BULL Machines Exclusive Problem Starement

Title:

Simulation of Electronic Control Piston Pump using MATLAB/Simulink.

Domain:

Mechatronics / Control Systems / MATLAB Simulation.

Challenge:

Design and simulate a control system for an electronic control piston pump used in off-highway equipment. The task is to:

1. Develop a control logic to regulate pump displacement and pressure through an electronic controller.

2. Simulate the dynamic response of the pump in MATLAB/Simulink, including parameters like:

   a. Flow vs. speed/load

   b. Pressure build-up vs. demand

   c. Controller response time and stability

3. Demonstrate how control strategy affects overall pump efficiency and system stability.

Objective:

Create a virtual test bench (digital mimic of real-time pump behaviour in MATLAB/Simulink, which can be used to evaluate and optimize control strategies before hardware implementation.

Expected Outcome:

- Functional simulation model of the pump + control system.

- Performance plots (flow vs. time, pressure vs. demand, efficiency curves).

- Comparative study of different control logics

Note: The final controller logic will be shared during HACKATHON.

Hardware Hackathon Themes :

Agriculture & Rural Development

- **AGR-01: Smart Irrigation Pump Controller** – Solar-powered pump with soil-moisture based auto ON/OFF.
- **AGR-02: Low-Cost Grain Moisture Analyzer** – Portable device for farmers to check grain moisture content before storage.
- **AGR-03: Livestock Wearable Tracker** – GPS + health sensor collar for real-time cattle monitoring.
- **AGR-04: Automated Seed Dispenser** – Handheld or tractor-mounted seeder ensuring uniform distribution.

Healthcare & MedTech

- **MED-01: Portable ECG & Vitals Monitor** – Battery-powered device for remote health centers.
- **MED-02: AI-Enabled Low-Cost Eye Screening Device** – Hardware for rural eye camps detecting cataracts.
- **MED-03: Wearable Posture Correction Belt** – Sensor-driven belt giving haptic feedback to improve spinal posture.
- **MED-04: Neonatal Temperature Incubator** – Low-cost, solar-assisted incubator for rural healthcare.

Disaster Management & Safety

- **DM-01: Smart Flood Level Alert Pole** – IoT pole with ultrasonic sensors to measure rising water levels.
- **DM-02: Earthquake Early Vibration Detector** – Low-power sensor box that triggers alarms in seismic activity.
- **DM-03: Fire Escape Smoke Guidance Lights** – Intelligent floor lights that guide evacuation paths during fire.
- **DM-04: Emergency Power Cube** – Compact, solar+hand-crank powered generator for disaster relief.

Clean & Green Technology

- **CGT-01: IoT Air Pollution Monitor – Portable sensor station for tracking PM2.5, CO_2, NO_2 levels.**
- **CGT-02: Smart Biogas Digester – Household digester with gas flow sensors and safety shutoff valve.**
- **CGT-03: Solar-Powered Smart Street Light – With motion sensor, dimming, and self-cleaning solar panel.**
- **CGT-04: Smart E-Waste Shredder – Small-scale machine for shredding and categorizing circuit boards.**

Smart Education & Accessibility

- **EDU-01: Interactive Braille Learning Device – Tactile hardware for visually impaired students.**
- **EDU-02: Low-Cost Digital Classroom Response System – Wireless clickers for quizzes and attendance.**
- **EDU-03: Portable Science Lab Kit – Modular hardware box with sensors for physics/chemistry experiments.**
- **EDU-04: AI-Assisted Sign Language Glove – Wearable translating gestures into audio/text in real time.**

Software Hackathon Themes :

- **On - spot problem statements will be given for the participants.**

General Rules:

- **Bring your own laptops, chargers, and other accessories.**
- **Internet access to a maximum of 2 Devices will be provided.**
- **Power source will be provided.**
- **Your college ID, our event ID, and T-shirt must be worn.**
- **Cross-team collaboration prohibited.**
- **Misconduct, plagiarism, or cheating can lead to disqualification.**

Hardware Hackathon Guidelines:

Event Format & Process

- **Duration: 24 hours of continuous development.**

- **Evaluation Criteria:**

  - **Creativity & Innovation**

  - **Technical Execution & Functionality**

  - **Feasibility of the Solution**

  - **Presentation & Demonstration**

- **Number of evaluation rounds announced during inauguration.**

Project Development Guidelines

- **Original Work: All hardware Prototypes can start to build after the release of Problem Statements.**

- **Pre-built projects lead to disqualification.**

- **Third-Party Resources: Commercial modules allowed; custom work must be original.**

- **Safety: Teams responsible for safe handling of all components.**

Submission & Evaluation

- **Document progress via geo-tag photos, videos have to submitted on the start of the Hackathon.**

- **Final evaluation based on:**

  - **Relevance to theme**

  - **Functionality & technical execution**

  - **Innovation & novelty**

  - **Scalability & impact**

Software Hackathon Guidelines:

Event Format & Process

- **Duration: 24 hours of continuous coding.**

- **Problem Statements: Provided at the start.**

- **Evaluation Criteria:**

  - **Creativity & Novelty**

  - **Technical Execution**

  - **Feasibility & Functionality**

  - **Presentation & Documentation**

- **Number of evaluation rounds announced during inauguration.**

Project Development Guidelines

- **Original Work: All code developed during hackathon; pre-built/AI-generated solutions can be used with a minimal level (Judge's Choices).**

- **Third-Party Resources: Public libraries, APIs, and frameworks allowed.**

- **Code Ownership: Code must be authored by team members.**

GitHub Repository Requirements

- **Private Repository: Team Leader creates.**

- **Naming Format: Chakravyuha25_<Team_Name>.**

- **Commit Frequency: Every 2 hours.**

- **Rules: No pushing/pulling outside 24-hour coding period.**

- **Final repository link submitted for evaluation.**