 3	Testing and evaluating the performance of live automotive projects.
CO 4	Presenting and documenting project outcomes effectively.

Course Outline

Unit Number: 1	**Title: Introduction to Automotive Engineering**	**No. of hours: 8**
Content:		

- Overview of automotive engineering
- Classification of vehicles
- Constructional details of automotive components
- Troubleshooting and Maintenance:
  - Basic troubleshooting techniques
  - Regular maintenance procedures
- Role of Accessories and Mountings:
  - Importance of automotive accessories
  - Mounting techniques and their significance

Unit Number: 2	**Title: Engines and Vehicle Components**	**No. of hours: 8**

Content:

- IC Engines: Overview and Constructional Details:
  - Basics of Internal Combustion (IC) engines
  - Constructional details of 2-stroke and 4-stroke engines
- Engine Types: Compression Ignition and Spark Ignition:
  - Differences between Compression Ignition (CI) and Spark Ignition (SI) engines
  - Practical understanding of engine components and functioning
- Troubleshooting and Maintenance:
  - Identifying and resolving common engine issues
  - Maintenance practices for IC engines
- Electrical and Electronics Components:
  - Overview of electrical and electronic components in vehicles
  - Hands-on exercises on component testing and maintenance

Unit Number: 3	**Title: Real-Time Projects/Hands-On Projects**	**No. of hours: 8**

Content:

- Problem Identification in Automobiles:
  - Techniques for identifying problems in automobiles
  - Practical exercises on vehicle diagnostics
- Testing of Automobiles:
  - Hands-on testing of automotive systems
  - Using diagnostic tools and equipment
- Incorporating Latest Smart Technology:
  - Adding and integrating smart technologies in vehicles
  - Practical modification exercises
- Project Execution and Documentation:
  - Planning and executing hands-on projects
  - Documenting project work and findings

Unit Number: 4	**Title: Live Project Development**	**No. of hours: 6**
Content:		

- Project Planning and Proposal:
  - Planning live projects based on semester learning
  - Preparing project proposals and timelines
- Hands-On Project Development:
  - Executing live projects with hands-on practices
  - Collaborating and working in teams
- Testing and Evaluation:
  - Testing project outcomes and functionality
  - Evaluating performance and making necessary adjustments
- Final Presentation and Report:
  - Preparing and presenting the final project
  - Writing comprehensive project reports

Learning Experience for Applied Automotive Engineering: Hands-On Practices and Innovations

Classroom Learning Experience

- **Hands-On Learning:** This course is centered around practical, hands-on experience where students will engage directly with automotive components, engines, and diagnostic tools. Through structured workshops and lab sessions, students will apply theoretical knowledge to real-world automotive systems.

- **Interactive Workshops:** The course includes interactive workshops on automotive diagnostics, maintenance, and the integration of smart technologies. Students will gain experience in troubleshooting and maintaining various vehicle systems, ensuring a comprehensive understanding of automotive engineering.

- **Collaborative Learning:** Students will work in teams to tackle complex automotive projects, fostering collaboration and teamwork. This approach mirrors industry practices, preparing students for professional roles where cooperation and joint problem-solving are essential.

- **Real-Time Problem Solving:** The course emphasizes real-time problem-solving, where students will diagnose and fix issues in live automotive projects. This hands-on approach is designed to enhance critical thinking and technical skills.

- **Guest Lectures and Industry Visits:** The course will include guest lectures from automotive industry experts and potential field visits to automotive workshops or manufacturing facilities. These experiences provide insights into the latest industry trends and practices.

Outside Classroom Learning Experience

- **Project-Based Learning:** Students will participate in project-based learning, where they will design, develop, and test automotive projects. These projects will be aligned with current industry challenges, allowing students to innovate and find solutions to practical problems.

- **Capstone Project:** The course will culminate in a capstone project where students will integrate the skills and knowledge gained throughout the semester to develop a comprehensive automotive project. This project will involve planning, execution, testing, and final presentation, simulating a real-world engineering project lifecycle.

- **Self-Study and Research:** Encourage students to explore advanced automotive topics such as electric vehicles, autonomous systems, and hybrid technologies through self-study and research to deepen their understanding of modern innovations.

- **Peer Review:** Organize peer review sessions where students evaluate each other's projects and provide constructive feedback on design, performance, and problem-solving strategies.

- **Online Collaboration and Discussion:** Facilitate online forums where students can collaborate, share insights, and troubleshoot technical challenges in automotive engineering, promoting continuous learning and engagement.

Books and Online Resources

- "Robotics: Modelling, Planning and Control" by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo
- "Introduction to Robotics: Mechanics and Control" by John J. Craig
- "Learning ROS for Robotics Programming" by Enrique Fernández, Luis Sánchez, Anil Mahtani, Aaron Martinez
- "Robotics: Everything You Need to Know About Robotics from Beginner to Expert" by Peter Mckinnon
- "Unmanned Aerial Vehicles: Embedded Control" by Rogelio Lozano

Practical Research Methodology for Engineers

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Practical Research Methodology for Engineers	VAC187	0-0-2	2
Type of Course:	Value Added Course (VAC)		
Pre-requisite(s):	None		

Course Perspective: This course provides students with a practical and hands-on approach to research methodology, focusing on the use of open-source tools and techniques relevant to various engineering domains. Students will learn the fundamentals of research methodology, explore a range of open-source tools, and apply these tools in conducting research, culminating in the preparation of an effective research paper.

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Identifying and explainning the fundamental principles of research methodology.
CO 2	Utilizing and demonstrating the use of open-source tools for data collection, analysis, and presentation.
CO 3	Developing and conducting research projects using appropriate methodologies and tools.
CO 4	Preparing and presenting a research paper effectively using open-source tools.

Course Outline

Unit Number: 1	Title: Fundamentals of Research Methodology	No. of hours: 8
Content:		

- Introduction to Research Methodology:
  - Definition and importance of research
  - Types of research: qualitative vs. quantitative, applied vs. fundamental
  - Research ethics and plagiarism
- Research Design and Planning:
  - Formulating research questions and hypotheses
  - Literature review techniques
  - Designing research methodologies: experimental, survey, case study
- Data Collection Methods:
  - Primary vs. secondary data
  - Techniques for data collection: surveys, interviews, observations
  - Sampling methods

Unit Number: 2	**Title: Open-Source Tools for Research**	**No. of hours: 8**
Content:		

- Literature Review and Reference Management:
  - Using Zotero and Mendeley for reference management
  - Conducting literature reviews with Google Scholar and PubMed
- Data Analysis Tools:
  - Introduction to R and Python for statistical analysis
  - Using JASP and PSPP for statistical tests and analysis
- Survey and Data Collection Tools:
  - Designing surveys with Google Forms and LimeSurvey
  - Collecting and managing data with OpenRefine

Unit Number: 3	**Title: Conducting Research with Open-Source Tools**	**No. of hours: 8**
Content:		

• Qualitative Data Analysis: – Using NVivo and QDA Miner for qualitative analysis – Coding and thematic analysis techniques • Quantitative Data Analysis: – Advanced statistical techniques with R and Python – Data visualization with Matplotlib and ggplot2 • Document Preparation and Presentation: – Writing research papers with LaTeX and Overleaf – Creating presentations with Beamer and LibreOffice Impress		
Unit Number: 4	**Title: Research Project and Paper Preparation**	**No. of hours: 6**
Content:		
• Project Planning and Execution: – Selecting a research topic and formulating objectives – Planning and conducting experiments or surveys • Data Analysis and Interpretation: – Analyzing collected data using appropriate tools – Interpreting results and drawing conclusions • Writing and Presenting Research Paper: – Structuring and writing a research paper – Preparing presentations and posters for conferences		

Learning Experience for Practical Research Methodology for Engineers

Classroom Learning Experience

- **Hands-On Research Training:** This course provides hands-on experience in research methodology, allowing students to engage directly with data collection, analysis, and presentation tools. The practical approach ensures that students can apply theoretical knowledge in real-world research scenarios.

- **Interactive Workshops:** The course includes interactive workshops on various research tools and techniques. Students will learn to use open-source software for data analysis, reference management, and document preparation, providing them with essential skills for conducting high-quality research.

- **Collaborative Learning:** Students will collaborate in groups to tackle research problems, fostering teamwork and the exchange of ideas. This collaborative approach prepares students for professional research environments where interdisciplinary teamwork is often essential.
- **Real-Time Problem Solving:** The course emphasizes real-time problem-solving through research. Students will address actual research questions, develop hypotheses, and test them using appropriate methodologies, enhancing their critical thinking and analytical skills.
- **Guest Lectures and Research Seminars:** The course includes guest lectures and research seminars by experienced researchers and academics. These sessions provide insights into current research trends, best practices, and real-world challenges in conducting research.

Outside Classroom Learning Experience

- **Project-Based Learning:** Students will participate in project-based learning, where they will design and conduct their own research projects. These projects will cover all stages of the research process, from planning and data collection to analysis and presentation, ensuring a comprehensive learning experience.
- **Capstone Research Project:** The course culminates in a capstone research project where students apply all the skills and knowledge gained to conduct a full-fledged research study. This project includes planning, execution, data analysis, and the preparation of a research paper, simulating the entire research process.
- **Self-Study and Literature Review:** Encourage students to conduct extensive literature reviews and explore academic papers related to their research topics. This self-study enhances their understanding of existing research and aids in the development of their research questions.
- **Peer Review:** Organize peer review sessions where students evaluate each other's research proposals, hypotheses, and findings, providing constructive feedback to improve their research quality and methodologies.
- **Online Collaboration and Discussion:** Facilitate online forums where students can collaborate, share insights, and troubleshoot research challenges, promoting continuous learning and engagement beyond the classroom.

Books and Online Resources

- "Research Methodology: A Step-by-Step Guide for Beginners" by Ranjit Kumar
- "Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python" by Peter Bruce and Andrew Bruce
- "The LaTeX Companion" by Frank Mittelbach and Michel Goossens
- "Qualitative Data Analysis with NVivo" by Patricia Bazeley and Kristi Jackson

Semester: 4

Fundamentals of Algorithm Design & Analysis

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Fundamentals of Algorithm Design & Analysis	ENBC202	3-1-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of algorithm design and analysis, focusing on complexity analysis, algorithm design techniques, and graph algorithms. The course is divided into 4 units:

1. Introduction and Complexity Analysis
2. Divide and Conquer, Greedy Algorithms, and Dynamic Programming
3. Graph Algorithms
4. Advanced Algorithms and Techniques

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the basic concepts of algorithms and their importance in problem-solving.
CO 2	Analyzing the time and space complexity of algorithms.
CO 3	Applying various algorithm design techniques to solve problems.
CO 4	Implementing graph algorithms and understand their applications.

A student is expected to have learned concepts and demonstrated abilities or skills related to algorithm design and analysis at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction and Complexity Analysis**	**No. of hours: 10**
Content:		
• Introduction to Algorithms: Definition, importance, specification, and role in problem-solving • Algorithm Analysis: RAM computational models, Time and space complexity, Asymptotic Notations, best, average, and worst-case analysis • Recurrence Relations: Solving recurrences using substitution and recursion tree • Sorting: Analysis of Time complexities of comparison and Linear sorting Algorithms		
Unit Number: 2	**Title: Divide and Conquer, Greedy Algorithms, and Dynamic Programming**	**No. of hours: 10**
Content:		
• Divide and Conquer: General method, Merge Sort, Quick Sort, Binary Search • Greedy Algorithms: Concept and characteristics, Fractional Knapsack, Activity Selection • Dynamic Programming: General Method, Longest Common Subsequence, 0/1 Knapsack problem		
Unit Number: 3	**Title: Graph Algorithms**	**No. of hours: 10**
Content:		
• Graph Representation: Adjacency matrix, adjacency list • Graph Traversal Algorithms: Depth First Search (DFS), Breadth First Search (BFS) • Shortest Path Algorithms: Dijkstra's algorithm, Bellman-Ford algorithm • Minimum Spanning Tree Algorithms: Kruskal's algorithm, Prim's algorithm		
Unit Number: 4	**Title: Advanced Algorithms and Techniques**	**No. of hours: 10**
Content:		
• Backtracking: Concept, examples (N-Queens problem, Sum of subsets) • Branch and Bound: Concept, examples (Traveling Salesman Problem) • String Matching Algorithms: Naive algorithm, Rabin-Karp algorithm		

Learning Experience for Fundamentals of Algorithm Design & Analysis

Classroom Learning Experience

- **Interactive Lectures and Discussions:** This course offers interactive lectures that encourage active participation and discussions, allowing students to deepen their understanding of complex algorithmic concepts and clarify doubts in real-time.

- **Problem-Solving Sessions:** Regular problem-solving sessions are integrated into the course to help students apply theoretical concepts to practical problems. These sessions reinforce learning by providing hands-on experience in designing and analyzing algorithms.

- **Case Studies and Real-World Applications:** The course includes case studies and examples from various domains to illustrate the real-world applications of different algorithms. This approach helps students understand the practical significance of algorithm design and analysis.

- **Collaborative Learning:** Students will work in groups on certain assignments and projects, promoting collaborative learning and the exchange of ideas. This collaborative approach mirrors the teamwork often required in professional settings.

- **Use of Visual Tools:** Visual tools and software will be utilized to help students better understand algorithm behavior and performance. These tools provide a graphical representation of algorithms, making complex concepts easier to grasp.

- **Continuous Assessment and Feedback:** Students will receive continuous feedback through quizzes, assignments, and project evaluations. This feedback is designed to help them improve their understanding and performance throughout the course.

Outside Classroom Learning Experience

- **Algorithm Design Projects:** Students will engage in mini-projects focused on the design and implementation of algorithms. These projects provide an opportunity to work on real-world problems, fostering creativity and innovation in algorithm development.

- **Performance Analysis and Optimization:** The course emphasizes the importance of performance analysis and optimization of algorithms. Students will learn how to analyze the time and space complexity of their solutions and optimize them for better efficiency.

- **Self-Study and Research:** Encourage students to independently explore advanced algorithmic concepts, such as dynamic programming, greedy algorithms, and graph theory, through self-study and research.

- **Peer Review:** Organize peer review sessions where students critique and provide feedback on each other's algorithmic solutions, fostering a deeper understanding of optimization techniques and alternative approaches.
- **Final Project and Presentation:** The course culminates in a final project where students apply all the knowledge and skills they have acquired. They will design, implement, and present an algorithmic solution to a complex problem, demonstrating their mastery of the subject.

Text Books

- "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
- "Algorithm Design" by Jon Kleinberg and Éva Tardos

Reference Books

- "Algorithms" by Robert Sedgewick and Kevin Wayne
- "The Algorithm Design Manual" by Steven S. Skiena

Additional Readings

Self-Learning Components:

1. Link to Algorithms course on NPTEL: https://nptel.ac.in/courses/106/106/106106131/
2. Link to Algorithms on Coursera: https://www.coursera.org/courses?query=algorithms
3. Link to Algorithms resources: https://www.geeksforgeeks.org/fundamentals-of-algorithms
4. Link to Algorithms tutorials: https://www.tutorialspoint.com/data_structures_algorithms/index.htm
5. Link to Algorithms lectures: https://ocw.mit.edu/courses/electrical-engineering-and-c 6-006-introduction-to-algorithms-fall-2011/

Introduction to Database Management Systems

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Database Management Systems	ENBC204	3-1-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of database management systems, focusing on database architecture, relational query languages, transaction processing, and database security. The course is divided into 4 units:

1. Introduction
2. Relational Query Languages
3. Transaction Processing and Storage Strategies
4. Advanced Topics and Database Security

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the basic concepts and architecture of database management systems.
CO 2	Using relational query languages to interact with databases.
CO 3	Managing transactions and apply storage strategies in database systems.
CO 4	Ensuring database security and explore advanced database topics.

A student is expected to have learned concepts and demonstrated abilities or skills related to database management systems at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction**	**No. of hours: 12**
Content:		
• Introduction to DBMS: Overview, benefits, and applications • Database System Architecture: Schemas, Instances, Data abstraction, data models (network model, relational model, object-oriented data model) • Entity-Relationship Model: Entity Types, Entity Sets, Attributes, and Keys, Relationship Types, ER diagrams • Integrity Constraints: Primary key, foreign key, unique, not null, check constraints		
Unit Number: 2	**Title: Relational Query Languages**	**No. of hours: 8**
Content:		
• Relational Database Design, Relational query languages, Relational algebra • SQL: DDL (Data Definition Language), DML (Data Manipulation Language), DCL (Data Control Language) • Query Processing and Optimization: Evaluation of relational algebra expressions, query optimization algorithms • Database Design: Functional dependencies, normalization (1NF, 2NF, 3NF, BCNF) • Overview of MySQL, Oracle, SQL Server		
Unit Number: 3	**Title: Transaction Processing and Storage Strategies**	**No. of hours: 12**
Content:		
• Transaction Management: ACID properties, transaction states, serializability • Concurrency Control: Lock-based protocols, timestamp-based protocols • Database Recovery: Recovery concepts, recovery techniques • Storage Strategies: File organization, indexing (single-level, multi-level), B-tree, B+ tree, hashing		
Unit Number: 4	**Title: Advanced Topics and Database Security**	**No. of hours: 8**
Content:		

- Database Security: Authentication, authorization, access control
- Intrusion Detection: Techniques and tools, SQL injection prevention
- Introduction to Object-oriented databases and web databases
- Introduction to Distributed Databases: Concepts, architecture
- Introduction to Data Warehousing and Data Mining: Concepts, architecture

Learning Experience for Introduction to Database Management Systems

Classroom Learning Experience

- **Interactive Lectures and In-Class Discussions:** The course includes interactive lectures that encourage students to engage with fundamental concepts of database management. These sessions are designed to provoke thought and foster a deep understanding of database architecture, relational models, and more.
- **Hands-On SQL Workshops:** Practical, hands-on workshops focusing on SQL provide students with the opportunity to write and optimize queries in a real-time environment. These workshops help bridge the gap between theory and practical application, enhancing student confidence in database management.
- **Case Studies and Practical Applications:** Through the analysis of case studies, students explore real-world applications of database management systems in various domains. This approach helps in understanding the relevance of database concepts in different industries and enhances problem-solving skills.
- **Use of Database Management Tools:** The course incorporates the use of popular database management tools like MySQL, Oracle, and SQL Server. These tools are used in lab sessions to provide students with a hands-on understanding of database operations, query optimization, and transaction processing.
- **Regular Assessments and Feedback:** Continuous assessment through quizzes, assignments, and lab exercises ensures that students receive timely feedback on their understanding of the course material. This helps in identifying areas of improvement and reinforcing learning.

Outside Classroom Learning Experience

- **Collaborative Group Projects:** Students will participate in group projects that simulate real-world database design and management tasks. These collaborative efforts allow students to apply concepts such as ER modeling, normalization, and transaction management in a team setting, mirroring industry practices.
- **Real-World Scenario Simulations:** Simulations of real-world scenarios, such as transaction processing and database recovery, are conducted to help students understand the challenges and solutions in managing large-scale databases. These simulations prepare students for practical challenges they may face in their careers.

- **Self-Study and Research:** Encourage students to independently explore advanced database concepts, including distributed databases, NoSQL databases, and cloud-based database management, through additional readings and tutorials.

- **Final Project and Presentation:** The course culminates in a final project where students design and implement a database system. This project, accompanied by a presentation, allows students to demonstrate their comprehensive understanding of the course material and their ability to apply it in a practical context.

- **Online Collaboration and Peer Review:** Facilitate online forums where students can collaborate, share insights, and review each other's database designs, promoting peer-to-peer learning and constructive feedback.

Text Books

- "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, and S. Sudarshan

- "Fundamentals of Database Systems" by Ramez Elmasri and Shamkant B. Navathe

Reference Books

- "An Introduction to Database Systems" by C.J. Date

- "Database Management Systems" by Raghu Ramakrishnan and Johannes Gehrke

Additional Readings

Self-Learning Components:

1. Link to Database Management Systems course on NPTEL: https://nptel.ac.in/courses/106/106/106106220/

2. Link to Database Management Systems on Coursera: https://www.coursera.org/courses?query=database%20management

3. Link to Database Management Systems resources: https://www.geeksforgeeks.org/dbms/

4. Link to Database Management Systems tutorials: https://www.tutorialspoint.com/dbms/index.htm

5. Link to Database Management Systems lectures: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-830-database-systems-fall-2012/

Introduction to Computer Networks

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Computer Networks	ENBC206	3-1-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of computer networks, focusing on the evolution of networking, data link layer, network layer, transport layer, and application layer. The course is divided into 4 units:

1. Evolution of Computer Networking
2. Data Link Layer
3. Introduction to Network Layer and Transport Services
4. Application Layer

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the basic components and evolution of computer networks.
CO 2	Explaining the data link layer and its protocols for error detection and correction.
CO 3	Describing the network layer, IP addressing, and transport services.
CO 4	Understanding the application layer protocols and their functionalities.

A student is expected to have learned concepts and demonstrated abilities or skills related to computer networks at the end of the course.

Course Outline

Unit Number: 1	Title: Evolution of Computer Networking	No. of hours: 10
Content:		
• Data communication components: Representation of data and its flow, Networks, Various connection topologies • Protocols and standards, OSI model, Access networks, physical media • Packet switching, Circuit switching, Network of networks, Packet delay and loss, End-to-end throughput		
Unit Number: 2	**Title: Data Link Layer**	**No. of hours: 10**
Content:		
• 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 • Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA/CD		
Unit Number: 3	**Title: Introduction to Network Layer and Transport Services**	**No. of hours: 10**
Content:		
• Network Layer: Switching, Logical addressing – IPV4, IPV6 • Address mapping – ARP, RARP, BOOTP, and DHCP • Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Congestion Control • Quality of Service: QoS improving techniques - Leaky Bucket and Token Bucket algorithm		
Unit Number: 4	**Title: Application Layer**	**No. of hours: 10**
Content:		
• Application Layer: Domain Name Space (DNS), TELNET, EMAIL, File Transfer Protocol (FTP), WWW, HTTP, SNMP • Bluetooth, Firewalls, Basic concepts of Cryptography		

Learning Experience for Introduction to Computer Networks

Classroom Learning Experience

- **Interactive Lectures and Discussions:** The course begins with interactive lectures, where fundamental networking concepts are introduced through engaging discussions. These sessions are designed to help students build a solid understanding of the evolution of computer networks, their architecture, and essential protocols.

- **Hands-On Lab Sessions:** Throughout the course, students participate in lab sessions that provide hands-on experience with network simulations and configurations. Using tools like Cisco Packet Tracer and Wireshark, students explore network topologies, configure network devices, and analyze packet flows in real-time.

- **Case Studies and Real-World Applications:** The course includes analysis of case studies that demonstrate the application of networking concepts in real-world situations. These case studies provide insights into the challenges and solutions in network design, security, and management across various industries.

- **Use of Networking Tools and Technologies:** The course incorporates the use of industry-standard networking tools and technologies. Students gain practical experience in configuring and managing network protocols, addressing schemes, and security mechanisms, preparing them for the demands of the industry.

- **Simulation-Based Learning:** Simulation tools are used to create virtual network environments where students can experiment with different network configurations and protocols. This approach enhances understanding of how networks operate and how various components interact within a network.

- **Continuous Assessment and Feedback:** Students receive regular assessments through quizzes, assignments, and lab exercises. Continuous feedback is provided to ensure students understand key concepts and can apply them effectively, allowing for ongoing improvement throughout the course.

Outside Classroom Learning Experience

- **Group Projects and Peer Learning:** Collaborative group projects are an integral part of the learning experience. Students work together to design and implement small-scale network models, applying the concepts learned in class to real-world scenarios. Peer learning is encouraged to foster teamwork and enhance problem-solving skills.

- **Self-Study and Research:** Encourage students to independently explore advanced networking topics such as routing protocols, network security, and wireless networks through self-study and research to deepen their understanding.

- **Final Project and Presentation:** The course culminates in a final project where students design and implement a comprehensive network solution. This project allows students to integrate their learning into a practical application, demonstrating their ability to design, configure, and troubleshoot computer networks effectively.

- **Online Collaboration and Peer Review:** Facilitate online forums where students can collaborate on network design challenges, share insights, and review each other's solutions, promoting peer-to-peer learning and constructive feedback.

- **Practice Labs and Simulations:** Provide supplementary lab exercises and simulations for students to practice network configurations and troubleshoot potential issues, reinforcing concepts outside of regular class hours.

Text Books

- "Data Communication and Networking" by Behrouz A. Forouzan, 5th Edition, McGraw-Hill, 2012

- "Computer Networks" by Andrew S. Tanenbaum and David J. Wetherall, Pearson, 5th Edition, 2010

- "Computer Networking: A Top-Down Approach" by James F. Kurose and Keith W. Ross, 5th Edition, Pearson

Reference Books

- "Introduction to Computer Networks" by Larry L. Peterson and Bruce S. Davie

- "Networking: A Beginner's Guide" by Bruce Hallberg

Additional Readings

Self-Learning Components:

1. Link to Computer Networks course on NPTEL: https://nptel.ac.in/courses/106/106/106106089/

2. Link to Computer Networks on Coursera: https://www.coursera.org/courses?query=computer%20networks

3. Link to Computer Networks resources: https://www.geeksforgeeks.org/computer-network-t

4. Link to Computer Networks tutorials: https://www.tutorialspoint.com/computer_fundamentals/computer_networking.htm

5. Link to Computer Networks lectures: https://ocw.mit.edu/courses/electrical-engineering 6-033-computer-system-engineering-spring-2018/lecture-videos/

Introduction to Database Management Systems Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Database Management Systems Lab	ENBC252	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

COs	Statements
CO 1	Understanding the fundamental concepts and architecture of database management systems.
CO 2	Developing proficiency in writing and optimizing SQL queries.
CO 3	Implementing transaction management and understand concurrency control mechanisms.
CO 4	Exploring advanced database topics including security, object-oriented databases, and data warehousing.

S.N	Lab Task	Mapped CO/COs
1	Write a program to understand the basic concepts and architecture of DBMS.	CO1
2	Develop an ER diagram for a given scenario.	CO1
3	Implement database schema based on ER diagram.	CO1
4	Write SQL queries to create and manipulate database tables using DDL commands.	CO2
5	Develop SQL queries for data insertion, updating, and deletion using DML commands.	CO2
6	Implement integrity constraints such as primary key, foreign key, unique, and not null.	CO2
7	Write complex SQL queries using joins, subqueries, and set operations.	CO2
8	Develop queries for aggregate functions and grouping of data.	CO2
9	Implement stored procedures and functions in SQL.	CO2
10	Write SQL queries to implement triggers and views.	CO2
11	Perform normalization up to BCNF for a given database schema.	CO2

S.N	Lab Task	Mapped CO/COs
12	Write queries to perform transaction management using ACID properties.	CO3
13	Implement concurrency control mechanisms using lock-based protocols.	CO3
14	Develop a program to demonstrate database recovery techniques.	CO3
15	Implement file organization and indexing techniques like B-tree and B+ tree.	CO3
16	Write a program to demonstrate hash-based indexing.	CO3
17	Implement database security mechanisms for authentication and authorization.	CO4
18	Develop a program to prevent SQL injection attacks.	CO4
19	Explore the concepts of object-oriented databases by implementing a basic object-oriented schema.	CO4
20	Develop a mini-project to demonstrate the concepts of data warehousing and data mining.	CO4
1	**Library Management System:** Develop a library management system using database concepts learned, including ER diagrams, SQL queries, and normalization.	CO1, CO2
2	**Hospital Management System:** Create a hospital management system with advanced SQL queries, transaction management, and security features.	CO2, CO3, CO4
3	**Online Retail Store:** Implement an online retail store database with product catalogs, customer orders, and inventory management using SQL and indexing techniques.	CO2, CO3
4	**Employee Management System:** Develop an employee management system incorporating transaction management, concurrency control, and recovery techniques.	CO3
5	**Student Information System:** Create a student information system with data warehousing and mining functionalities to analyze student performance data.	CO4

Online Learning Resources

- **GeeksforGeeks:** Tutorials and articles on database management systems.
  https://www.geeksforgeeks.org/dbms/
- **TutorialsPoint:** Comprehensive guides on database management systems and SQL.
  https://www.tutorialspoint.com/dbms/index.htm
- **NPTEL:** Video lectures and course materials on database management systems.
  https://nptel.ac.in/courses/106/106/106106093/

- **Coursera:** Courses on database management systems from leading universities. https://www.coursera.org/courses?query=dbms

Fundamentals of Algorithm Design & Analysis Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Fundamentals of Algorithm Design & Analysis Lab	ENBC254	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

COs	Statements
CO 1	Understanding the basic concepts of algorithms and their importance in problem-solving.
CO 2	Analyzing the complexity of algorithms using asymptotic notations and recurrence relations.
CO 3	Implementing algorithms using divide and conquer, greedy, and dynamic programming techniques.
CO 4	Developing and apply graph algorithms and understand advanced algorithms such as backtracking and branch and bound.

S.N	Lab Task	Mapped CO/COs
1	Write a program to understand the basic concepts and importance of algorithms.	CO1
2	Develop a program to analyze the time and space complexity of an algorithm.	CO2
3	Implement sorting algorithms and analyze their time complexities.	CO2
4	Solve recurrence relations using substitution and recursion tree methods.	CO2
5	Implement merge sort and quick sort using the divide and conquer method.	CO3
6	Write a program to perform binary search using the divide and conquer technique.	CO3
7	Develop a program for the fractional knapsack problem using the greedy algorithm.	CO3
8	Implement the activity selection problem using the greedy approach.	CO3

S.N	Lab Task	Mapped CO/COs
9	Write a program for the longest common subsequence problem using dynamic programming.	CO3
10	Implement the 0/1 knapsack problem using dynamic programming.	CO3
11	Develop a program to represent a graph using adjacency matrix and adjacency list.	CO4
12	Implement depth first search (DFS) and breadth first search (BFS) algorithms for graph traversal.	CO4
13	Write a program to find the shortest path using Dijkstra's algorithm.	CO4
14	Implement the Bellman-Ford algorithm for shortest path determination.	CO4
15	Develop a program to find the minimum spanning tree using Kruskal's algorithm.	CO4
16	Implement Prim's algorithm to find the minimum spanning tree.	CO4
17	Write a program to solve the N-Queens problem using backtracking.	CO4
18	Develop a program to solve the sum of subsets problem using backtracking.	CO4
19	Implement the Traveling Salesman Problem using the branch and bound technique.	CO4
20	Write a program for string matching using the naive algorithm and Rabin-Karp algorithm.	CO4
1	**Sorting Algorithm Analysis:** Develop a project to compare and analyze various sorting algorithms (merge sort, quick sort, bubble sort, etc.) in terms of their time and space complexities.	CO2
2	**Graph Traversal Visualizer:** Create a visual representation tool for graph traversal algorithms (DFS, BFS) to demonstrate their workings and applications.	CO4
3	**Dynamic Programming Solver:** Implement a tool that solves dynamic programming problems (0/1 knapsack, longest common subsequence) and provides step-by-step solutions.	CO3
4	**Shortest Path Finder:** Develop a project to find the shortest path in a graph using Dijkstra's and Bellman-Ford algorithms and compare their performance.	CO4
5	**Algorithm Efficiency Analyzer:** Create a project to analyze the efficiency of different algorithmic approaches (divide and conquer, greedy, dynamic programming) for solving common problems.	CO2, CO3, CO4

Online Learning Resources

- **GeeksforGeeks:** Tutorials and articles on algorithm design and analysis. https://www.geeksforgeeks.org/fundamentals-of-algorithms/
- **Coursera:** Courses on algorithms from leading universities. https://www.coursera.org/courses?query=algorithms
- **Khan Academy:** Lessons on algorithm design and analysis. https://www.khanacademy.org/computing/computer-science/algorithms
- **MIT OpenCourseWare:** Free course materials on algorithms. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-006-introduction-to-algorithms-fall-2011/

Introduction to Computer Networks Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Introduction to Computer Networks Lab	ENBC256	0-0-2	1
Type of Course:	Major		

Defined Course Outcomes

COs	Statements
CO 1	Understanding the basic concepts and evolution of computer networking.
CO 2	Implementing error detection and correction, flow control, and multiple access protocols.
CO 3	Developing a comprehensive understanding of network and transport layer services and protocols.
CO 4	Exploring and implement various application layer protocols and basic network security concepts.

S.N	Lab Task	Mapped CO/COs
1	Write a program to understand the basic concepts and evolution of computer networks.	CO1
2	Develop a simulation for data communication components and data flow representation.	CO1
3	Implement and analyze different network topologies.	CO1
4	Write a program to demonstrate the OSI model and its layers.	CO1
5	Develop a simulation for packet switching and circuit switching techniques.	CO1
6	Implement error detection techniques such as parity check, checksum, and CRC.	CO2
7	Write a program to implement error correction techniques using Hamming code.	CO2
8	Develop a simulation for flow control protocols: Stop and Wait, Go-Back-N ARQ, and Selective Repeat ARQ.	CO2
9	Implement multiple access protocols: Pure ALOHA, Slotted ALOHA, and CSMA/CD.	CO2
10	Write a program to simulate IP addressing and subnetting.	CO3

S.N	Lab Task	Mapped CO/COs
11	Develop a simulation for address mapping protocols: ARP and RARP.	CO3
12	Implement the basics of the transport layer: UDP and TCP protocols.	CO3
13	Write a program to demonstrate congestion control algorithms.	CO3
14	Develop a simulation for QoS techniques: Leaky Bucket and Token Bucket algorithms.	CO3
15	Implement a DNS lookup program.	CO4
16	Write a program to simulate email protocols (SMTP, POP3, IMAP).	CO4
17	Develop a simulation for file transfer using FTP.	CO4
18	Implement a simple web server and client using HTTP.	CO4
19	Write a program to demonstrate the basics of network security: cryptographic algorithms.	CO4
20	Develop a firewall simulation program.	CO4
1	**Network Topology Visualizer:** Develop a project to visualize and analyze different network topologies and their performance.	CO1
2	**Network Protocol Simulator:** Create a simulation tool to demonstrate the working of various network protocols (ARP, RARP, TCP, UDP).	CO2, CO3
3	**QoS and Congestion Control Analyzer:** Implement a project to analyze the impact of QoS techniques and congestion control algorithms on network performance.	CO3
4	**Network Security Suite:** Develop a suite of programs to implement basic network security measures including cryptography and firewall.	CO4
5	**Application Layer Protocol Simulator:** Create a simulation for various application layer protocols such as HTTP, FTP, DNS, and Email.	CO4

Online Learning Resources

- **GeeksforGeeks:** Tutorials and articles on computer networks and protocols.
  https://www.geeksforgeeks.org/computer-network-tutorials/
- **Coursera:** Courses on computer networks from leading universities.
  https://www.coursera.org/courses?query=computer%20networks
- **Khan Academy:** Lessons on computer networks.
  https://www.khanacademy.org/computing/computer-science/internet-intro
- **Cisco Networking Academy:** Courses and certifications on networking.
  https://www.netacad.com/

Life Skills for Professionals-II

Program Name:	B.Sc (Hons.) Data Science		
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):	None		

Course Perspective: This course aims to further develop essential life skills for professionals, focusing on personality improvement, arithmetic, presentation skills, and leadership skills. The course is divided into 5 units:

1. Personality Improvement
2. Ratio and its Application
3. Arithmetic
4. Presentation Skills
5. Leadership Skills

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Enhancing personality traits and interpersonal communication skills.
CO 2	Applying concepts of ratio and its applications in problem-solving.
CO 3	Understanding and solve arithmetic problems efficiently.
CO 4	Developing effective presentation skills and professional etiquette.
CO 5	Cultivating leadership skills for personal and professional growth.

A student is expected to have learned concepts and demonstrated abilities or skills related to life skills for professionals at the end of the course.

Course Outline

Unit Number: 1	**Title: Personality Improvement**	**No. of hours: 6**
Content:		
• 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 and its Application**	**No. of hours: 6**
Content:		
• Time and Work • Time and Distance • Train, Boat and Stream problems • Permutation and Combination • Probability		
Unit Number: 3	**Title: Arithmetic**	**No. of hours: 6**
Content:		
• Inequalities • Logarithms • Progressions • Mensuration • BODMAS		
Unit Number: 4	**Title: Presentation Skills**	**No. of hours: 6**
Content:		

• Presentation Skills • Telephone Etiquettes • LinkedIn Profile and Professional Networking • Video Resumes and Mock Interview Sessions		
Unit Number: 5	**Title: Leadership Skills**	**No. of hours: 6**
Content:		
• Nurturing future leaders • Increasing productivity of the workforce • Imparting self-leadership • Executive leadership		

Learning Experience for Life Skills for Professionals-II

Classroom Learning Experience

- **Interactive Workshops:** The course emphasizes interactive workshops where students actively engage in activities aimed at improving personality traits, communication skills, and professional etiquette. Role-playing scenarios and real-life simulations are used to enhance learning outcomes.

- **Group Discussions and Peer Feedback:** Students participate in group discussions that focus on the application of arithmetic concepts and problem-solving techniques. Peer feedback sessions are integrated into the learning process to foster collaboration and self-improvement.

- **Presentation and Communication Drills:** The course includes extensive practice in presentation skills, where students prepare and deliver presentations on various topics. Communication drills, including telephone etiquettes and mock interviews, are conducted to build confidence and professionalism.

- **Leadership Development Activities:** Leadership skills are cultivated through structured activities designed to nurture future leaders. These activities include leadership exercises, team-building tasks, and executive leadership training, all aimed at increasing productivity and fostering self-leadership.

- **Continuous Assessment and Personal Reflection:** Students undergo continuous assessment through quizzes, assignments, and participation in class activities. Personal reflection sessions are encouraged, where students assess their progress in personality development and leadership growth.

Outside Classroom Learning Experience

- **Practical Exercises and Case Studies:** Practical exercises in topics such as ratio applications, time management, and leadership skills are conducted. These exercises are supplemented with case studies that provide real-world context, allowing students to apply their learning to professional scenarios.
- **Mentorship and Guidance:** The course provides opportunities for students to receive mentorship from instructors and industry professionals. This guidance helps students refine their skills and prepares them for the demands of the professional world.
- **Self-Study and Personal Development:** Encourage students to engage in self-study on topics such as conflict resolution, emotional intelligence, and personal branding to enhance their professional and personal growth.
- **Final Project and Presentation:** The course culminates in a final project where students apply their life skills in a comprehensive task, such as creating a professional presentation or conducting a leadership exercise. This project is presented and critiqued, providing valuable feedback for future improvement.
- **Peer Collaboration and Review:** Facilitate peer collaboration and review sessions where students provide constructive feedback on each other's progress in communication and leadership tasks, encouraging mutual growth and improvement.

Text Books

- "Personality Development and Soft Skills" by Barun K. Mitra
- "Business Communication and Personality Development" by C.S. Rayudu

Reference Books

- "Developing Communication Skills" by Krishna Mohan and Meera Banerji
- "The Time Trap: The Classic Book on Time Management" by R. Alec Mackenzie

Additional Readings

Self-Learning Components:

1. Link to Communication Skills course on NPTEL: https://nptel.ac.in/courses/109/104/109104031/
2. Link to Soft Skills on Coursera: https://www.coursera.org/courses?query=soft%20skills
3. Link to Time Management resources: https://www.mindtools.com/pages/main/newMN_HTE.htm
4. Link to Presentation Skills tutorials: https://www.skillsyouneed.com/present/presentation-skills.html
5. Link to Leadership Skills lectures: https://www.coursera.org/learn/leadership-skills

Minor Project-II

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Minor Project-II	SIBC252	0-0-0	2
Type of Course:	Proj		
Pre-requisite(s):	None		

Duration

The minor project will last for three months.

Project Requirements

1. **Understanding of Societal Problems:**
   - Students must have a basic understanding of societal problems, the concerned domain, and relevant issues.
2. **Critical Thinking and Problem Formulation:**
   - Students are expected to think critically about formulated problems and review existing solutions.
3. **Data Gathering and ETL Activities:**
   - Students should gather relevant data and perform ETL (Extract, Transform, Load) activities to prepare the data for analysis.
4. **Innovation and Entrepreneurship Focus:**
   - Students should develop innovative ideas or entrepreneurial solutions to address the identified problems.
5. **Implementation (Optional):**
   - While implementation of the proposed solutions is encouraged, it is not strictly required. The focus should be on idea development.

Guidelines

1. **Project Selection:**
   - Choose a societal problem relevant to the field of computer science and engineering.
   - Ensure the problem is specific and well-defined.
2. **Literature Review:**

- Conduct a thorough review of existing literature and solutions related to the problem.
- Identify gaps in existing solutions and potential areas for further investigation.

3. **Data Gathering and ETL:**
    - Collect relevant data from various sources.
    - Perform ETL activities to clean, transform, and load the data for analysis.
4. **Analysis and Critical Thinking:**
    - Analyze the problem critically, considering various perspectives and implications.
    - Evaluate the effectiveness and limitations of current solutions.
5. **Innovation and Idea Development:**
    - Develop innovative ideas or entrepreneurial solutions to address the identified problem.
    - Focus on the feasibility, impact, and potential of the proposed solutions.
6. **Documentation:**
    - Document the entire process, including problem identification, literature review, data gathering, ETL activities, analysis, and ideas.
    - Use appropriate formats and standards for documentation.
7. **Presentation:**
    - Prepare a presentation summarizing the problem, existing solutions, data analysis, and proposed ideas.
    - Ensure the presentation is clear, concise, and well-structured.

Evaluation Criteria for Minor Project (Out of 100 Marks)

1. **Understanding of Societal Problems (15 Marks):**
    - Comprehensive understanding of the problem: 15 marks
    - Good understanding of the problem: 12 marks
    - Basic understanding of the problem: 9 marks
    - Poor understanding of the problem: 5 marks
    - No understanding of the problem: 0 marks
2. **Critical Thinking and Analysis (20 Marks):**
    - Exceptional critical thinking and analysis: 20 marks
    - Good critical thinking and analysis: 15 marks
    - Moderate critical thinking and analysis: 10 marks
    - Basic critical thinking and analysis: 5 marks
    - Poor critical thinking and analysis: 0 marks

3. **Data Gathering and ETL Activities (20 Marks):**
    - Comprehensive and effective ETL activities: 20 marks
    - Good ETL activities: 15 marks
    - Moderate ETL activities: 10 marks
    - Basic ETL activities: 5 marks
    - Poor ETL activities: 0 marks
4. **Innovation and Idea Development (25 Marks):**
    - Highly innovative and feasible ideas: 25 marks
    - Good innovative ideas: 20 marks
    - Moderate innovative ideas: 15 marks
    - Basic innovative ideas: 10 marks
    - Poor innovative ideas: 5 marks
    - No innovative ideas: 0 marks
5. **Documentation Quality (10 Marks):**
    - Well-structured and detailed documentation: 10 marks
    - Moderately structured documentation: 7 marks
    - Poorly structured documentation: 3 marks
    - No documentation: 0 marks
6. **Presentation (10 Marks):**
    - Clear, concise, and engaging presentation: 10 marks
    - Clear but less engaging presentation: 7 marks
    - Somewhat clear and engaging presentation: 3 marks
    - Unclear and disengaging presentation: 0 marks

Total: 100 Marks

Course Outcomes

By the end of this course, students will be able to:

- **Understand Societal Issues:**
    - Demonstrating a basic understanding of societal problems and relevant issues within the concerned domain.
- **Critical Thinking:**
    - Thinking critically about formulated problems and existing solutions.
- **Data Management:**
    - Gathering relevant data and perform ETL activities to prepare the data for analysis.

- **Innovation and Entrepreneurship:**
  - Developing innovative ideas or entrepreneurial solutions to address identified problems.
- **Literature Review:**
  - Conducting comprehensive literature reviews and identify gaps in existing solutions.
- **Documentation:**
  - Documenting findings and analysis in a well-structured and appropriate format.
- **Presentation Skills:**
  - Presenting findings and analysis effectively, using clear and concise communication skills.
- **Problem Analysis:**
  - Analyzing problems from various perspectives and evaluate the effectiveness of existing solutions.
- **Professional Development:**
  - Developing skills in research, analysis, documentation, and presentation, contributing to overall professional growth.

Competitive Coding Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Competitive Coding Lab	SEC036	0-0-4	2
Type of Course:	SEC		

Defined Course Outcomes

COs	Statements
CO 1	Demonstrating the ability to implement and analyze basic data structures and algorithms for various computational problems.
CO 2	Developing and optimizing advanced data structures and their associated algorithms to solve complex problems efficiently.
CO 3	Applying dynamic programming and greedy algorithms to solve optimization problems and analyze their computational complexity.
CO 4	Implementing and evaluating graph algorithms for various real-world applications, focusing on shortest paths, spanning trees, and string matching problems.

S.N	Lab Task	Mapped CO/COs
1	Two Sum Problem: Find indices of two numbers that add up to a target number.	CO1
2	Reverse Integer: Reverse the digits of a given 32-bit signed integer.	CO1
3	Longest Substring Without Repeating Characters: Find the length of the longest substring without repeating characters.	CO1
4	Median of Two Sorted Arrays: Find the median of two sorted arrays.	CO1
5	Longest Palindromic Substring: Return the longest palindromic substring.	CO1
6	Zigzag Conversion: Convert a string into a zigzag pattern on a given number of rows.	CO1
7	Container With Most Water: Find two lines that together with the x-axis form a container that holds the most water.	CO1
8	Integer to Roman: Convert an integer to a Roman numeral.	CO1
9	Roman to Integer: Convert a Roman numeral to an integer.	CO1
10	Valid Parentheses: Determine if a string with characters (,), , , [, and] is valid.	CO1

S.N	Lab Task	Mapped CO/COs
11	Merge Two Sorted Lists: Merge two sorted linked lists into a single sorted list.	CO1
12	Remove Nth Node From End of List: Remove the nth node from the end of a linked list.	CO1
13	Valid Palindrome: Determine if a string is a palindrome, considering only alphanumeric characters.	CO1
14	Longest Common Prefix: Find the longest common prefix among an array of strings.	CO1
15	3Sum: Find all unique triplets in an array that sum up to zero.	CO1
16	Letter Combinations of a Phone Number: Return all possible letter combinations that a number could represent.	CO1
17	Generate Parentheses: Generate all combinations of well-formed parentheses.	CO1
18	Merge k Sorted Lists: Merge k sorted linked lists into a single sorted linked list.	CO1
19	Group Anagrams: Group anagrams together from an array of strings.	CO1
20	Maximum Subarray: Find the contiguous subarray with the largest sum.	CO1
21	Coin Change: Compute the fewest number of coins needed to make up a given amount.	CO1
22	Longest Increasing Subsequence: Return the length of the longest strictly increasing subsequence.	CO1
23	Edit Distance: Return the minimum number of operations required to convert one string to another.	CO1
24	Shortest Path in Binary Matrix: Return the length of the shortest clear path in an n x n binary matrix.	CO1
25	Dijkstra's Algorithm: Find the shortest path between nodes in a graph using Dijkstra's algorithm.	CO1
26	Kruskal's Algorithm: Find the minimum spanning tree of a given graph using Kruskal's algorithm.	CO1
27	Knapsack Problem: Find the maximum total value in a knapsack given weights and values of n items.	CO1
28	Bellman-Ford Algorithm: Find the shortest path from a single source vertex to all other vertices in a weighted graph.	CO1
29	Travelling Salesman Problem: Find the shortest possible route that visits each city exactly once and returns to the origin city.	CO1
30	Rabin-Karp Algorithm: Implement the Rabin-Karp algorithm for substring search.	CO1

Online Learning Resources

- **GeeksforGeeks:** Tutorials and articles on competitive coding problems and solutions.
  https://www.geeksforgeeks.org/competitive-programming/
- **LeetCode:** Platform for practicing coding problems and participating in coding contests.
  https://leetcode.com/
- **HackerRank:** Coding practice platform with problems from various domains.
  https://www.hackerrank.com/
- **Codeforces:** Online platform for competitive programming and coding contests.
  https://codeforces.com/

Competitive Coding Bootcamp- II

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Competitive Coding Bootcamp-II	-	2-0-0	0
Type of Course:	Audit		
Pre-requisite(s):	None		

Course Outcomes (COs):

- **CO1:** Understanding fundamental tree structures, including AVL trees, and their balancing mechanisms.
- **CO2:** Applying graph representations (adjacency matrix and adjacency list) to solve basic graph traversal problems.
- **CO3:** Implementing shortest path algorithms such as Dijkstra's algorithm and Bellman-Ford.
- **CO4:** Exploring dynamic programming concepts, including memoization and tabulation, to solve classic problems.

Course Outline

Unit No.	Title	No. of hours
1	**Object-Oriented Programming Concepts** **Content:** • OOP Basics: Encapsulation, Inheritance, Polymorphism, Class Design and Object Creation • C++ OOP Concepts: Classes and Objects, Constructors/Destructors, Operator Overloading, Inheritance, Virtual Functions • Java OOP Concepts: Classes and Objects, Constructors, Method Overloading, Inheritance, Polymorphism, Abstract Classes, Interfaces • Python OOP Concepts: Classes and Objects, Constructors, Method Overloading (via default arguments), Inheritance, Polymorphism, Multiple Inheritance	8

Unit No.	Title	No. of hours
2	**Linked Lists, Stacks and Queues** **Content:** • Linked Lists: Singly and doubly linked lists: Creation, insertion, deletion, traversal. • Stacks and Queues: Stack operations: Push, pop, top, isEmpty. Queue operations: Enqueue, dequeue, front, isEmpty. • Applications: Parentheses matching, queue-based problems (e.g., sliding window problems from LeetCode).	8
3	**Sorting & Searching** **Content:** • Basic Sorting Algorithms: Implementing Bubble Sort, Selection Sort, Insertion Sort. • Advanced Sorting Algorithms: Implementing Merge Sort, Quick Sort, Heap Sort. • Binary Search: Implementing binary search for sorted arrays.	8
4	**Trees** **Content:** • Basic Tree Concepts: Introduction to tree terminology and operations, Tree Traversals: Preorder, inorder, postorder. • Binary Trees: Basic operations on binary trees: Insertion, deletion, searching. • Binary Search Trees: Understanding BST properties: Every left subtree is smaller, and every right subtree is larger.	6

Lab Experiments

Problem Statement	Mapped COs
Design a Parking Lot System using OOP concepts (Classes, Objects, Inheritance, Polymorphism).	CO1
Implement a Student Management System with Classes and Objects.	CO1
Create a Banking System with Constructors and Destructors.	CO1
Implement Method Overloading and Overriding in a chosen language.	CO1
Demonstrate Multiple Inheritance with a practical example.	CO1
Design a Library Management System with OOP principles.	CO1
Use Virtual Functions to implement polymorphism.	CO1
Implement Abstract Classes and Interfaces for a Payment System.	CO1

Problem Statement	Mapped COs
Create a simple calculator with Operator Overloading.	CO1
Build a Polymorphic class hierarchy (e.g., Shapes) to showcase polymorphism.	CO1
Reverse a Linked List (Iterative and Recursive).	CO2
Detect a cycle in a Linked List using Floyd's Cycle-Finding Algorithm.	CO2
Implement basic operations on a Singly Linked List (Insertion, Deletion).	CO2
Implement and traverse a Doubly Linked List.	CO2
Implement Stack operations (Push, Pop, Top) using arrays or linked lists.	CO2
Implement Queue operations (Enqueue, Dequeue, Front) using arrays or linked lists.	CO2
Solve the Parentheses Matching problem using Stack.	CO2
Implement Sliding Window Maximum using Deque.	CO2
Check for balanced parentheses using Stack.	CO2
Design a Circular Queue using linked list or array.	CO2
Implement Bubble Sort and analyze its time complexity.	CO3
Implement Merge Sort to sort an array of integers.	CO3
Find the Kth largest element in an array using Quick Sort.	CO3
Perform Binary Search to find an element in a sorted array.	CO3
Implement Heap Sort to sort a list of elements.	CO3
Find the position to insert an element in a sorted array using Binary Search.	CO3
Implement a custom sort based on frequency of elements.	CO3
Compare sorting results using Insertion Sort and Bubble Sort.	CO3
Perform Preorder, Inorder, and Postorder Traversal on a Binary Tree.	CO4
Find the Lowest Common Ancestor in a Binary Search Tree.	CO4
Implement an algorithm to check if a Binary Tree is balanced.	CO4
Determine if two Binary Trees are identical.	CO4
Find the maximum path sum in a Binary Tree.	CO4
Convert a Binary Search Tree to a Greater Tree.	CO4
Count the number of nodes in a complete Binary Tree.	CO4
Flatten a Binary Tree to a linked list using preorder traversal.	CO4
Serialize and deserialize a Binary Tree.	CO4
Find the diameter of a Binary Tree.	CO4
Check if a Binary Tree is a subtree of another Binary Tree.	CO4
Find the level order traversal of a Binary Tree.	CO4

Learning Experiences

- **Interactive Lectures:** Engage students with visual PPTs, encourage questions, and simplify complex concepts.
- **Problem-Based Assignments:** Assign theory problems and practical lab tasks (e.g., segment trees, shortest path algorithms).

- **Continuous Assessment:** Regular quizzes, mini-projects, and formative assessments to reinforce learning.
- **Peer Collaboration:** Group activities, case studies, and peer reviews for diverse perspectives.
- **Feedback and Support:** Instructors provide timely feedback, and students seek help as needed.
- **Life-Long Learning:** Foster curiosity, critical thinking, and skills beyond the syllabus.

Textbooks

- *Introduction to Algorithms* by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein.
- *Data Structures and Algorithms Made Easy* by Narasimha Karumanchi.

Online References

1. **GeeksforGeeks:**
   - Offers articles on advanced data structures like self-balancing trees, segment trees, tries, and more.
   - Link to GeeksforGeeks
2. **Coursera:**
   - Various data structures and algorithms courses available online.
   - Examples include *Data Structures and Algorithms* from the University of California San Diego and *Algorithms, Part I* from Princeton University.
   - Link to Coursera
3. **Princeton University References:**
   - Provides a list of seminal papers and advanced resources.
   - Includes textbooks like *Algorithms, 4th Edition* by Robert Sedgewick and Kevin Wayne.

Semester: 5

Computer Organization and Architecture

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Computer Organization and Architecture	ENBC301	3-1-0	4
Type of Course:	Major		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of computer organization and architecture, focusing on computer systems, memory hierarchy, processor design, and input/output systems. The course is divided into 4 units:

1. Introduction
2. Memory Hierarchy, Storage, and I/O
3. The Processor
4. Input/Output Systems and Advanced Topics

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the basic concepts of computer architecture and data representation.
CO 2	Explaining the memory hierarchy and storage systems.
CO 3	Describing the design and operation of processors.
CO 4	Understanding the input/output systems and advanced computer architecture topics.

A student is expected to have learned concepts and demonstrated abilities or skills related to computer organization and architecture at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction**	**No. of hours: 10**
Content:		
• Introduction to Computer Architecture: Definitions and Concepts, Levels of abstraction, Von Neumann Architecture • Functional Blocks of a Computer: CPU, memory, input-output subsystems, control unit • Instruction Set Architecture (ISA) of CPU: Registers, instruction execution cycle, RTL (Register Transfer Language) interpretation of instructions, addressing modes, instruction set • Types of Instruction Set Architectures: Reduced Instruction Set Computer (RISC) and Complex Instruction Set Computer (CISC) • Data Representation: Number Systems (binary, octal, decimal, hexadecimal), Arithmetic Operations (addition, subtraction, multiplication, division)		
Unit Number: 2	**Title: Memory Hierarchy, Storage and I/O**	**No. of hours: 10**
Content:		
• Memory Hierarchy: Types of memory: RAM, ROM, Cache, and Secondary Storage, SRAM vs. DRAM, Locality of reference • Caching: Different indexing mechanisms: direct-mapped, set-associative, fully associative, Processor-cache interactions for read/write requests, Cache replacement policies: Least Recently Used (LRU), First-In-First-Out (FIFO) • Storage: Introduction to magnetic disks, Flash memory: NAND and NOR flash • I/O Data Transfer Techniques: Programmed I/O, Interrupt-Driven I/O, Direct Memory Access (DMA)		
Unit Number: 3	**Title: The Processor**	**No. of hours: 10**
Content:		

• Building a Datapath: Introduction, Logic Design Conventions, A Simple Implementation scheme, Overview of Pipelining: Pipelined Datapath and Control, Data Hazards: Forwarding versus Stalling, Control Hazards and their mitigation • Clocking Methodology: Revisiting clocking methodology, Amdahl's Law and its implications • Processor Design: Single cycle processor design, Multi-cycle processor design, Instruction pipelining: stages and performance considerations		
Unit Number: 4	**Title: Input/Output Systems and Advanced Topics**	**No. of hours: 10**
Content:		
• I/O Systems: I/O Mapped vs. Memory-Mapped I/O, I/O Data Transfer Techniques: Programmed I/O, Interrupt-Driven I/O, Direct Memory Access (DMA) • Storage Technologies: Introduction to Magnetic Disks: Tracks, Sectors, Flash Memory Technology: Structure and Performance Characteristics • Cache Memory: Different Indexing Mechanisms: Direct-Mapped, Set-Associative, Fully Associative Caches, Processor-Cache Interactions for Read/Write Requests, Cache Replacement Policies: Least Recently Used (LRU), First-In-First-Out (FIFO)		

Learning Experience for Computer Organization and Architecture

Classroom Learning Experience

- **Hands-On Hardware Labs:** The course integrates practical hardware labs where students interact with and assemble basic computer components. Students gain hands-on experience in understanding the physical architecture of computers by dismantling and reassembling hardware components such as processors, memory modules, and storage devices.

- **Simulation-Based Learning:** Students use simulation tools like Logisim and Multisim to design and analyze circuits and processors. These simulations allow students to visualize data flow and the functioning of different components within a computer system, reinforcing theoretical concepts with practical application.

- **Problem-Solving Workshops:** Regular workshops are conducted to solve complex problems related to memory management, cache optimization, and processor pipelining. These workshops are designed to enhance critical thinking and analytical skills, allowing students to apply theoretical knowledge in practical scenarios.

- **Case Studies and Industry Examples:** The course includes case studies and real-world examples from the computer industry, such as the design of modern CPUs by companies like Intel and AMD. These case studies help students understand how theoretical concepts are applied in the design and optimization of commercial processors.

- **Continuous Assessment and Feedback:** Students are continuously assessed through quizzes, assignments, and lab reports. Regular feedback is provided to help students identify areas of improvement and enhance their understanding of course material.

- **Guest Lectures and Industry Insights:** Guest lectures by industry professionals and experts in computer architecture are organized to provide students with insights into current trends and future directions in the field. These sessions are designed to bridge the gap between academic learning and industry practice.

Outside Classroom Learning Experience

- **Collaborative Group Projects:** The course includes group projects where students collaborate to design and implement a simple computer system. These projects emphasize the integration of various concepts such as memory hierarchy, processor design, and I/O systems, fostering teamwork and problem-solving skills.

- **Capstone Project:** The course culminates in a capstone project where students design a simplified, yet fully functional, processor or memory hierarchy system. This project synthesizes all the learning from the course and allows students to demonstrate their proficiency in computer organization and architecture.

- **Self-Study and Research:** Encourage students to explore advanced topics such as multicore processors, parallel processing, and hardware optimization through independent research and self-study.

- **Peer Review and Collaboration:** Organize peer review sessions where students provide constructive feedback on each other's designs and projects, promoting collaboration and improving problem-solving strategies.

- **Online Collaboration and Practice Tools:** Provide access to online tools and discussion forums where students can collaborate on projects, troubleshoot hardware simulations, and share insights on computer architecture challenges.

Text Books

- "Computer Organization and Design" by David A. Patterson and John L. Hennessy

- "Computer System Architecture" by M. Morris Mano

Reference Books

- "Computer Architecture: A Quantitative Approach" by John L. Hennessy and David A. Patterson

- "Structured Computer Organization" by Andrew S. Tanenbaum

Additional Readings

Self-Learning Components:

1. Link to Computer Organization course on NPTEL: https://nptel.ac.in/courses/106/103/106103180/
2. Link to Computer Architecture on Coursera: https://www.coursera.org/courses?query=computer%20architecture
3. Link to Computer Organization resources: https://www.geeksforgeeks.org/computer-organi
4. Link to Computer Organization tutorials: https://www.tutorialspoint.com/computer_fundamentals/computer_architecture.htm
5. Link to Computer Architecture lectures: https://ocw.mit.edu/courses/electrical-engineer
6-823-computer-system-architecture-fall-2005/

Natural language Processing Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Natural language Processing Lab	ENSP369	0-0-4	2
Type of Course:	SEC		

The Course Outcomes (COs)

On completion of the lab, students will be able to:

COs	**Statements**
CO 1	Understanding the basic principles of natural language processing and text processing methods.
CO 2	Implementing text preprocessing tasks such as tokenization, stemming, lemmatization, and stop word removal using Python libraries.
CO 3	Applying machine learning techniques for text classification, sentiment analysis, and information extraction.
CO 4	Developing and evaluate NLP models for real-world applications such as chatbot development, language translation, and text summarization.

S.N	**Experiment Title**	**Mapped CO/COs**
P1	Project Title: Text Preprocessing and Tokenization Problem Statement: Write a Python program to perform text tokenization, stemming, and lemmatization using the NLTK library.	CO1, CO2
P2	Project Title: Sentiment Analysis on Twitter Data Problem Statement: Implement a sentiment analysis model using a supervised machine learning technique to classify tweets as positive or negative.	CO3
P3	Project Title: Named Entity Recognition (NER) Problem Statement: Develop an NLP model to perform Named Entity Recognition using the spaCy or NLTK library on a news dataset.	CO3
P4	Project Title: Text Classification Using TF-IDF Problem Statement: Build a text classification model using Term Frequency-Inverse Document Frequency (TF-IDF) and apply it to a news dataset to classify articles.	CO3

S.N	Experiment Title	Mapped CO/COs
P5	Project Title: Building a Simple Chatbot Problem Statement: Create a rule-based chatbot using Python and NLTK to handle basic user queries and responses.	CO4
P6	Project Title: Machine Translation System Problem Statement: Implement a machine translation system using a seq2seq model to translate text from English to another language.	CO4
P7	Project Title: Word Embedding with Word2Vec Problem Statement: Develop word embeddings using the Word2Vec model and visualize the semantic relationships between words.	CO3
P8	Project Title: Text Summarization with NLP Problem Statement: Create an NLP model for automatic text summarization using extractive or abstractive methods.	CO4
P9	Project Title: Topic Modeling with LDA Problem Statement: Perform topic modeling using Latent Dirichlet Allocation (LDA) to identify topics from a corpus of documents.	CO3
P10	Project Title: Information Extraction from Text Problem Statement: Extract useful information from unstructured text, such as key phrases or entities, using NLP techniques.	CO4
P11	Project Title: Sentiment Analysis with Pre-trained Models Problem Statement: Use a pre-trained deep learning model (e.g., BERT or GPT) to perform sentiment analysis on a large dataset.	CO4
P12	Project Title: Language Model Evaluation Problem Statement: Evaluate the performance of different language models (e.g., n-grams, RNN, transformers) on text generation tasks.	CO4
P13	Project Title: Text Clustering for News Articles Problem Statement: Perform text clustering on a dataset of news articles using unsupervised learning techniques like K-means or hierarchical clustering.	CO3
P14	Project Title: Speech-to-Text Conversion Problem Statement: Implement a simple speech-to-text conversion system using Python's SpeechRecognition library.	CO4
P15	Project Title: Creating an NLP Pipeline Problem Statement: Develop a full NLP pipeline from text preprocessing to model evaluation for a specific NLP task (e.g., sentiment analysis, NER).	CO4

Text Books

- T1: "Speech and Language Processing" by Daniel Jurafsky and James H. Martin
- T2: "Natural Language Processing with Python" by Steven Bird, Ewan Klein, and

Edward Loper

Reference Books

- R1: "Deep Learning for Natural Language Processing" by Palash Goyal, Sumit Pandey, and Karan Jain
- R2: "Neural Network Methods for Natural Language Processing" by Yoav Goldberg

Online Learning Resources

- **Kaggle:** Hands-on NLP projects and datasets.
  https://www.kaggle.com/learn/natural-language-processing
- **Coursera:** Natural Language Processing courses from top universities.
  https://www.coursera.org/courses?query=natural%20language%20processing
- **DataCamp:** Interactive NLP learning platform.
  https://www.datacamp.com/
- **GitHub:** Explore open-source NLP projects.
  https://github.com/

Summer Internship-II

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Summer Internship-II	SIBC351	0-0-0	2
Type of Course:	INT		

Duration

The minor project will last for three months.

Project Requirements

1. **Problem Identification and Analysis:**
   - Identify a relevant problem in society or industry.
   - Conduct a thorough analysis of the problem, considering various perspectives and implications.
2. **Implementation:**
   - Develop and implement a solution to address the identified problem.
3. **Data Visualization:**
   - Utilize appropriate data visualization techniques to represent the problem, solution, and outcomes effectively.
4. **Presentation of Solutions:**
   - Prepare a comprehensive presentation of the implemented solution, including its development process, outcomes, and impact.
5. **Case Studies:**
   - Conduct case studies related to the problem and solution, analyzing existing examples and drawing relevant insights.

Guidelines

1. **Project Selection:**
   - Choose a societal or industrial problem relevant to the field of computer science and engineering.
   - Ensure the problem is specific and well-defined.
2. **Literature Review:**

- Conduct a thorough review of existing literature and solutions related to the problem.
- Identify gaps in existing solutions and potential areas for further investigation.

3. **Implementation:**

   - Develop a detailed plan for implementing the solution.
   - Execute the implementation using appropriate tools, technologies, and methodologies.

4. **Data Visualization:**

   - Collect relevant data and use visualization techniques to represent the problem, solution, and outcomes.
   - Ensure the visualizations are clear, accurate, and effectively communicate the information.

5. **Documentation:**

   - Document the entire process, including problem identification, literature review, implementation, data visualization, and case studies.
   - Use appropriate formats and standards for documentation.

6. **Presentation:**

   - Prepare a presentation summarizing the problem, existing solutions, implementation process, data visualization, and case studies.
   - Ensure the presentation is clear, concise, and well-structured.

Evaluation Criteria for Minor Project (Out of 100 Marks)

1. **Problem Identification and Analysis (15 Marks):**

   - Comprehensive identification and analysis of the problem: 15 marks
   - Good identification and analysis of the problem: 12 marks
   - Basic identification and analysis of the problem: 9 marks
   - Poor identification and analysis of the problem: 5 marks
   - No identification and analysis of the problem: 0 marks

2. **Implementation (30 Marks):**

   - Successful and thorough implementation: 30 marks
   - Good implementation: 25 marks
   - Moderate implementation: 20 marks
   - Basic implementation: 15 marks
   - Poor implementation: 10 marks
   - No implementation: 0 marks

3. **Data Visualization (20 Marks):**

- Effective and clear data visualization: 20 marks
- Good data visualization: 15 marks
- Moderate data visualization: 10 marks
- Basic data visualization: 5 marks
- Poor data visualization: 0 marks

4. **Presentation of Solutions (15 Marks):**
   - Clear, concise, and engaging presentation: 15 marks
   - Clear but less engaging presentation: 12 marks
   - Somewhat clear and engaging presentation: 9 marks
   - Unclear and disengaging presentation: 5 marks
   - No presentation: 0 marks
5. **Case Studies (20 Marks):**
   - Comprehensive and insightful case studies: 20 marks
   - Good case studies: 15 marks
   - Moderate case studies: 10 marks
   - Basic case studies: 5 marks
   - Poor case studies: 0 marks

Total: 100 Marks

Course Outcomes

By the end of this course, students will be able to:

- **Identify and Analyze Problems:**
  - Identifying relevant societal or industrial problems and conduct a thorough analysis of these problems.
- **Implement Solutions:**
  - Developing and implement effective solutions to address identified problems using appropriate tools and technologies.
- **Visualize Data:**
  - Utilizing data visualization techniques to represent problems, solutions, and outcomes clearly and effectively.
- **Present Solutions:**
  - Preparing and deliver comprehensive presentations summarizing the implementation process, outcomes, and impact of their solutions.
- **Conduct Case Studies:**

  - Conducting case studies related to the problem and solution, analyzing existing examples and drawing relevant insights.

- **Literature Review:**
  - Conducting comprehensive literature reviews to identify gaps in existing solutions and potential areas for further investigation.

- **Documentation:**
  - Documenting the entire process, including problem identification, literature review, implementation, data visualization, and case studies, using appropriate formats and standards.

- **Professional Development:**
  - Developing skills in research, analysis, implementation, data visualization, documentation, and presentation, contributing to overall professional growth.

Life Skills for Professionals-III

Program Name:	B.Sc (Hons.) Data Science		
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):	None		

Course Perspective: This course aims to enhance essential life skills for professionals, focusing on data interpretation, logical reasoning, stress management, and employability skills. The course is divided into 5 units:

1. Data Interpretation
2. Logical Reasoning
3. Logical & Non-verbal Reasoning
4. Understanding Stress
5. Employability Skills

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Interpreting and analyze data presented in various graphical forms.
CO 2	Solving problems related to logical reasoning and non-verbal reasoning.
CO 3	Understanding the nature of stress and develop strategies to manage it effectively.
CO 4	Developing employability skills, including resume writing, job interviews, and teamwork.

A student is expected to have learned concepts and demonstrated abilities or skills related to life skills for professionals at the end of the course.

Course Outline

Unit Number: 1	**Title: Data Interpretation**	**No. of hours: 6**
Content:		
• Table chart • Line graph • Bar graph • Pie chart		
Unit Number: 2	**Title: Logical Reasoning**	**No. of hours: 6**
Content:		
• Coding & Decoding • Sitting arrangement • Calendar, Clock • Direction Sense, Blood relation • Syllogism		
Unit Number: 3	**Title: Logical & Non-verbal Reasoning**	**No. of hours: 6**
Content:		
• Series, Puzzle Text • Statement & Arguments • Cube & Dice • Non-verbal Reasoning		
Unit Number: 4	**Title: Understanding Stress**	**No. of hours: 6**
Content:		
• Introduction to Stress: Meaning, Definition, Eustress, Distress • Types of Stress: Acute stress, Episodic Acute stress, and Chronic stress • Sources of Stress: Psychological, Social, Environmental, Academic, Family, and Work stress • Impact of Stress: Signs and Symptoms		

Unit Number: 5	Title: Employability Skills	No. of hours: 6
Content:		
- 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, Feedback and Improvement		

Learning Experience for Life Skills for Professionals-III

Classroom Learning Experience

- **Interactive Workshops:** The course incorporates interactive workshops where students engage in activities designed to enhance their logical reasoning and data interpretation skills. These workshops include solving real-world problems, participating in group discussions, and presenting solutions to peers.

- **Case Studies and Real-Life Scenarios:** Students analyze case studies and real-life scenarios that require the application of stress management techniques and employability skills. This approach helps them understand the practical relevance of the skills learned and how to apply them in professional settings.

- **Mock Interviews and Group Discussions:** The course includes mock interviews and group discussions to simulate real-world job interview scenarios. These activities help students build confidence, improve communication skills, and receive constructive feedback on their performance.

- **Collaborative Learning:** Students participate in collaborative learning sessions where they work in teams to solve logical and non-verbal reasoning puzzles. This not only enhances their problem-solving abilities but also fosters teamwork and leadership skills.

- **Stress Management Techniques:** Through guided practice, students learn and apply various stress management techniques, such as mindfulness, relaxation exercises, and time management strategies. These techniques are integrated into the course to help students manage stress effectively during their studies and in their future careers.

- **Continuous Assessment and Feedback:** Students receive continuous assessment through quizzes, assignments, and presentations. Regular feedback is provided to help them identify areas for improvement and to track their progress in mastering life skills.

Outside Classroom Learning Experience

- **Practical Assignments and Projects:** The course includes practical assignments and projects that require students to create and present data interpretations using graphs and charts. These projects provide hands-on experience in analyzing and presenting data, which are essential skills in many professional fields.
- **Self-Study and Personal Development:** Encourage students to engage in self-study on topics such as logical reasoning, stress management, and employability skills to further enhance their personal and professional growth.
- **Peer Collaboration and Review:** Organize peer collaboration and review sessions where students provide constructive feedback on each other's assignments and presentations, encouraging continuous improvement and learning from peers.
- **Guest Lectures and Industry Insights:** The course features guest lectures by industry professionals who provide insights into the importance of employability skills, logical reasoning, and stress management in the workplace. These sessions help bridge the gap between academic learning and industry expectations.
- **Online Collaboration and Discussion:** Facilitate online discussion forums where students can share experiences, discuss challenges, and collaborate on problem-solving tasks, promoting a collaborative learning environment.

Text Books

- "Quantitative Aptitude for Competitive Examinations" by R.S. Aggarwal
- "A Modern Approach to Logical Reasoning" by R.S. Aggarwal

Reference Books

- "How to Prepare for Logical Reasoning for CAT" by Arun Sharma
- "Verbal and Non-Verbal Reasoning" by Dr. R.S. Aggarwal

Additional Readings

Self-Learning Components:

1. Link to Data Interpretation resources: https://www.indiabix.com/data-interpretation/questions-and-answers/
2. Link to Logical Reasoning tutorials: https://www.indiabix.com/logical-reasoning/questions-and-answers/
3. Link to Non-verbal Reasoning tutorials: https://www.tutorialspoint.com/verbal_and_non_verbal_reasoning/non_verbal_reasoning_classification.htm
4. Link to Stress Management resources: https://www.mindtools.com/pages/main/newMN_TCS.htm
5. Link to Employability Skills course on Coursera: https://www.coursera.org/courses?query=employability%20skills

Career Readiness Boot Camp

Program Name:	B.Tech, BCA, MCA, B.Sc		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Career Readiness Boot Camp	VAC IV	0-0-0	2
Type of Course:	VAC		
Pre-requisite(s):	None		

Course Perspective: The Boot Camp (Training and Placement) module is a comprehensive course designed to equip final-year B.Tech, BCA, MCA, and B.Sc students with the necessary skills and knowledge to excel in campus placement drives. All students are required to pass the individual components to receive the final marks out of 100 and earn 2 credits for the Practical Training Module (Bootcamp training) in their course structure. Students must obtain specific free certifications from Infosys Springboard (https://infytq.onwingspan.com/web/en/page/home).

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Applying data structures and algorithms to solve complex programming problems.
CO 2	Implementing object-oriented programming principles and develop robust Java applications.
CO 3	Designing and managing databases efficiently using advanced SQL and database management techniques.
CO 4	Demonstrating aptitude, soft skills, and interview readiness through practical evaluations.

A student is expected to have learned concepts and demonstrated abilities or skills related to career readiness at the end of the course.

Course Outline

Module: 1	**Title: Data Structures and Algorithms - Part 1**	**No. of hours: 30 (Online, Self-Paced)**
Content Summary:		
• Foundational data structures including arrays, strings, and linked lists • Key operations and practical applications		
Module: 2	**Title: Data Structures and Algorithms - Part 2**	**No. of hours: 30 (Online, Self-Paced)**
Content Summary:		
• Advanced data structures such as stacks, queues, trees, and graphs • Essential operations and real-world applications		
Module: 3	**Title: Object-Oriented Programming**	**No. of hours: 46 (Online, Self-Paced)**
Content Summary:		
• Fundamental concepts of OOP: classes, objects, inheritance, polymorphism, and encapsulation • Designing and implementing software using these principles		
Module: 4	**Title: Programming using Java**	**No. of hours: 113 (Online, Self-Paced)**
Content Summary:		
• Basics of Java: syntax, data types, operators, and control structures • Object-oriented principles specific to Java: classes, objects, inheritance, and polymorphism • Advanced topics: exception handling and file I/O		
Module: 5	**Title: Database Management Systems (Part I)**	**No. of hours: 64 (Online, Self-Paced)**
Content Summary:		

• Fundamental concepts of database systems: database models, relational databases, and SQL • Key topics: entity-relationship modeling, normalization, and basic query operations		
Module: 6	**Title: Database Management Systems (Part II)**	**No. of hours: 40 (Online, Self-Paced)**
Content Summary:		
• Advanced database concepts: transaction management, concurrency control, and database security • Complex SQL queries, stored procedures, and triggers • Performance optimization techniques		
Module: 7	**Title: Aptitude Exam**	**No. of hours: Online**
Module: 8	**Title: Independent Evaluation through 3rd party**	**No. of hours: Offline**
Module: 9	**Title: Soft Skills**	**No. of hours: Online**
Module: 10	**Title: Mock Interview**	**No. of hours: Hybrid**

Text Books

- "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein
- "Cracking the Coding Interview" by Gayle Laakmann McDowell
- "Elements of Programming Interviews" by Adnan Aziz, Tsung-Hsien Lee, and Amit Prakash
- "Head First Java" by Kathy Sierra and Bert Bates
- "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, and S. Sudarshan
- "Introduction to the Theory of Computation" by Michael Sipser
- "Programming Challenges: The Programming Contest Training Manual" by Steven S. Skiena and Miguel A. Revilla
- "The Algorithm Design Manual" by Steven S. Skiena
- "Algorithms" by Robert Sedgewick and Kevin Wayne
- "Effective Java" by Joshua Bloch

Discipline Specific Elective - I (Cloud Computing)

Computational Services in The Cloud

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Computational Services in The Cloud	ENSP401	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts and applications of cloud computing, exploring the paradigm shift towards cloud-based IT resources and services. It covers various cloud service models (IaaS, PaaS, SaaS), deployment models (public, private, hybrid), and key characteristics and challenges of cloud computing. Students will learn about virtualization, cloud storage, serverless computing, and resource management fundamentals. Additionally, the course includes case studies on cloud market analysis, security, compliance, big data handling, and a comparative study of public clouds. By the end of the course, students will be equipped to understand, implement, and analyze cloud computing technologies and solutions. The course is divided into 4 modules:

1. Foundations of Cloud Computing
2. Advanced Cloud Computing and Virtualization
3. Cloud Security, Privacy, and Compliance
4. Applications of Cloud Computing and Future Trends

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Explaining 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.
CO 2	Applingy the fundamental concepts in data centers to understand the trade-offs in power, efficiency, and cost.
CO 3	Identifying resource management fundamentals, i.e. resource abstraction, sharing, and sandboxing, and outline their role in managing infrastructure in cloud computing.
CO 4	Analyzing various cloud programming models and apply them to solve problems on the cloud.

A student is expected to have learned concepts and demonstrated abilities or skills related to cloud computing at the end of the course.

Course Outline

<table>
<tr><td><b>Unit Number: 1</b></td><td><b>Title: Foundations of Cloud Computing</b></td><td><b>No. of hours: 10</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• Introduction to Cloud Computing: Definitions and basic concepts, Cloud delivery models (IaaS, PaaS, SaaS), Cloud deployment models (Public, Private, Hybrid), Benefits and challenges of cloud computing
• Cloud Infrastructure and Architecture: Cloud computing services and inter-cloud interoperability, Virtualization and its importance
• Security and Ethical Issues: Security and privacy concerns, Ethical issues in cloud computing</td></tr>
<tr><td><b>Unit Number: 2</b></td><td><b>Title: Advanced Cloud Computing and Virtualization</b></td><td><b>No. of hours: 12</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• Virtualization Technologies: Virtual machine monitors, Full virtualization and paravirtualization, Virtualization technology (hardware-based and OS-based)
• Resource Management and Scheduling: Cloud resource management, Scheduling algorithms and dynamic application scaling, Optimization of network virtualization
• Virtualization Security: Virtualization security risks</td></tr>
<tr><td><b>Unit Number: 3</b></td><td><b>Title: Cloud Security, Privacy, and Compliance</b></td><td><b>No. of hours: 10</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
<tr><td colspan="3">• Cloud Security Basics: Cloud security risks and challenges, Security mechanisms (encryption, hashing, digital signatures), Identity and access management
• Advanced Security Measures: Trusted virtual machine monitors, Cloud security policies and controls, Cloud security threats (traffic eavesdropping, denial of service)
• Compliance and Legal Issues: Multi-regional compliance, Privacy impact assessment, Case studies on cloud security</td></tr>
<tr><td><b>Unit Number: 4</b></td><td><b>Title: Applications of Cloud Computing and Future Trends</b></td><td><b>No. of hours: 8</b></td></tr>
<tr><td colspan="3"><b>Content:</b></td></tr>
</table>

- Cloud Applications: Scientific research and high-performance computing, Social computing and digital content, Big data and cloud-based AI/ML applications
- Emerging Trends: Edge computing and fog computing, Future challenges and opportunities, Energy use and ecological impact of data centers

Learning Experience for Computational Services in The Cloud

Classroom Learning Experience

- **Hands-On Lab Sessions:** The course incorporates hands-on lab sessions where students are given access to cloud platforms like AWS, Google Cloud, or Azure. These sessions involve deploying virtual machines, setting up cloud storage, and experimenting with different cloud service models (IaaS, PaaS, SaaS).
- **Case Studies and Real-World Applications:** Students analyze case studies that explore the practical applications of cloud computing in various industries such as healthcare, finance, and entertainment. This helps them understand how cloud computing is utilized in real-world scenarios and the impact it has on different sectors.
- **Guest Lectures and Industry Insights:** The course features guest lectures from cloud computing professionals who share insights into the latest trends, technologies, and best practices in the industry. These sessions provide students with valuable knowledge from experienced practitioners and help them stay updated with current industry standards.
- **Security and Compliance Simulations:** The course includes simulations and exercises focused on cloud security and compliance. Students learn to identify and mitigate security risks, ensuring that they understand the importance of protecting data and maintaining compliance in cloud environments.
- **Continuous Assessment and Feedback:** Throughout the course, students receive continuous assessment through quizzes, assignments, and lab work. Regular feedback is provided to help them improve their understanding of cloud computing concepts and to guide their learning process.

Outside Classroom Learning Experience

- **Project-Based Learning:** The course includes project-based learning where students are required to design, implement, and manage a cloud-based solution for a given problem. This allows them to apply theoretical knowledge to practical situations and develop problem-solving skills in cloud computing.
- **Collaborative Group Work:** Students participate in collaborative group work, where they work in teams to solve complex cloud computing challenges. This fosters teamwork, communication, and the ability to work effectively in a cloud computing environment.

- **Exploration of Emerging Technologies:** Students are encouraged to explore emerging cloud technologies such as serverless computing, edge computing, and containerization. This exploration helps them stay ahead of the curve and prepares them for future trends in cloud computing.
- **Self-Study and Research:** Encourage students to engage in self-study and research on advanced topics such as multi-cloud architectures, cloud cost optimization, and cloud-native application development.
- **Peer Review and Collaboration:** Facilitate peer review sessions where students critique and provide feedback on each other's cloud projects, fostering collaboration and learning from different approaches.

Text Books

- "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Zaigham Mahmood, and Ricardo Puttini
- "Cloud Computing: Theory and Practice" by Dan C. Marinescu

Reference Books

- "Cloud Computing" by Lizhe Wang, Rajiv Ranjan, Jinjun Chen, and Boualem Benatallah, CRC Press, 2017
- "Cloud Computing For Dummies" by Judith S. Hurwitz and Daniel Kirsch, 2nd Edition, Hoboken: John Wiley & Sons, 2020

Additional Readings

Self-Learning Components:

1. Link to Cloud Computing course on NPTEL: https://nptel.ac.in/courses/106/106/106106218/
2. Link to Cloud Computing on Coursera: https://www.coursera.org/courses?query=cloud%20computing
3. Link to Cloud Computing resources: https://www.geeksforgeeks.org/cloud-computing/
4. Link to Cloud Computing tutorials: https://www.tutorialspoint.com/cloud_computing/index.htm
5. Link to Cloud Computing lectures: https://ocw.mit.edu/courses/electrical-engineering-
6-897-selected-topics-in-cryptography-spring-2004/lecture-notes/

Computational Services in The Cloud Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Computational Services in The Cloud Lab	ENSP451	0-0-2	1
Type of Course:	SEC		

Defined Course Outcomes

COs	Statements
CO 1	Implementing advanced resource management and scheduling systems in cloud environments to optimize the efficiency and performance of virtualized resources.
CO 2	Developing comprehensive security and compliance frameworks for cloud infrastructures, addressing various security threats and ensuring regulatory compliance.
CO 3	Enhancing data privacy and compliance strategies for multi-regional cloud deployments, ensuring adherence to global and regional data protection regulations.
CO 4	Leveraging cloud computing resources for high-performance scientific research, enabling scalable and efficient data processing, storage, and analysis.

S.N	Project Detail	Mapped CO/COs
1	Set up a virtual machine (VM) on a cloud platform (e.g., AWS, Azure, Google Cloud). Explore different VM configurations and understand the basics of IaaS.	CO1
2	Deploy a simple web application using a PaaS provider (e.g., Heroku, Google App Engine). Demonstrate the deployment process and manage application scaling.	CO2
3	Implement a cloud storage solution using a SaaS provider (e.g., Dropbox, Google Drive). Upload, share, and manage files to understand cloud storage benefits and challenges.	CO2
4	Investigate the security and privacy settings of a cloud service provider. Configure security groups and access controls to secure your cloud resources.	CO3

S.N	Project Detail	Mapped CO/COs
5	Install and configure a virtual machine monitor (VMM) like VMware or VirtualBox. Compare full virtualization and paravirtualization techniques.	CO1
6	Optimize network virtualization by setting up and managing virtual networks in a cloud environment. Analyze the performance benefits of network virtualization.	CO3
7	Implement encryption and hashing mechanisms to secure data stored in the cloud. Demonstrate how these mechanisms protect data integrity and confidentiality.	CO3
8	Set up identity and access management (IAM) in a cloud environment. Configure single sign-on (SSO) for multiple cloud services to streamline user access.	CO3
9	Develop a cloud-based AI application using a cloud provider's machine learning services (e.g., AWS SageMaker, Google AI Platform). Train and deploy a machine learning model in the cloud.	CO4
10	Implement a cloud-based big data solution using Hadoop or Spark on a cloud platform. Process and analyze a large dataset to understand the benefits of cloud-based big data processing.	CO4
11	Explore edge computing by deploying a cloud application that interacts with IoT devices. Demonstrate how edge computing can reduce latency and improve performance.	CO4

Online Learning Resources

- **AWS Documentation:** Comprehensive guide on using AWS services.
  https://docs.aws.amazon.com/
- **Microsoft Azure Documentation:** Resources for learning and using Azure services.
  https://docs.microsoft.com/en-us/azure/
- **Google Cloud Documentation:** Guide on Google Cloud Platform services.
  https://cloud.google.com/docs
- **Coursera:** Courses on cloud computing from leading universities.
  https://www.coursera.org/courses?query=cloud%20computing

Microsoft Azure Cloud Fundamentals

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Microsoft Azure Cloud Fundamentals	ENSP403	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: This course introduces students to the fundamental concepts of cloud computing with a focus on Microsoft Azure. It aims to bridge the gap between theoretical cloud principles and practical Azure applications, emphasizing the relevance of cloud services in modern engineering and technology. Students will explore core topics such as cloud computing models, Azure architecture, compute and networking services, storage services, and cost management. The course is divided into four modules:

1. Introduction to Cloud Computing and Azure Fundamentals
2. Introduction to Microsoft Azure
3. Azure Storage Services and Identity Management
4. Azure Cost Management, Governance, and Monitoring

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	**Statements**
CO 1	Identifying the core concepts of cloud computing and Microsoft Azure, including deployment models and service models.
CO 2	Understanding the benefits of cloud services, such as high availability, scalability, and security.
CO 3	Understanding Azure architecture components and compute/networking services, analyzing their functionality and use cases.
CO 4	Determining the appropriate Azure storage services for different performance requirements and analyze identity management and security features for access control.
CO 5	Critiquing cost management strategies in Azure, analyze governance and compliance tools, and determine effective methods for managing and deploying Azure resources.

A student is expected to have learned concepts and demonstrated abilities or skills related to Microsoft Azure cloud fundamentals at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to Cloud Computing and Azure Fundamentals**	**No. of hours: 10**
Content:		
• Cloud Computing Basics: What is cloud computing, Delivery models, deployment models, defining attributes, resources, and organization of the infrastructure • Network-Centric Computing and Network-Centric Content • Cloud computing delivery models and services, Applications of cloud • Ethical Issues in Cloud Computing, Major Challenges Faced by Cloud Computing		
Unit Number: 2	**Title: Introduction to Microsoft Azure**	**No. of hours: 12**
Content:		
• Azure Architecture Components: Azure regions, availability zones, datacenters, Azure resources, resource groups, subscriptions, Management groups hierarchy • Azure Compute and Networking Services: Compute types comparison: Container instances, VMs, Functions, Virtual machine options: VMs, VM Scale Sets, availability sets, Azure Virtual Desktop, Application hosting options • Virtual networking: Azure Virtual Networks, subnets, peering, DNS, VPN Gateway, ExpressRoute, Public and private endpoints		
Unit Number: 3	**Title: Azure Storage Services and Identity Management**	**No. of hours: 10**
Content:		
• Azure Storage Services: 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 Cost Management, Governance, and Monitoring**	**No. of hours: 8**
Content:		

- Cost Management in Azure: Factors affecting costs, Pricing and TCO calculators, Azure Cost Management and Billing tool, Tagging usage
- Governance and Compliance: Azure Blueprints, Azure Policy, Resource locks, Service Trust Portal
- Monitoring Tools in Azure: Azure Advisor, Azure Service Health, Azure Monitor: Log Analytics, alerts, Application Insights

Learning Experience for Microsoft Azure Cloud Fundamentals

Classroom Learning Experience

- **Practical Lab Exercises:** Students will engage in hands-on lab exercises that involve creating and managing virtual machines, configuring Azure networking, and deploying storage solutions. These labs provide practical experience with Azure's core services and help students understand the real-world applications of cloud computing.
- **Case Studies and Industry Scenarios:** Students will analyze case studies that highlight the use of Azure in various industries, such as healthcare, finance, and retail. These scenarios help students appreciate the impact of cloud computing on business operations and decision-making.
- **Guest Lectures and Industry Insights:** The course features guest lectures from cloud computing experts who share insights into the latest trends, best practices, and challenges in the industry. These sessions provide valuable knowledge and industry perspectives that enhance the learning experience.
- **Security and Compliance Simulations:** The course includes simulations focused on Azure security and compliance. Students will learn to implement security policies, manage identities, and ensure compliance with industry standards, preparing them for real-world challenges in cloud security.
- **Continuous Assessment and Feedback:** Throughout the course, students will undergo continuous assessment through quizzes, assignments, and lab work. Regular feedback is provided to ensure that students understand the concepts and can apply them effectively.

Outside Classroom Learning Experience

- **Project-Based Learning:** The course includes project-based learning where students are tasked with designing and implementing a cloud solution using Microsoft Azure. Projects may involve setting up a complete virtual network, deploying scalable applications, or optimizing storage and compute resources, offering students a comprehensive understanding of Azure's capabilities.

- **Collaborative Group Work:** Students will participate in group activities where they will collaborate to solve complex cloud infrastructure problems. This collaborative approach fosters teamwork, problem-solving, and the ability to work effectively in a cloud environment.
- **Exploration of Emerging Trends:** Students are encouraged to explore emerging trends in cloud computing, such as AI integration, IoT on Azure, and serverless computing. This exploration helps them stay updated with the latest advancements in the field and prepares them for future developments in cloud technology.
- **Self-Study and Research:** Encourage students to explore Azure documentation, tutorials, and advanced topics such as Azure Kubernetes Service (AKS) and Azure DevOps to deepen their understanding and proficiency.
- **Peer Review and Collaboration:** Facilitate peer review sessions where students provide feedback on each other's Azure projects, fostering a collaborative learning environment and improving project outcomes.

Text Books

- "Cloud Computing: Theory and Practice" by Dan C. Marinescu
- "Exam Ref AZ-900 Microsoft Azure Fundamentals" by Jim Cheshire

Reference Books

- "Microsoft Azure Essentials: Fundamentals of Azure" by Michael Collier and Robin Shahan
- "Azure for Architects: Implementing cloud design, DevOps, IoT, and serverless solutions on your public cloud" by Ritesh Modi
- "Azure Security Center: Protecting your cloud workloads" by Yuri Diogenes, Tom Shinder, and Debra Shinder
- "Azure Cost Management and Billing" by Sjoukje Zaal

Additional Readings

Self-Learning Components:

1. Link to Microsoft Learn: https://docs.microsoft.com/en-us/learn/azure/
2. Link to Coursera Azure Courses: https://www.coursera.org/courses?query=azure
3. Link to OSSU Cloud Computing Curriculum: https://github.com/ossu/computer-science#cloud-computing

Microsoft Azure Cloud Fundamentals Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Microsoft Azure Cloud Fundamentals Lab	ENSP453	0-0-2	1
Type of Course:	SEC		

Defined Course Outcomes

COs	Statements
CO 1	Deploying and manage scalable web applications using Azure architecture components, ensuring high availability, fault tolerance, and optimal performance.
CO 2	Developing and optimize Azure storage solutions for data-intensive applications, focusing on efficient data storage, retrieval, and performance.
CO 3	Establishing secure and compliant environments in Azure, ensuring governance, cost management, and continuous monitoring for mission-critical applications.
CO 4	Migrating on-premise applications to Azure, ensuring minimal downtime and optimized performance through effective planning, resource management, and monitoring.

S.N	Project Detail	Mapped CO/COs
1	Set up a cloud environment using a chosen cloud provider (e.g., AWS, Azure, Google Cloud). Explore and document the different delivery models (IaaS, PaaS, SaaS) and deployment models (Public, Private, Hybrid).	CO1
2	Implement a network-centric application using cloud services. Demonstrate how network-centric content can be delivered and managed in a cloud environment.	CO1
3	Explore a cloud-based application (e.g., Google Docs, Office 365). Analyze its benefits and the ethical issues it presents in terms of data privacy and security.	CO3
4	Explore Azure regions, availability zones, and datacenters. Create and manage Azure resources and resource groups, and understand the subscription and management groups hierarchy.	CO1

S.N	Project Detail	Mapped CO/COs
5	Compare different Azure compute types (Container instances, VMs, Functions). Create and manage VMs, VM Scale Sets, and availability sets. Explore Azure Virtual Desktop and application hosting options.	CO1
6	Set up a virtual network in Azure. Configure subnets, peering, DNS, VPN Gateway, and ExpressRoute. Explore the use of public and private endpoints in Azure networking.	CO1
7	Host a web application on Azure using different hosting options. Compare the performance and cost implications of using VMs, Azure App Service, and Azure Functions.	CO1
8	Create and manage virtual machines in Azure. Explore different VM sizes and types based on performance requirements. Implement VM scaling and load balancing to optimize application performance.	CO1
9	Set up Azure Blob Storage and upload/download data. Explore Table Storage and File Storage services. Implement Disk Storage and understand its use cases.	CO2
10	Use the Azure Pricing Calculator and TCO Calculator to estimate the costs of running a sample application on Azure. Explore the Azure Cost Management and Billing tool to monitor and control costs.	CO3
11	Set up monitoring for an Azure application using Azure Monitor. Configure Log Analytics, set up alerts, and use Application Insights to monitor application performance and health.	CO3
12	Use Azure Advisor and Azure Service Health to optimize and maintain the health of Azure resources. Implement recommendations provided by Azure Advisor and monitor service issues using Azure Service Health.	CO3

Online Learning Resources

- **Microsoft Azure Documentation:** Comprehensive guide on using Azure services.
  https://docs.microsoft.com/en-us/azure/
- **Azure Learning Paths:** Guided learning paths to master Azure concepts and services.
  https://docs.microsoft.com/en-us/learn/azure/
- **Coursera:** Courses on Azure cloud computing from leading universities.
  https://www.coursera.org/courses?query=azure
- **Pluralsight:** Training and certification courses for Azure.
  https://www.pluralsight.com/paths/microsoft-azure

Storage and Databases on Cloud

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Storage and Databases on Cloud	ENSP405	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: The course covers the basics of cloud computing and introduces various cloud storage and database types. It discusses migration techniques, security, and performance considerations for cloud databases. The AWS cloud storage unit focuses on Amazon S3, EC2 Instance Storage, and more. It also helps students analyze case studies of companies like Netflix and Spotify using cloud storage and databases. The course is divided into 4 modules:

1. Introduction to Storage on Cloud
2. Data Integration, Migration, Security, and Performance on Cloud
3. Cloud-Hosted Data Storage Systems
4. Case Study

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding cloud storage and database fundamentals, including security best practices.
CO 2	Applying indexing, caching, and query optimization for performance in cloud storage and databases.
CO 3	Analyzing requirements to select suitable cloud storage and database solutions.
CO 4	Differentiating between types of cloud storage and database services.
CO 5	Articulating best practices for designing scalable, reliable, and secure cloud storage and databases.

A student is expected to have learned concepts and demonstrated abilities or skills related to cloud storage and databases at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to Storage on Cloud**	**No. of hours: 8**
Content:		
• 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:		
• Techniques, tools, methods, and considerations for migrating from on-premise databases 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, including load balancing, replication, sharding, and auto-scaling • Cloud data warehousing		
Unit Number: 3	**Title: Cloud-Hosted Data Storage Systems**	**No. of hours: 10**
Content:		

• 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 CloudFront • Brief introduction to Google Cloud Storage, and Azure Blob Storage		
Unit Number: 4	**Title: Case Study**	**No. of hours: 12**
Content:		
• Case Studies and Real-world Examples of Netflix, Airbnb, Pinterest, Spotify, Coca-Cola • Analyzing real-world use cases of organizations using cloud storage and databases • Discussing architecture decisions, challenges, and lessons learned		

Learning Experience for Storage and Databases on Cloud

Classroom Learning Experience

- **Hands-On Lab Activities:** Students will participate in lab sessions where they configure and manage cloud storage solutions on platforms such as AWS, Google Cloud, and Azure. These labs include tasks like setting up Amazon S3 buckets, deploying databases, and optimizing storage performance, providing students with practical experience in cloud storage and database management.

- **Real-World Case Studies:** The course includes in-depth analysis of case studies from companies like Netflix, Airbnb, and Spotify. Students will explore how these organizations utilize cloud storage and databases to meet their business needs. This approach helps students connect theoretical concepts with practical industry applications.

- **Guest Lectures and Expert Sessions:** Industry experts and cloud professionals will be invited to share insights into the latest trends, best practices, and challenges in cloud storage and database management. These sessions provide students with valuable knowledge and industry perspectives that enhance their learning experience.

- **Security and Compliance Simulations:** The course includes simulations focused on securing cloud storage and databases. Students will learn to implement security measures, manage access controls, and ensure compliance with industry standards, preparing them for the complexities of cloud security.

- **Continuous Assessment and Feedback:** Students will be continuously assessed through quizzes, assignments, and lab work, with regular feedback provided to ensure they are grasping key concepts and applying them effectively in practical scenarios.

Outside Classroom Learning Experience

- **Project-Based Learning:** Students will undertake projects that involve designing and implementing cloud storage and database solutions. These projects require them to assess requirements, choose appropriate cloud services, and implement solutions that are scalable, secure, and cost-effective, preparing them for real-world challenges in cloud computing.
- **Collaborative Group Work:** Group activities will enable students to work together on complex cloud migration scenarios, where they plan and execute the migration of on-premises databases to the cloud. This collaborative learning process fosters teamwork and problem-solving skills in a cloud environment.
- **Exploration of Emerging Trends:** Students are encouraged to explore emerging trends in cloud storage and databases, such as serverless architecture, AI-driven database management, and multi-cloud strategies. This exploration helps them stay updated with the latest advancements in the field.
- **Self-Study and Research:** Students are encouraged to dive deeper into advanced topics such as distributed databases, cloud storage cost optimization, and hybrid cloud architectures through independent research and self-study.
- **Peer Review and Collaboration:** Facilitate peer review sessions where students collaborate on projects and provide feedback on each other's cloud storage and database designs, promoting a collaborative and reflective learning environment.

Text Books

- "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood
- "Designing Data-Intensive Applications" by Martin Kleppmann
- "Cloud Architecture Patterns: Using Microsoft Azure" by Bill Wilder

Reference Books

- "Cloud Computing: Concepts, Technology & Architecture" by Thomas Erl, Ricardo Puttini, and Zaigham Mahmood
- "Designing Data-Intensive Applications" by Martin Kleppmann
- "Cloud Architecture Patterns: Using Microsoft Azure" by Bill Wilder

Additional Readings

Self-Learning Components:

1. Microsoft Learn: Introduction to Azure Storage
   Description: Comprehensive learning path covering Azure Storage services, including Blob, File, and Disk Storage.
   Link: `https://docs.microsoft.com/en-us/learn/paths/azure-storage/`

2. AWS Training and Certification: Storage Learning Path
   Description: AWS offers a detailed learning path for storage services, including Amazon S3, EBS, and more.
   Link: `https://aws.amazon.com/training/learn-about/storage/`

3. Google Cloud Training: Storage and Databases
   Description: Google Cloud offers courses on Cloud Storage, SQL, and NoSQL database services.
   Link: `https://cloud.google.com/training/storage-and-databases`

Storage and Databases on Cloud Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Storage and Databases on Cloud Lab	ENSP455	0-0-2	1
Type of Course:	SEC		

Defined Course Outcomes

COs	Statements
CO 1	Implementing database migration, backup, recovery, and performance optimization strategies for transitioning on-premise databases to AWS cloud.
CO 2	Developing cloud storage solutions for large-scale file management and optimize performance using AWS storage services and content delivery networks.
CO 3	Design ingand manage cloud data warehousing solutions, including ETL processes, performance monitoring, and scalability configurations.
CO 4	Analyzing and apply best practices from real-world cloud storage use cases to enhance the scalability, reliability, and performance of cloud-based applications.

S.N	**Project Detail**	**Mapped CO/COs**
1	Explore different types of cloud storages (Object, Block, File). Set up and compare examples of each type using a cloud provider (e.g., AWS S3 for object storage, EBS for block storage, EFS for file storage).	CO1
2	Research and analyze the Gartner Magic Quadrant for Cloud Database Management Systems. Create a report summarizing the top cloud database providers and their key features.	CO1
3	Implement a migration process from an on-premise database to a cloud database using a migration tool (e.g., AWS Database Migration Service, Google Cloud Database Migration Service). Document the steps and considerations involved.	CO2
4	Develop a cloud storage solution for a media sharing platform using AWS storage services to handle large-scale file uploads and downloads.	CO2
5	Configure Amazon CloudFront for content delivery. Upload and distribute content using CloudFront and analyze the performance benefits. Briefly explore and set up storage using Google Cloud Storage and Azure Blob Storage.	CO3

S.N	Project Detail	Mapped CO/COs
6	Create a cloud data warehouse for an e-commerce company to store and analyze sales data using AWS Redshift.	CO3
7	Develop a cloud storage and content delivery network (CDN) solution for a video streaming service to ensure high performance and scalability.	CO4
8	Conduct a comprehensive analysis of how major companies like Netflix, Airbnb, and Spotify use cloud storage and databases to enhance their operations.	CO4

Online Learning Resources

- **AWS Documentation:** Comprehensive guide on using AWS storage and database services.
  https://docs.aws.amazon.com/
- **Google Cloud Documentation:** Resources for learning and using Google Cloud storage and database services.
  https://cloud.google.com/docs
- **Microsoft Azure Documentation:** Guide on Azure storage and database services.
  https://docs.microsoft.com/en-us/azure/
- **Coursera:** Courses on cloud storage and database management from leading universities.
  https://www.coursera.org/courses?query=cloud%20storage

Application Development and DevOps on Cloud

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Application Development and DevOps on Cloud	ENSP407	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: 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. The course is divided into 4 modules:

1. Introduction to Cloud Computing
2. Cloud-Based Application Development
3. DevOps Practices in Cloud
4. Cloud-Based DevOps Tools and Best Practices

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the fundamental concepts of cloud computing and the various service and deployment models.
CO 2	Developing cloud-native applications using containerization and microservices architecture.
CO 3	Implementing DevOps practices in cloud environments, including CI/CD pipelines and Infrastructure as Code.
CO 4	Utilizing cloud-based DevOps tools for version control, collaboration, testing, and performance optimization.
CO 5	Analyzing best practices for application security, cost management, and high availability in the cloud.

A student is expected to have learned concepts and demonstrated abilities or skills related to cloud application development and DevOps at the end of the course.

Course Outline

Unit Number: 1	**Title: The Problem of Delivering Software**	**No. of hours: 10**
Content:		
• Introduction to DevOps: Principles, Practices, Common Release antipatterns, benefits • Configuration Management: using version control, managing dependencies, managing software configuration, managing tools		
Unit Number: 2	**Title: Continuous Integration and Testing Strategy**	**No. of hours: 10**
Content:		
• Introduction to Continuous Integration: Implementing continuous integration, Essential practices, distributed version control system • Testing Strategy: Introduction to testing, Types of tests, real-life situation and strategies, and managing defect backlogs		
Unit Number: 3	**Title: The Deployment Pipeline**	**No. of hours: 10**
Content:		
• Anatomy of the Deployment Pipeline: Introduction to deployment pipeline, deployment pipeline practices, the automated acceptance test gate, test strategy, prepare to release, implement a deployment pipeline • Build and Deployment Scripting: The commit stage: principles and practices, Automated Acceptance testing, Testing Non-functional Requirements, deploying and releasing application		
Unit Number: 4	**Title: The Delivering Ecosystem**	**No. of hours: 10**
Content:		

- Managing Infrastructure and Environments: Understanding the needs of the operation team, Managing server provisioning and configuration, managing the configuration of middleware, managing infrastructure services, virtualization, cloud architecture, monitoring infrastructure and application
- Managing Data: Database scripting, data management, and deployment pipeline
- Managing Components and Dependencies: Introduction, keeping your application releasable, dependencies, components, managing dependency graph
- Managing Continuous Delivery: Introduction, maturity model, project lifecycle, risk management process

Learning Experience for Application Development and DevOps on Cloud

Classroom Learning Experience

- **Hands-On Lab Activities:** Students will engage in lab sessions where they set up continuous integration/continuous deployment (CI/CD) pipelines, automate testing and deployment processes, and manage cloud infrastructure using Infrastructure as Code (IaC) tools like Terraform and AWS CloudFormation. These activities provide practical experience in cloud-native application development and DevOps practices.
- **Case Studies and Industry Examples:** The course will feature case studies and examples from companies that have successfully implemented DevOps practices in the cloud. Students will analyze these examples to understand the benefits, challenges, and best practices in cloud-based DevOps.
- **Guest Lectures and Industry Insights:** Industry experts will be invited to share insights on the latest trends and challenges in DevOps and cloud application development. These sessions provide students with valuable industry knowledge and help them stay updated with current best practices.
- **Simulation of DevOps Pipelines:** The course includes simulations where students will build and manage DevOps pipelines, automate testing, deployment, and monitor applications in real-time. These simulations provide a risk-free environment for students to experiment and learn.
- **Continuous Assessment and Feedback:** Students will be continuously assessed through quizzes, assignments, and lab work, with regular feedback to ensure they understand and can apply the concepts taught. This approach helps in reinforcing learning and improving practical skills.

Outside Classroom Learning Experience

- **Real-World Project Work:** The course includes project-based learning where students will work on developing and deploying cloud-native applications using microservices architecture, containerization with Docker, and orchestration with

Kubernetes. These projects simulate real-world scenarios, preparing students for industry challenges.

- **Collaboration and Teamwork:** Students will collaborate in teams to design, develop, and deploy a fully automated DevOps pipeline on cloud platforms like AWS, Azure, or Google Cloud. This teamwork fosters collaboration, communication, and problem-solving skills in a DevOps environment.
- **Exploration of Emerging Trends:** Students are encouraged to explore emerging trends such as serverless architecture, GitOps, and cloud-native security, encouraging them to stay ahead in the rapidly evolving field of cloud DevOps.
- **Self-Study and Research:** Students are encouraged to explore advanced topics like container security, CI/CD optimization, and cloud cost management through independent research and study.
- **Peer Review and Collaboration:** Organize peer review sessions where students collaborate on DevOps projects, provide feedback on each other's pipeline designs, and share insights on improving automation workflows.

Text Books

- Jez Humble and David Farley, "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation," Pearson Education, Inc., 2011.

Reference Books

- Thomas Erl, Ricardo Puttini, and Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture," Prentice Hall, 2013.
- Arun Eapen, "Docker on Amazon Web Services: Build, deploy, and manage your container applications at scale on AWS," Packt Publishing, 2017.
- Sam Newman, "Building Microservices: Designing Fine-Grained Systems," O'Reilly Media, Inc., 2015.
- Mark Richards and Neal Ford, "Fundamentals of Software Architecture: An Engineering Approach," O'Reilly Media, Inc., 2020.

Additional Readings

Self-Learning Components:

1. Microsoft Learn: Azure DevOps and Development
   Description: Comprehensive learning paths and modules on Azure DevOps, including CI/CD, IaC, and cloud-based application development.
   Link: https://docs.microsoft.com/en-us/learn/azure/devops/
2. AWS Training and Certification: DevOps on AWS
   Description: Detailed courses and certifications for learning DevOps practices and application development on AWS, covering tools like AWS CodePipeline, CodeBuild, and more.
   Link: https://aws.amazon.com/training/devops/

3. Google Cloud Training: Application Development
   Description: Google Cloud provides courses on developing applications using Google Cloud services, including Kubernetes, App Engine, and Cloud Functions.
   Link: https://cloud.google.com/training/application-development

Application Development and DevOps on Cloud Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Application Development and DevOps on Cloud Lab	ENSP457	0-0-2	1
Type of Course:	SEC		

Defined Course Outcomes

COs	Statements
CO 1	Implementing continuous integration (CI) pipelines to automate the build, test, and integration processes, ensuring smooth and efficient integration of new code changes.
CO 2	Developing and implement automated deployment pipelines for microservices and mobile applications, ensuring reliable and efficient deployment processes.
CO 3	Integrating comprehensive testing strategies, including acceptance and non-functional requirements testing, into CI/CD pipelines to ensure high code quality and performance standards.
CO 4	Managing and monitor cloud-based application infrastructure using automation tools, ensuring efficient provisioning, configuration, and continuous monitoring.

S.N	**Experiment**	**Mapped CO/COs**
1	Set up a version control system (e.g., Git) for a sample software project. Demonstrate how to manage code versions, branches, and merges.	CO1
2	Implement configuration management using a tool such as Ansible or Chef. Create scripts to manage software configurations and dependencies for a sample application.	CO4
3	Explore common release antipatterns in software delivery. Analyze a real-world case study and propose solutions to mitigate these antipatterns using DevOps principles.	CO2
4	Implement continuous integration for a sample project using a CI tool (e.g., Jenkins, Travis CI). Configure the tool to automatically build and test the project whenever code changes are committed.	CO1

S.N	Experiment	Mapped CO/COs
5	Set up a distributed version control system (e.g., Git) for a collaborative project. Demonstrate branching, merging, and managing code changes in a distributed environment.	CO1
6	Implement a deployment pipeline for a sample application. Automate the build, test, and deployment stages using a CI/CD tool like Jenkins or GitLab CI.	CO2
7	Write and execute build and deployment scripts for a sample project. Use scripting languages like Bash or PowerShell to automate the process.	CO2
8	Set up and configure infrastructure for a sample application using Infrastructure as Code (IaC) tools like Terraform or CloudFormation. Demonstrate server provisioning, middleware configuration, and monitoring.	CO4
9	Implement continuous delivery for a sample project. Develop a maturity model, define the project lifecycle, and establish a risk management process to ensure smooth delivery and deployment.	CO3

Online Learning Resources

- **Git Documentation:** Comprehensive guide on using Git for version control. https://git-scm.com/doc
- **Jenkins Documentation:** Resources for learning and using Jenkins for CI/CD. https://www.jenkins.io/doc/
- **Terraform Documentation:** Guide on using Terraform for infrastructure as code. https://www.terraform.io/docs/
- **Coursera:** Courses on DevOps and cloud computing from leading universities. https://www.coursera.org/courses?query=devops

Discipline Specific Elective - II (Full Stack Development)

Mobile Application Development using iOS

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Mobile Application Development using iOS	ENSP409	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: The objective of the course is to provide skills to develop applications for OS X and iOS. It includes an introduction to the development framework Xcode. Objective-C is used as a programming language to develop 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. The course is divided into 4 modules:

1. Introduction to IDE and SDK of iOS App Development
2. Swift Programming
3. Encapsulating Data
4. Developing iOS Applications

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the fundamental concepts of variables, constants, and basic data types in SWIFT.
CO 2	Analyzing the use of control flow statements such as for, if, and switch in various programming scenarios.
CO 3	Applying object-oriented concepts in SWIFT, including the use of classes, structures, and protocols.
CO 4	Creating functions, closures, and extensions to enhance code modularity and reuse.
CO 5	Evaluating error handling techniques and type checking mechanisms to develop robust SWIFT applications.

A student is expected to have learned concepts and demonstrated abilities or skills related to mobile application development using iOS at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to SWIFT Language**	**No. of hours: 10**
Content:		
• Variables & Constants, Introduction to functions (methods), Arrays, Dictionaries, Data, Date and other basic data types, Enums, structures, closures • For, If, switch statement, Object-oriented concepts with SWIFT • Type check, AnyObject, Any Protocols, Extensions, Error handling, Working with classes		
Unit Number: 2	**Title: Working with Xcode**	**No. of hours: 8**
Content:		
• Introduction to XCODE, COCOA touch framework, iOS application architecture, Application lifecycle		
Unit Number: 3	**Title: Introduction to View Controllers and Views**	**No. of hours: 12**
Content:		
• View Controllers, view, view lifecycle, Basic Controls – Label, Buttons, Text field, image View, Table view with default cells and customized cells • Collection view with default cells and customized cells, Picker view, Date picker, scroll view, navigation and Tab bar controller • Understanding Interface builder, XIB files, Creating outlets and Actions, Handling touch and gesture events, Segment and Page control, switch view, UIAlertView		
Unit Number: 4	**Title: Integrating with Database**	**No. of hours: 10**
Content:		
• Introduction to data storage methods in iOS, Using Core Data, SQLite database, User Defaults, Property List		

Learning Experience for Mobile Application Development using iOS

Classroom Learning Experience

- **Hands-On Development:** Students will actively engage in building iOS applications using Xcode, starting from the basics of Swift programming to developing complex apps with integrated databases. This hands-on approach ensures that students gain practical experience in coding, debugging, and deploying iOS apps.

- **Exploration of iOS Ecosystem:** Students will explore various components of the iOS ecosystem, including the use of Apple's frameworks, design patterns, and best practices for app development. This exploration helps students create apps that are efficient, user-friendly, and aligned with industry standards.

- **Real-World Case Studies:** The course will incorporate case studies of successful iOS applications, analyzing their design, architecture, and development process. This analysis helps students learn from existing apps and apply these lessons to their own projects.

- **Guest Lectures and Industry Insights:** Industry experts will be invited to share their experiences and insights into mobile application development. These sessions provide valuable industry perspectives, keeping students updated on the latest trends and best practices in iOS development.

- **Continuous Feedback and Assessment:** Regular assessments through quizzes, assignments, and project presentations ensure that students are on track with their learning. Continuous feedback helps students improve their coding skills and understand the nuances of iOS app development.

Outside Classroom Learning Experience

- **Project-Based Learning:** The course includes comprehensive projects where students design and develop complete iOS applications. These projects help students apply theoretical knowledge to real-world scenarios, such as creating user interfaces, managing app states, and working with data persistence.

- **Team Collaboration:** Students will work in teams to develop iOS apps, fostering collaboration, communication, and project management skills. These team projects simulate professional environments, preparing students for industry roles.

- **Advanced Topics and Emerging Trends:** Students will be introduced to advanced topics such as Core Data, integrating with cloud services, and using third-party libraries. Additionally, emerging trends in iOS development, such as SwiftUI and ARKit, will be explored, encouraging students to stay ahead in the rapidly evolving field of mobile development.

- **Self-Study and Research:** Encourage students to independently explore additional iOS development topics such as accessibility features, performance optimization, and app store submission guidelines through self-study and research.

- **Peer Collaboration and Review:** Organize peer review sessions where students provide feedback on each other's iOS projects, fostering a collaborative learning environment and helping students improve their design and coding skills.

Text Books

- "iOS 14 Programming for Beginners: Kickstart your iOS app development journey with the Swift programming language and Xcode 12, 6th Edition" by Ahmad Sahar and Craig Clayton
- "Mastering iOS 14 Programming: Build professional-grade iOS applications with Swift 5 and Xcode 12" by Ahmad Sahar and Craig Clayton

Reference Books

- "iOS 14 Programming for Beginners: Kickstart your iOS app development journey with the Swift programming language and Xcode 12, 6th Edition" by Ahmad Sahar and Craig Clayton
- "Mastering iOS 14 Programming: Build professional-grade iOS applications with Swift 5 and Xcode 12" by Ahmad Sahar and Craig Clayton

Additional Readings

Self-Learning Components:

1. Apple Developer Documentation
   Description: Comprehensive documentation and tutorials for iOS app development using Swift and Xcode.
   Link: https://developer.apple.com/documentation/
2. Ray Wenderlich: iOS and Swift Tutorials
   Description: A collection of high-quality tutorials and courses on iOS app development, covering Swift, Xcode, and various iOS frameworks.
   Link: https://www.raywenderlich.com/ios
3. GitHub: iOS Development Resources
   Description: A curated list of open-source projects, libraries, and resources for learning and improving iOS development skills.
   Link: https://github.com/vsouza/awesome-ios

Mobile Application Development using iOS Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Mobile Application Development using iOS Lab	ENSP459	0-0-2	1
Type of Course:	SEC		

Defined Course Outcomes

COs	Statements
CO 1	Understanding and apply fundamental concepts of iOS development using Xcode and the Cocoa Touch framework to build robust and user-friendly applications.
CO 2	Developing interactive and dynamic user interfaces in iOS applications using view controllers, views, and gesture recognizers.
CO 3	Creating and manage user interfaces and view controllers in iOS applications using Xcode, demonstrating proficiency in Interface Builder and UIKit components.
CO 4	Developing interactive and dynamic user interfaces in iOS applications using view controllers, views, and gesture recognizers.

S.N	Experiment	Mapped CO/COs
1	Set up the iOS development environment by installing Xcode. Create a simple "Hello, World!" iOS application to familiarize with the Xcode IDE and Swift programming basics.	CO1
2	Develop a basic iOS application that demonstrates the use of Swift syntax, variables, data types, and control flow. Create a simple calculator app to perform basic arithmetic operations.	CO1
3	Use Xcode and Interface Builder to design a user interface for an iOS app. Create a simple user interface with labels, buttons, and text fields, and handle user interactions.	CO3
4	Implement a simple iOS app to demonstrate the app lifecycle and navigation between view controllers. Create a multi-screen app that navigates between different views using navigation controllers.	CO1

S.N	Experiment	Mapped CO/COs
5	Design a responsive user interface using Auto Layout and the constraint system. Create an iOS app with a login screen that adjusts to different screen sizes and orientations.	CO2
6	Implement navigation between different views using storyboards and segues. Create a multi-screen app with a main menu and detailed views for each menu item.	CO2
7	Implement gesture recognition and touch event handling in an iOS app. Create an app that responds to tap, swipe, and pinch gestures to perform different actions.	CO2
8	Implement data persistence using Core Data. Create an iOS app that allows users to add, edit, and delete notes, and save them to a local database.	CO1
9	Use User Defaults and the file system to store and retrieve user preferences and data. Create an app that saves user settings and displays them when the app is reopened.	CO1
10	Implement offline data storage and synchronization. Create an iOS app that allows users to add data while offline and syncs with a remote server when the device is back online.	CO1
11	Implement advanced UI components and animations in an iOS app. Create a visually appealing app with custom views, animations, and transitions between screens.	CO3
12	Access and use iOS sensors and hardware features. Create an app that uses the camera to take photos, and the GPS to display the user's current location on a map.	CO2
13	Debug and test an iOS app using Xcode's debugging tools. Implement unit tests and UI tests to ensure the app functions correctly under different scenarios.	CO4

Online Learning Resources

- **Apple Developer Documentation:** Comprehensive guide on iOS development and using Xcode.
  https://developer.apple.com/documentation/
- **Swift Documentation:** Resources for learning and using Swift for iOS development.
  https://swift.org/documentation/
- **Ray Wenderlich:** Tutorials and guides on iOS app development.
  https://www.raywenderlich.com/
- **Coursera:** Courses on iOS app development from leading universities.
  https://www.coursera.org/courses?query=ios%20app%20development

DevOps & Automation

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
DevOps & Automation	ENSP411	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: 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. The course is divided into 4 modules:

1. Introduction to DevOps
2. Version Control and CI/CD
3. Containerization and Orchestration
4. Configuration Management and Monitoring

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding the principles and benefits of DevOps, and its role in enhancing collaboration and efficiency between development and operations teams.
CO 2	Acquiring 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.
CO 3	Demonstrating proficiency in containerization and orchestration techniques using Docker and Kubernetes for efficient and scalable application deployment and management.
CO 4	Implementing configuration management and Infrastructure as Code (IaC) using Ansible and Terraform to automate the provisioning and management of infrastructure resources.
CO 5	Developing skills in monitoring, logging, and security practices in the context of DevOps, ensuring application performance, resilience, and adherence to security best practices.

A student is expected to have learned concepts and demonstrated abilities or skills related to DevOps and automation at the end of the course.

Course Outline

Unit Number: 1	**Title: Introduction to DevOps**	**No. of hours: 12**
Content:		
• DevOps Principles and Culture: Understand the core principles of DevOps and its cultural impact. Collaboration, automation, continuous integration, continuous delivery, and continuous deployment. • DevOps Toolchain: Overview of tools and technologies used in DevOps practices. 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.		
Unit Number: 2	**Title: Version Control and CI/CD**	**No. of hours: 8**
Content:		
• Version Control with Git: Version control concepts, Git workflows, and collaboration strategies. • Continuous Integration with Jenkins: Setting up Jenkins pipelines, automated testing, and deployment. • Maven Integration: Integrate Maven for dependency management and building projects.		
Unit Number: 3	**Title: Containerization and Orchestration**	**No. of hours: 8**
Content:		
• Introduction to Docker: Docker concepts, container management, and Docker file creation. • Container Orchestration with Kubernetes: Kubernetes architecture, deployment, scaling, and networking. • Docker Compose: Managing multi-container applications with Docker Compose.		
Unit Number: 4	**Title: Configuration Management and Monitoring**	**No. of hours: 12**
Content:		

- Configuration Management with Ansible: Ansible playbooks, roles, and infrastructure automation.
- Infrastructure as Code (IaC): Terraform for provisioning and managing infrastructure.
- Monitoring and Logging: Monitoring tools, log management, and application performance monitoring in DevOps.
- Security in DevOps: Implementing security best practices in CI/CD pipelines and containerized environments.

Learning Experience for DevOps & Automation

Classroom Learning Experience

- **Hands-On Tool Usage:** Students will gain practical experience with a wide range of DevOps tools, such as Git, Jenkins, Docker, Kubernetes, Ansible, and Terraform. Through labs and assignments, they will learn to implement continuous integration, continuous delivery, and automated deployment processes.
- **Industry-Relevant Case Studies:** The course will feature case studies from leading tech companies, analyzing how they implement DevOps practices and automation in their operations. This will provide students with insights into industry standards and best practices.
- **Exploration of Automation Techniques:** Students will explore various automation techniques in DevOps, including the use of scripting, configuration management tools, and Infrastructure as Code. This will enable them to automate repetitive tasks and manage large-scale infrastructures efficiently.
- **Real-Time Monitoring and Logging:** Students will learn to implement monitoring and logging solutions to ensure application performance, availability, and security. They will work with tools like Prometheus, Grafana, and ELK Stack to gain insights into system health and troubleshoot issues effectively.
- **Continuous Feedback and Iterative Learning:** Regular assessments, including quizzes, assignments, and peer reviews, will be used to gauge student understanding and provide feedback. This iterative approach will allow students to continuously improve their skills and knowledge.

Outside Classroom Learning Experience

- **Project-Based Learning:** The course will include projects where students will work on real-world scenarios, such as setting up CI/CD pipelines, containerizing applications, and managing infrastructure as code. These projects will help students apply their knowledge in practical contexts, preparing them for industry roles.
- **Collaboration and Teamwork:** Students will engage in collaborative projects that mimic real-world DevOps practices, emphasizing the importance of teamwork, communication, and shared responsibility in software development and operations.

- **Advanced Topics and Emerging Trends:** The course will introduce advanced topics such as microservices architecture, serverless computing, and DevSecOps. Students will also stay updated on emerging trends in DevOps and automation, preparing them for future developments in the field.
- **Security Integration:** Emphasis will be placed on integrating security practices within the DevOps pipeline, ensuring that students are equipped to build secure, compliant, and resilient systems.
- **Self-Study and Peer Review:** Encourage students to explore additional DevOps practices and trends through independent research, while organizing peer review sessions to provide feedback on each other's projects and automation workflows.

Text Books

- "Continuous Delivery: Reliable Software Releases through Build, Test, and Deployment Automation" by Jez Humble and David Farley, Pearson Education, Inc., 2011

Reference Books

- "The Kubernetes Book" by Nigel Poulton, Independently published, 2018
- "Building Microservices: Designing Fine-Grained Systems" by Sam Newman, O'Reilly Media, Inc., 2015
- "Microservices Patterns: With examples in Java" by Eberhard Wolff, Manning Publications, 2018
- "Terraform: Up & Running: Writing Infrastructure as Code" by Yevgeniy Brikman, O'Reilly Media, Inc., 2017

Additional Readings

Self-Learning Components:

1. Kubernetes Academy by VMware
   Description: Free courses provided by VMware on Kubernetes, covering everything from basic concepts to advanced orchestration techniques.
   Link: https://kubernetes.academy
2. HashiCorp Learn: Terraform
   Description: HashiCorp's official resource for learning Terraform, providing tutorials and hands-on labs for infrastructure as code.
   Link: https://learn.hashicorp.com/terraform
3. Docker: Docker for Developers
   Description: Docker's official training resources for developers, covering containerization, Docker Compose, and more.
   Link: https://www.docker.com/docker-developer

DevOps & Automation Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
DevOps & Automation Lab	ENSP461	0-0-2	1
Type of Course:	SEC		

Defined ing

COs	Statements
CO 1	Implementing collaborative development and continuous integration using Git and Jenkins, demonstrating proficiency in version control, automated testing, and deployment processes.
CO 2	Developing and deploy microservices applications using Docker for containerization and Kubernetes for orchestration, managing multi-container applications efficiently.
CO 3	Managing automated infrastructure provisioning and configuration using Ansible and Terraform, demonstrating expertise in infrastructure as code and configuration management.
CO 4	Implementing continuous monitoring, logging, and security best practices in a DevOps environment, ensuring application performance, system health, and data integrity.

S.N	Experiment	Mapped CO/COs
1	Set up a Git repository and practice branching, merging, and collaborative development. Create a small project and manage code versions using Git.	CO1
2	Install and configure Jenkins for continuous integration. Create a simple CI pipeline that automatically builds and tests a project whenever code changes are committed to the repository.	CO1
3	Implement a continuous delivery pipeline using Jenkins. Deploy a sample application to a staging environment automatically after successful builds and tests.	CO1
4	Implement different Git workflows (e.g., GitFlow, Feature Branch Workflow) for a collaborative project. Manage branches, merges, and resolve conflicts.	CO1
5	Set up a Jenkins pipeline for continuous integration. Configure automated testing and deployment for a sample project. Integrate with a version control system like Git.	CO1

S.N	Experiment	Mapped CO/COs
6	Install Docker and create Dockerfiles for a sample application. Build, run, and manage containers using Docker commands.	CO2
7	Use Docker Compose to manage multi-container applications. Create a Docker Compose file to run a web application with a database and other services.	CO2
8	Use Terraform to provision and manage cloud infrastructure. Create Terraform scripts to deploy a web application on a cloud provider (e.g., AWS, Azure).	CO3
9	Set up monitoring and logging for a sample application. Use tools like Prometheus, Grafana, and ELK Stack (Elasticsearch, Logstash, Kibana) to monitor and analyze application performance and logs.	CO4

Online Learning Resources

- **Git Documentation:** Comprehensive guide on using Git for version control.
  https://git-scm.com/doc

- **Jenkins Documentation:** Resources for learning and using Jenkins for CI/CD.
  https://www.jenkins.io/doc/

- **Docker Documentation:** Guide on using Docker for containerization.
  https://docs.docker.com/

- **Terraform Documentation:** Guide on using Terraform for infrastructure as code.
  https://www.terraform.io/docs/

- **Prometheus Documentation:** Resources for learning and using Prometheus for monitoring.
  https://prometheus.io/docs/introduction/overview/

- **ELK Stack Documentation:** Guide on using the ELK Stack for logging and monitoring.
  https://www.elastic.co/what-is/elk-stack

.NET Framework

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
.NET Framework	ENSP413	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: 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. The course is divided into 4 modules:

1. .NET Framework
2. .NET Framework Fundamentals
3. Building Applications with .NET Framework
4. ASP.NET Framework

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding .NET Framework's architecture, CLR, and CTS for cross-language integration and platform independence.
CO 2	Applying OOP concepts in .NET for designing robust software solutions.
CO 3	Utilizing Visual Studio debugging for diagnosing and fixing errors in .NET applications.
CO 4	Demonstrating proficiency in memory management and garbage collection in .NET.
CO 5	Designing web applications using ASP.NET, incorporating best practices.

A student is expected to have learned concepts and demonstrated abilities or skills related to the .NET Framework at the end of the course.

Course Outline

Unit Number: 1	**Title: .NET Framework**	**No. of hours: 8**
Content:		
• .NET Framework - Architecture, Common Language Runtime, Common Type System, Namespaces, Assemblies, Memory Management, Process Management, Class Libraries		
Unit Number: 2	**Title: .NET Framework Fundamentals**	**No. of hours: 8**
Content:		
• 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, Finalizers and the Dispose pattern		
Unit Number: 3	**Title: Building Applications with .NET Framework**	**No. of hours: 12**
Content:		
• .NET - Declaration, Expression, Control Structures, Function, String, Array, Encapsulation, Class, Property, Indexer, Delegate, Inheritance, Interface, Polymorphism, Exception Handling, Modules, Graphics, File handling and Data Access. • .NET – Form- Event–Form Controls – Containers – Menus - Data controls - Printing – Reporting – Dialogs – Components - Single and Multiple Document Interfaces.		
Unit Number: 4	**Title: ASP.NET Framework**	**No. of hours: 12**
Content:		
• ASP.NET – Web Pages, Web Forms, Web Site Design, Data Controls, Validation Controls, HTML, Navigation Controls, Login Controls, Reports - Master Pages – Web Service Architecture - Basic Web Services – Web Reference – Standards		

Learning Experience for .NET Framework

Classroom Learning Experience

- **Comprehensive Understanding of .NET Architecture:** Students will develop a deep understanding of the .NET Framework, including its architecture, components, and functionalities such as the Common Language Runtime (CLR) and the Common Type System (CTS). This knowledge is essential for building cross-platform and language-integrated applications.

- **Hands-On OOP in .NET:** Through practical exercises, students will apply Object-Oriented Programming (OOP) concepts within the .NET environment. They will design and implement classes, objects, inheritance, and polymorphism, which are crucial for creating robust and maintainable software solutions.
- **Debugging and Exception Handling:** The course emphasizes the importance of debugging and error handling in software development. Students will gain hands-on experience with Visual Studio's debugging tools and learn how to manage exceptions effectively, ensuring the reliability of their applications.
- **Memory Management Proficiency:** Understanding and implementing memory management techniques in .NET is a critical skill. Students will learn about garbage collection, finalizers, and the Dispose pattern, which are essential for optimizing application performance and resource management.
- **Continuous Feedback and Iterative Learning:** Regular assessments, peer reviews, and instructor feedback will help students refine their skills and knowledge. This iterative learning process ensures that students can continuously improve and adapt to the complexities of .NET development.

Outside Classroom Learning Experience

- **Application Development with Visual Studio:** The course includes extensive hands-on sessions where students will build both desktop and web applications using Visual Studio. They will learn to use various controls, event handling, data access methods, and form designs to create fully functional applications.
- **Web Development with ASP.NET:** Students will explore the ASP.NET framework, gaining the ability to design and develop dynamic web pages and services. They will work with web forms, data controls, validation controls, and master pages to build secure and scalable web applications.
- **Real-World Project Development:** The course culminates in a capstone project where students will apply all the concepts learned to develop a complete .NET application. This project-based learning approach ensures that students are industry-ready and can confidently develop enterprise-level applications.
- **Exploration of Advanced .NET Features:** Students will explore advanced features of the .NET Framework, such as working with Windows Presentation Foundation (WPF) and Windows Communication Foundation (WCF). These features allow for the creation of rich user interfaces and reliable communication services.
- **Self-Study and Research:** Encourage students to independently explore additional .NET topics such as asynchronous programming, LINQ, and secure coding practices to deepen their knowledge of the framework.

Text Books

- "Pro C# 8 with .NET Core: Foundational Principles and Practices in Programming" by Andrew Troelsen and Philip Japikse, Apress, 9th Edition, 2020

- "Pro ASP.NET Core 3" by Adam Freeman, Apress
- "ASP.NET Core in Action" by Andrew Lock

Reference Books

- "Pro C# 8 with .NET Core: Foundational Principles and Practices in Programming" by Andrew Troelsen and Philip Japikse, Apress, 9th Edition, 2020
- "Pro ASP.NET Core 3" by Adam Freeman, Apress
- "ASP.NET Core in Action" by Andrew Lock

Additional Readings

Self-Learning Components:

1. Microsoft .NET Documentation
   Description: Direct students to the official Microsoft documentation for .NET Framework, which provides comprehensive guides and resources.
   Link: https://docs.microsoft.com/en-us/dotnet/

2. LeetCode
   Description: Assign coding exercises from platforms like LeetCode that focus on implementing concepts of .NET Framework.
   Link: https://leetcode.com/

3. HackerRank
   Description: Assign coding exercises from platforms like HackerRank that focus on implementing concepts of .NET Framework.
   Link: https://www.hackerrank.com/

4. GitHub
   Description: 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.
   Link: https://github.com/

.NET Framework Lab

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
.NET Framework Lab	ENSP463	0-0-2	1
Type of Course:	SEC		

Defined Course Outcomes

COs	Statements
CO 1	Understanding and apply object-oriented design principles, exception handling, memory management, and debugging techniques to develop robust .NET applications.
CO 2	Developing graphical user interfaces and handle events in .NET applications to create interactive and user-friendly software solutions.
CO 3	Implementing web development techniques in ASP.NET, including web forms, user authentication, master pages, and web services to build secure and dynamic web applications.
CO 4	Analyzing and utilize data handling, reporting, and visualization techniques to create comprehensive and functional software systems for various domains.

S.N	Experiment	Mapped CO/COs
1	Explore the architecture of the .NET Framework. Create a simple console application to understand the basic structure and components of a .NET project.	CO1
2	Demonstrate the functionality of the Common Language Runtime (CLR). Create a .NET application that uses various data types and namespaces to show how the CLR manages execution.	CO1
3	Implement a .NET application that showcases the Common Type System (CTS). Define and use various data types, and demonstrate type conversion and interoperability.	CO1
4	Create and manage assemblies in a .NET application. Demonstrate how to build, reference, and use assemblies in a multi-project solution.	CO1
5	Implement a simple object-oriented application in .NET. Define classes, create objects, and demonstrate inheritance and polymorphism.	CO2
6	Implement a .NET application that logs errors and handles exceptions gracefully. Use a logging framework (e.g., NLog, log4net) to record application events and errors.	CO2

S.N	Experiment	Mapped CO/COs
7	Build a .NET application demonstrating advanced OOP concepts such as encapsulation, properties, indexers, delegates, interfaces, and polymorphism.	CO3
8	Create a .NET application that handles graphics and file I/O. Implement functionality to draw shapes, handle images, and perform file read/write operations.	CO3
9	Implement a .NET application with a rich user interface. Use forms, event handling, form controls, containers, menus, data controls, printing, and reporting functionalities to create a feature-rich application.	CO3
10	Create a basic ASP.NET web application. Design web pages and web forms to understand the structure and components of an ASP.NET project.	CO4
11	Develop an ASP.NET application with user authentication. Use login controls to implement user authentication and authorization, and create a simple reporting feature to display user data.	CO4
12	Create and consume a basic web service in ASP.NET. Implement a web service that provides data to a client application, and demonstrate how to use web references to integrate the web service with an ASP.NET project.	CO4

Online Learning Resources

- **Microsoft .NET Documentation:** Comprehensive guide on using .NET for application development.
  https://docs.microsoft.com/en-us/dotnet/
- **ASP.NET Documentation:** Resources for learning and using ASP.NET for web development.
  https://docs.microsoft.com/en-us/aspnet/core/
- **Microsoft Learn:** Interactive tutorials and learning paths for .NET and ASP.NET.
  https://docs.microsoft.com/en-us/learn/dotnet/
- **Pluralsight:** Training and certification courses for .NET and ASP.NET development.
  https://www.pluralsight.com/paths/dotnet

New Age Programming Languages

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
New Age Programming Languages	ENSP415	4-0-0	4
Type of Course:	SEC		
Pre-requisite(s):	None		

Course Perspective: New-Age programming languages (GO, F#, Clojure, Kotlin) provide an introduction to the concepts and applications of modern programming languages. It explores the features and benefits of GO, F#, Clojure, and Kotlin, and develops 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. The course is divided into 4 modules:

1. GO Programming Language
2. F# Programming Language
3. Clojure Programming Language
4. Kotlin Programming Language

The Course Outcomes (COs)

On completion of the course, the participants will be able to:

COs	Statements
CO 1	Understanding principles and paradigms of modern programming languages.
CO 2	Developing proficiency in syntax, data structures, and control flow of each language.
CO 3	Exploring unique features and strengths of each language.
CO 4	Applying development tools to improve code quality and productivity.
CO 5	Designing and implement projects integrating multiple programming languages.

A student is expected to have learned concepts and demonstrated abilities or skills related to modern programming languages at the end of the course.

Course Outline

Unit Number: 1	**Title: GO Programming Language**	**No. of hours: 10**
Content:		
• Overview and Comparison: Overview of GO, F#, Clojure, and Kotlin, Comparison with traditional programming languages, Installation and setup of development environment • GO Programming Basics: Introduction to GO syntax and data types, Control structures in GO, Functions and packages, Arrays, slices, and maps, Structs and custom data types, Pointers and memory management		
Unit Number: 2	**Title: F# Programming Language**	**No. of hours: 10**
Content:		
• 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:		
• Introduction to Clojure: Overview of Clojure and its features, Setting up the development environment • Basic Syntax and Functional Programming, Basic syntax and data structures, Functional programming concepts, Immutable data and pure functions, Higher-order functions and recursion, Collections and sequence operations, Restructuring and pattern matching • 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:		

- 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

Learning Experience for New Age Programming Languages

Classroom Learning Experience

- **Exploration of Modern Programming Paradigms:** Students will gain exposure to a diverse range of programming paradigms, including functional, concurrent, and object-oriented programming, by exploring languages such as GO, F#, Clojure, and Kotlin. This broadens their understanding of different approaches to software development.

- **Hands-On Coding with New-Age Languages:** Through practical assignments, students will become proficient in the syntax, control structures, and unique features of each language. They will build applications that demonstrate their ability to write clean, efficient, and effective code using GO, F#, Clojure, and Kotlin.

- **Functional Programming Proficiency:** The course places a strong emphasis on functional programming, particularly in F# and Clojure. Students will learn to implement functional constructs such as higher-order functions, immutability, and recursion, which are essential for developing scalable and maintainable code.

- **Concurrency and Parallelism in GO and F#:** Students will explore the concurrency models in GO and F#, gaining hands-on experience in writing concurrent applications. This includes understanding goroutines in GO and asynchronous workflows in F#, preparing them to tackle performance-critical tasks in modern software systems.

- **Integration with Modern Technologies:** The course will teach students how to integrate these modern programming languages with contemporary tools and technologies, such as databases, web frameworks, and cloud services. This ensures that students are equipped to use these languages in real-world development environments.

Outside Classroom Learning Experience

- **Project-Based Learning:** Students will apply their learning by developing projects that integrate multiple programming languages. These projects will demonstrate their ability to select the appropriate language for a given task and to combine the strengths of various languages in a single application.
- **Advanced Programming Techniques:** The course will introduce advanced topics such as metaprogramming in Clojure, domain-specific languages (DSLs) in Kotlin, and memory management in GO. Students will gain insights into how these techniques can be used to optimize and extend the capabilities of their applications.
- **Continuous Feedback and Collaboration:** The learning experience will be enhanced by regular peer reviews, code walkthroughs, and instructor feedback. This collaborative environment will encourage students to refine their skills and learn from their peers, fostering a deeper understanding of the course material.
- **Development of a Language-Agnostic Perspective:** By studying multiple languages, students will develop a language-agnostic mindset, allowing them to adapt quickly to new programming languages and paradigms in the future. This adaptability is crucial in the ever-evolving field of software development.
- **Self-Study and Research:** Encourage students to independently explore additional language-specific features, libraries, and best practices, enhancing their understanding of each language's unique capabilities and applications.

Text Books

- "The Go Programming Language" by Alan A. A. Donovan and Brian W. Kernighan, Addison-Wesley Professional.
- "An Introduction to Programming in Go" by Caleb Doxsey, CreateSpace Independent Publishing.

Reference Books

- "Real-World Functional Programming: With Examples in F# and C#" by Tomas Petricek and Jon Skeet, Manning.
- "Programming F# 3.0: A Comprehensive Guide for Writing Simple Code to Solve Complex Problems" by Chris Smith, O'Reilly Media.
- "Getting Clojure: Build Your Functional Skills One Idea at a Time" by Russ Olsen, O'Reilly.
- "The Joy of Clojure" by Michael Fogus and Chris Houser, Manning Publication.
- "Atomic Kotlin" by Bruce Eckel and Svetlana Isakova, Mindview LLC.
- "Kotlin in Action" by Dmitry Jemerov and Svetlana Isakova, Manning Publication.

Additional Readings

Self-Learning Components:

1. Go (Golang)

   (a) Coursera: Programming with Google Go
   Description: An introductory course to Go programming, covering language syntax, data structures, and more.
   Link: https://www.coursera.org/learn/golang-programming

   (b) Go by Example
   Description: A hands-on introduction to Go using annotated example programs.
   Link: https://gobyexample.com/

2. F#

   (a) Microsoft Learn: Introduction to F#
   Description: A series of modules introducing the F# language, its syntax, and functional programming concepts.
   Link: https://docs.microsoft.com/en-us/learn/modules/fsharp-introduction/

3. Clojure

   (a) ClojureBridge
   Description: Free Clojure workshops for beginners, including resources and exercises.
   Link: https://clojurebridge.org/

   (b) Learn Clojure: Clojure for the Brave and True
   Description: A beginner-friendly book that teaches Clojure through real-world projects and examples.
   Link: https://www.braveclojure.com/clojure-for-the-brave-and-true/

4. Kotlin

   (a) Kotlin Lang: Kotlin Documentation
   Description: Official Kotlin documentation and tutorials by JetBrains.
   Link: https://kotlinlang.org/docs/reference/

   (b) Udacity: Kotlin for Android Developers
   Description: A course by Udacity focusing on Kotlin for Android development.
   Link: https://www.udacity.com/course/kotlin-for-android-developers--ud888

Semester: 6

Major Project/Indusrial Training/Startup

Program Name:	B.Sc (Hons.) Data Science		
Course Name:	**Course Code**	**L-T-P**	**Credits**
Major Project/Indusrial Training/Startup	SIBC352	0-0-0	12
Type of Course:	Proj		
Pre-requisite(s):	None		

Preface

The **B.Sc (Hons.) Data Science Final Semester Major Project/Industrial Training/Startup** is a culmination of the academic journey for students in this program. This Standard Operating Procedure (SOP) is designed to provide guidance, ensuring a comprehensive, practical, and outcome-driven approach. The SOP provides a framework for students to choose from three types of projects—Industrial Projects, Research & Development (R&D) Projects, and Start-up Projects—emphasizing experiential learning, problem-solving, and interdisciplinary collaboration. Students will be mentored by both internal faculty and external industry or academic experts.

1. Introduction

The **B.Sc (Hons.) Data Science Final Semester Major Project/Industrial Training/Startup** is an essential academic requirement that enables students to apply theoretical knowledge to practical challenges. This project fosters critical thinking, problem-solving, innovation, and research-oriented learning with a focus on real-world problems in industrial, research, and entrepreneurial domains. Students may choose from:

- **Industrial Project:** Solving real industrial problems in collaboration with an industry partner.
- **Research & Development (R&D) Project:** Contributing to academic and applied research, with external guidance from academic or research institutions.
- **Start-up Project:** Developing and launching innovative start-up ideas with entrepreneurial mentors.

The SOP ensures that these projects emphasizing interdisciplinary, practical, and outcome-based learning.

2. Objectives

The primary objectives of the full-time project are:

- **Application of Theoretical Knowledge:** Enable students to apply their academic learning to practical problems.
- **Holistic Development:** Promote interdisciplinary learning, critical thinking, creativity, and problem-solving.
- **Research and Innovation:** Encourage innovative solutions, leading to publications, patents, or prototypes.
- **Industry Collaboration:** Foster partnerships with industries for real-world problem-solving.
- **Entrepreneurship Development:** Develop entrepreneurial skills and create viable start-ups.
- **Global Competency:** Equip students with the skills required to excel in global environments through research, innovation, and collaboration.

3. Types of Projects

a) Industrial Project

Students working on Industrial Projects will:

- Collaborate with an industry partner.
- Identify specific, real-world challenges faced by the company.
- Propose and implement a solution that provides value to the industry.
- Develop a final product or prototype that can be implemented in the industrial setting.

Project Proposal:

- **Problem Statement and Objectives:** Identify the industrial problem and outline the objectives.
- **Proposed Solution:** Present a detailed methodology for solving the problem.
- **Deliverables:** Define tangible deliverables, including prototypes, software, or hardware.
- **Expected Impact:** Outline the expected impact on the industry.

Evaluation Criteria:

- Practical implementation and solution viability (40%)
- Project innovation (20%)
- Industrial applicability and impact (20%)
- Final presentation and report quality (20%)

b) Research & Development (R&D) Project

The R&D Project focuses on creating innovative research outcomes through collaborations with academic or research institutions. This can result in publications, research reports, or new discoveries.

Project Proposal:

- **Literature Review:** Detailed research on existing work related to the chosen topic.
- **Hypothesis/Research Questions:** Define the specific research problem or question.
- **Methodology:** Include data collection, experimental design, and analysis techniques.
- **Research Timeline:** Step-by-step phases of research with milestones.

Mentorship:

- **External Mentor:** Collaboration with an external academic expert is mandatory for research projects.
- **Internal Mentor:** Each student will also be assigned an internal faculty member who will supervise the project.

Evaluation Criteria:

- Quality of Research and Novelty (30%)
- Research Methodology (25%)
- Contributions to the field (20%)
- Final Report, Presentation, and Publication (25%)

c) Start-up Project

The Start-up Project involves developing a business model or creating a start-up venture. Students work on a product/service idea that addresses a significant market need or societal problem.

Project Proposal:

- **Start-up Idea:** Explain the business or product idea.
- **Market Research:** Detailed research on the market, target customers, competitors, and potential revenue streams.
- **Business Plan:** Define the steps needed to take the idea to market, including funding, development phases, marketing, and operational plans.
- **Product Prototype:** If applicable, develop a working prototype.

Mentorship:

- **External Mentor:** An industry/start-up expert will guide the student.

- **Internal Faculty Mentor:** An internal mentor will provide academic guidance and ensure the start-up idea is feasible and innovative.

Evaluation Criteria:

- Start-up viability and market potential (30%)
- Product or service innovation (30%)
- Prototype/Business Model Development (20%)
- Final Pitch/Presentation and Start-up Plan (20%)

4. Roles and Responsibilities

a) Student's Responsibilities

- Select a suitable project topic based on interests (industrial, R&D, or start-up).
- Draft and submit a detailed proposal with objectives, methodology, timelines, and deliverables.
- Coordinate with both external and internal mentors regularly for feedback and guidance.
- Maintain a weekly progress report for both mentors.
- Submit a final comprehensive report and present the project.

b) Internal Supervisor

- Guide the student throughout the project.
- Provide academic input and ensure the project aligns with program outcomes.
- Conduct progress reviews and ensure timelines are adhered to.
- Evaluate the project at the mid-term and final stages.

c) External Mentor

- Offer specialized industrial, research, or entrepreneurial guidance.
- Provide real-world problem insights for industrial and start-up projects.
- Ensure the project is relevant to the chosen industry, research domain, or start-up ecosystem.
- Participate in the final evaluation of the project.

5. Project Phases

Phase 1: Proposal Submission and Approval

- Students must submit a project proposal during the first two weeks of the final semester.
- The proposal must include the problem statement, objectives, literature review (for R&D projects), methodology, and expected outcomes.
- The proposal is subject to review and approval by the internal supervisor and external mentor.

Phase 2: Planning and Resource Allocation

- Once approved, the student will develop a project plan that includes:
  - **Project Milestones:** Break down the project into smaller tasks with defined milestones.
  - **Resource Requirements:** Identify any software, hardware, lab resources, or tools required for the project.
  - **Team Roles:** For group projects, define the roles of each team member.
  - **Risk Assessment:** Highlight potential risks and corresponding mitigation strategies.

Phase 3: Mid-term Review

- A mid-term review will be conducted halfway through the project to assess progress.
- Students will present their work to a committee consisting of the internal supervisor, external mentor, and department head.
- The review will assess the progress against the timeline and suggest course corrections if needed.

Phase 4: Final Execution and Evaluation

- **Industrial Projects:** Students must submit a prototype or industrial report.
- **R&D Projects:** Students must submit a final research report or publish findings.
- **Start-up Projects:** Students must present a business plan along with a prototype, market analysis, and revenue model.

Phase 5: Final Report Submission and Presentation

- **Final Report:** The project report should contain a title page, abstract, introduction, problem statement, objectives, methodology, results, discussion, conclusions, future scope, references, and appendices.
- **Presentation:** Students will deliver a final presentation to a panel of evaluators, showcasing their work, findings, or product.

6. Collaboration and Mentorship

For Research Projects, mentorship will involve both:

- **External Mentor:** An academic expert outside the institution, preferably from a reputed university or research institute.
- **Internal Mentor:** A faculty member from the student's department to provide academic and administrative guidance.

For Industrial Projects:

- External mentorship will come from industry professionals, preferably from the partnering company.

For Start-up Projects:

- External mentorship will involve experienced entrepreneurs, start-up founders, or investors.

7. Documentation and Submission Requirements

Students are required to:

- Submit their proposal, mid-term report, final report, and any supporting documents via the Learning Management System (LMS).
- Maintain detailed project logs and weekly reports.