

## **HackForge 2.0 – Advanced Research-Oriented Problem Statements**

*HackForge 2.0 aims to encourage students and innovators to design and develop intelligent, scalable, and socially impactful technological **frameworks or prototype systems** that address real-world challenges across domains such as artificial intelligence, IoT systems, sustainable engineering, mechanical automation, and digital social innovation.*

### **1. AI & Computer Science**

Develop a scalable and explainable AI-driven decision intelligence framework capable of integrating heterogeneous data sources to generate predictive, prescriptive, and adaptive insights for complex real-world systems. The proposed solution should incorporate advanced machine learning techniques such as deep learning, reinforcement learning, and explainable AI (XAI) to improve model transparency, fairness, and reliability. The framework must support distributed data processing, model optimization, and real-time analytics while addressing challenges related to bias mitigation, privacy preservation, and computational efficiency.

### **2. IoT & Embedded Systems**

Design and implement a secure, energy-efficient, and scalable IoT architecture capable of real-time sensing, data aggregation, and intelligent control across distributed environments. The system should integrate embedded systems, wireless sensor networks, edge computing, and cloud analytics to enable low-latency data processing and autonomous decision-making. The framework must address key challenges such as device interoperability, energy optimization, secure communication protocols, and fault tolerance, enabling deployment across diverse application scenarios.

### **3. Mechanical & Smart Design**

Develop an intelligent mechatronic system that integrates advanced mechanical design, embedded sensing, and adaptive control algorithms to automate and optimize engineering processes. The proposed solution should utilize sensor fusion, real-time feedback control, and intelligent actuation mechanisms to enhance system performance, reliability, and operational safety. The framework should support modular design principles and integrate digital technologies such as robotics, computer vision, and automated control systems to address modern industrial and societal challenges.

### **4. Sustainable Solutions**

Develop a data-driven sustainable resource optimization framework that leverages intelligent monitoring, predictive analytics, and automated control to improve environmental sustainability and resource efficiency. The proposed system should integrate IoT sensing technologies, AI-driven predictive models, and real-time optimization algorithms to support

sustainable decision-making. The framework must address challenges related to energy efficiency, environmental impact assessment, resource allocation optimization, and long-term ecological sustainability.

## **5. Social Impact Innovation**

Design and develop a technology-driven inclusive innovation platform that leverages emerging digital technologies to address critical societal challenges and enhance community well-being. The proposed solution should integrate AI, IoT, mobile computing, and data analytics to deliver scalable, affordable, and accessible services for underserved populations. The framework should prioritize usability, scalability, data privacy, and ethical technology deployment, ensuring meaningful social impact and sustainable adoption.