

# Muhammad Refansa Annaafi

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## SUMMARY

Electrical engineering graduate (Universitas Indonesia, 2026) who designs and tests hardware end to end: PCBs and firmware, FPGA logic, and chip-level timing closure. Co-author of an open-hardware plasma source under review at HardwareX.

## SKILLS

**Embedded:** C, C++, ESP32, Arduino, Zynq-7000 (bare-metal, Vitis), I2C, UART

**FPGA / Digital:** Verilog, Vivado, Vitis HLS, hls4ml, AXI4-Lite, RISC-V

**PCB / Hardware:** KiCad, STM32, LTspice, oscilloscope and high-voltage probe measurement

**ASIC:** OpenROAD, OpenSTA, Yosys, KLayout, Tcl, static timing analysis

**Software:** Python, Keras/TensorFlow, React, TypeScript, Supabase, Flutter, Firebase, Git, Linux, OpenUSD

**Languages:** Indonesian (native), English (advanced; EPT 553, TOEFL-equivalent), Korean (beginner)

## EXPERIENCE

**Research Assistant**, Renewable Energy Laboratory, Universitas Indonesia | Oct 2026 – present

- Designed the test protocol for a second-life 15S1P LFP battery pack (48 V, about 19 Ah measured) whose capacity, efficiency, and temperature feed an OpenLCA life-cycle assessment.
- Wrote the build manual and wiring diagram for a 15-lamp AC load board and specified DS18B20 temperature logging on an ESP32 (45 °C stop criterion). Rig build and first test cycles in progress.

**Research Assistant**, Plasma Research Group, Universitas Indonesia | Aug 2025 – Sep 2026

- Designed and characterized PenPlasma (undergraduate thesis), a portable pen-tip microplasma source with a US\$6.46 bill of materials, powered by a single 3.7 V Li-ion cell.
- Modeled the high-voltage flyback driver in LTspice and validated it with a 1000:1 probe: 4.7 kV peak-to-peak at about 61.7 kHz. Traced an undershoot 3 times larger than simulated to transformer leakage inductance.
- Swept the electrode gap from 0.5 to 2.5 mm (5 measurements per gap) and selected 1.5 mm: 163.4 s discharge, with 11.3% duration and 8.7% intensity variation (CV).
- Second author of the resulting manuscript, under review at HardwareX; design files released as open hardware (CERN-OHL-S-2.0).

**Teaching Assistant, Embedded Systems**, Department of Electrical Engineering, Universitas Indonesia | Feb 2026 – Jun 2026

- Led lab sessions for a 36-student international undergraduate class.

**SCADA & Grid Operations Intern**, PT PLN UP2B Jakarta & Banten (state electricity company) | Jan 2025 – Feb 2025

- Monitored real-time operation of 150–500 kV transmission across three substations using SCADA.
- Supported an IEC telecontrol protocol migration and helped resolve 3 operational incidents in a 3-intern team.
- Analyzed power-disturbance data for grid-stability patterns; wrote technical reports and daily recaps.

## PROJECTS

**Edge-AI Motion Classifier on FPGA (ESP32 + Zynq-7010)** | Sep 2026

- Built an end-to-end system verified on hardware: MPU6050 IMU on ESP32, UART link to bare-metal C on the Zynq processor, and an hls4ml neural-network IP in the FPGA fabric over AXI4-Lite.
- Collected 264 labeled windows over 5 motion classes; a 581-parameter Keras MLP reached 77.4% accuracy on the collected data (no held-out split) at about 150 ns inference latency.
- Fit the Zynq-7010 (DSP 52%, LUT 42%) by tuning the reuse factor (default needed 577% of DSPs); `ap_fixed<16,6>` matched float accuracy while `ap_fixed<8,3>` lost about 21 points.

**RTL-to-GDSII Physical Design with OpenROAD** | Aug 2026 – Sep 2026

- Ran the full backend flow (synthesis, floorplan, placement, CTS, routing, STA signoff) on a GCD unit and the ibex RISC-V core (about 31,800 cells) in Nangate45 and SkyWater Sky130.
- Traced a 4 GHz GCD timing failure (51 setup violations) to an unrealistic constraint; 2 GHz gave clean signoff and 65% lower power.
- Closed all 240 setup violations on ibex (WNS -15 ps to +5 ps) with a manual cell upsize and a `repair_timing` ECO, verified by static timing analysis.

#### **PrioWatt Smart kWh Meter with Load Shedding (capstone, team of 4) | Aug 2025 – Dec 2025**

- Integrated the energy sensor with an ESP32 and a Flutter + Firebase app: real-time monitoring of 6 electrical parameters, automatic priority-based shedding of 4 loads, and remote manual override.
- Built the LSTM electricity-cost prediction and anomaly detection behind the app's savings tips.

#### **FOTRIX, PIMNAS 2025 National Finalist (team of 5) | Jan 2025 – Nov 2025**

- Built the sensor and telemetry architecture and the Flutter + Firebase monitoring app for a solar-powered seawater-hydrogen and microplastic-degradation prototype, plus integration and a 2-week field test.

#### **STM32 Development Boards (KiCad 9) | 2026**

- Took a 2-layer STM32F103 board (33.5 x 24.2 mm) to fab-ready Gerbers; designing a 4-layer STM32G474 board with USB-C power, filtered analog supply, and HSE/LSE crystals (in progress).

#### **Additional projects**

- **Zynq AXI IIC audio codec bring-up** (Zybo Z7-10): bare-metal C driver configuring the SSM2603 over I2C.
- **Verilog FPGA coursework**: 12 modules from counters and UART to a single-cycle RISC-V core and small SoC, with testbenches.
- **OpenUSD scene authoring** (Python, usd-core): meshes, materials, STL-to-USD conversion, USD references with time-sampled animation.
- **Robot Team Hub**: realtime progress tracker for a 4-person robotics team (React, Supabase, Vercel).

### **EDUCATION**

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#### **B.Eng. in Electrical Engineering**, Universitas Indonesia, Depok | Aug 2022 – Aug 2026

- GPA 3.31 / 4.00. Thesis: PenPlasma, a low-cost, portable point-discharge microplasma excitation source.

### **TRAINING**

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#### **Korea-Indonesia Engineering Talent Program**, Korea Chamber of Commerce and Industry (KCCI) | Jul 2026 – Oct 2026

- 500 h: firmware (100), PCB design (100), FPGA/semiconductor (100), Korean (200).

### **PUBLICATIONS AND AWARDS**

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- T. Abuzairi, M. R. Annaafi, M. L. Khainama, "PenPlasma: an open-source pen-tip microplasma excitation source for portable elemental analysis in resource-limited settings," submitted to HardwareX (under review).
- National Finalist, PIMNAS 2025 (Indonesian National Student Science Week), PKM-KC category, team project FOTRIX.