1. **Course Title:**

Infrastructure Planning and Management for Smart Cities

2. **Course Objectives:**

Objective 1	To provide a comprehensive understanding of smart city concepts, including sustainable infrastructure, green buildings, intelligent transport systems, and ICT integration, in line with national and global urban development goals.
Objective 2	To equip participants with computational thinking and programming skills using functional and imperative paradigms, enabling them to solve engineering problems relevant to smart city systems.
Objective 3	To introduce the principles of infrastructure planning and management, including cost estimation, resource allocation, risk analysis, and scheduling, with hands-on exposure to industry-standard project management software.
Objective 4	To develop participants' understanding of data science tools and statistical methods, empowering them to analyze urban infrastructure data and make data-driven decisions for smart city development.
Objective 5	To foster interdisciplinary thinking by integrating civil engineering, data science, and computing knowledge, supporting holistic planning and innovation in smart city infrastructure projects.
Objective 6	To promote experiential learning through project-based work, encouraging participants to design, analyze, and present smart infrastructure solutions that address real-world urban challenges.

3. **Rationale for the course**

The infrastructure sector is transforming through digital technologies, data analytics, and the increasing emphasis on sustainability and smart urban development. Initiatives like India's Smart Cities Mission, global climate commitments, and the growing integration of ICT (Information and Communication Technology) in civil infrastructure highlight the urgent need to align academic instruction with these evolving industry requirements.

Despite the technological advancements and changing demands in the construction and urban development sectors, a significant gap exists in the current curriculum of many civil engineering programs. Most faculty members are well-versed in traditional infrastructure topics but lack formal training in computational thinking, programming, data science, and smart city technologies—skills now essential for students and future engineers.

This course is designed to equip civil engineering faculty members with interdisciplinary knowledge and pedagogical tools needed to modernize their teaching practices and enhance student learning. The course bridges multiple knowledge domains by integrating:

a. Programming and problem-solving using functional and object-oriented paradigms to introduce algorithmic thinking.
b. Data science applications in infrastructure, including statistical analysis, regression, classification, and clustering, to address real-world problems in urban systems.
c. Infrastructure planning and project management, including hands-on training in tools like MS Project and Primavera, which are widely used in the industry.
d. Smart city concepts, such as intelligent transportation, green buildings, renewable energy integration, and urban sustainability, are often missing or superficially covered in existing syllabi.

By completing this course, participants will be better prepared to teach students in a more contemporary and practical manner, integrating theory with application and exposing them to industry-relevant tools and case studies. The course also encourages a paradigm shift in civil engineering education, moving beyond conventional design to data-informed, sustainable, and digitally enabled urban infrastructure development.

4. Course Structure:

Course	Contents
CS Core 1 **Introduction to Problem Solving and Programming**	Basic model of computation, Notion of Algorithms, Principle of Mathematical Induction Basics of functional programming, notion of types Iterative versus recursive style Correctness and efficiency issues in programming, time, and space measures Basics of imperative style programming Assertions and loop invariants Top-down design and examples of step-wise refinement Programming using structures, introduction to encapsulation, and object-oriented programming
Domain Core **Infrastructure Planning and Management**	Definitions of infrastructure Infrastructure planning phases Scheduling and management of planning activities Project Cost Management Resource planning, leveling, and allocation Cost estimating and control Earned value method Infrastructure financing Quality and safety in infrastructure Infrastructure risk management Life-cycle Costing Value Engineering Hands-on practice on project management software: MS Project and Primavera
CS Core 2 **Data Science for Engineers**	Course Philosophy and Introduction to R Linear algebra for data science Algebraic view - vectors, matrices, a product of matrix & vector, rank, null space, solution of an over-determined set of equations, and pseudo-inverse Geometric view - vectors, distance, projections, eigenvalue decomposition Statistics (descriptive statistics, notion of probability, distributions, mean, variance, covariance, covariance matrix, understanding univariate and multivariate normal distributions, introduction to hypothesis testing, confidence interval for estimates) Optimization Typology of data science problems and a solution framework Simple linear regression and verifying assumptions used in linear regression Multivariate linear regression, model assessment, assessing importance of different variables, subset selection Classification using logistic regression Classification using kNN and k-means clustering
Domain specialized	Introduction to Smart Cities Definition, concept, need, and importance of smart cities Features and characteristics of a smart city Government of India: India's "100 Smart Cities" Policy and Mission

	Case Studies of Smart City Infrastructure Management in India, its Challenges and Objectives Sustainable building housing Introduction to Green Buildings, features of green building rating systems in India: LEED, GRIHA, energy saving system, solar energy for smart city Intelligent transport systems smart vehicles and fuels, traffic safety management, and mobility services
Project	**Optimizing Urban Transport Flow Using Data-Driven Clustering** You are hired as a data analyst for a city municipality to improve public transportation. Using traffic flow data (vehicle count, travel time, peak hours) from multiple intersections in a smart city zone, identify congestion hotspots and cluster them using k-means to suggest optimal routes or locations for traffic lights or public transit hubs. **Infrastructure Planning for a Resilient Smart Sub-City** Design a basic infrastructure plan for a new sub-city area to be developed under the Smart Cities Mission. The plan should include scheduling infrastructure components (roads, water, energy, housing), estimation of project cost, and resource allocation using the Primavera/MS Project. Consider sustainable alternatives (green buildings, solar power) and apply risk management principles. **Statistical Analysis of Urban Water Usage Patterns** Analyze domestic water consumption data across different housing types in a smart city. Apply statistical methods (mean, variance, distribution fitting, hypothesis testing) to determine factors influencing usage and propose smart water management recommendations. **Automating Task Allocation for Civil Infrastructure Projects** Develop a simple program using object-oriented principles to automate task allocation and scheduling in a small construction project. The program should take input as team capacity, task durations, and dependencies, and generate a schedule that minimizes overall project time. **Life Cycle Cost Comparison of Conventional vs. Green Buildings** Compare the life-cycle cost of a conventional office building with that of a green building using LEED/GRIHA standards. Include initial construction cost, operation and maintenance costs, energy consumption, and lifespan. Use basic cost modeling and optimization tools to identify the more cost-effective option in the long term.

5. Learning Outcomes

Demonstrate proficiency in computational thinking and programming skills (functional and imperative styles) to solve basic to intermediate problems relevant to civil and infrastructure engineering.

Apply data science techniques—including statistical analysis, regression, and clustering—to analyze and interpret urban infrastructure data for informed decision-making in smart city contexts.

Develop infrastructure planning strategies using project scheduling, cost estimation, resource allocation, and risk management concepts with hands-on experience in tools like MS Project and Primavera.

Critically evaluate the components of smart city development, including green buildings, intelligent transport systems, and sustainable energy solutions, with an understanding of national policies and global trends.

Design effective instructional strategies and course content to teach civil engineering students about smart infrastructure systems and emerging technologies in a more integrated, application-oriented manner.

6. Infrastructure and Resources available:

The relevant studios for teaching theoretical concepts, labs for hands-on software practices, and rooms for tutorials are available in the institute. Hostel accommodation is also available.

7. Expected Outcomes of the Course

a. Upon successfully completing the course, it is expected that a cohort of 30–50 civil engineering faculty members from various institutes will have significantly enhanced their understanding of smart city infrastructure, computational tools, and data-driven approaches in urban planning.
b. Participants will receive a certificate of completion, demonstrating their competency in integrating modern technologies such as programming, data science, and project management software into civil engineering education.
c. The course will equip them with the necessary skills to develop and deliver advanced, interdisciplinary content in their respective institutions, thereby contributing to curriculum modernization and capacity building.
d. Additionally, the participants will be capable of guiding students through practical, project-based learning in areas such as smart infrastructure, sustainability, and intelligent urban systems—aligning engineering education more closely with industry needs and national missions like the Smart Cities Mission.