20 days rough plan

DAY 1 — System Planning & Architecture (NO HARDWARE)

Tasks:

- Finalize full system architecture (advanced + basic):
    - ESP32 block
    - Pressure sensors
    - EEV + stepper driver
    - Inverter compressor control
    - Condenser fan control
    - Cloud + AI backend
    - ESP32-CAM inventory system
- Create:
    - **Block diagram**
    - **Data flow diagram**
    - **Functional flowchart**
- Finalize all features of your project
- Prepare a clean architecture page for your report

Deliverables:

- Final architecture diagram (I can draw this for you if you want)

DAY 2 — Cloud, Dashboard & Backend Setup (NO HARDWARE)

Tasks:

- Create Firebase/Firestore/Realtime DB project
- Create database collections:
    - /temperature
    - /humidity
    - /door
    - /vibration
    - /power

- o /high_side_pressure

- o /low_side_pressure

- o /camera_inventory

- Set up MQTT broker (choose: AWS IoT Core or Mosquitto Cloud)

- Create initial Grafana/Node-RED dashboard

- Prepare API endpoints for:

  - o Data upload

  - o Alerts

  - o Inventory image upload

Deliverables:

- Live dashboard (empty now, values will come from Day 8+)

DAY 3 — Firmware Skeleton + Simulation (NO HARDWARE)

Tasks:

- Write **ESP32 firmware skeleton** (no sensors yet):

  - o Wi-Fi connection

  - o MQTT/HTTPS client setup

  - o Cloud connection test

  - o Empty functions for:

    - ▪ readTemperature()

    - ▪ readHumidity()

    - ▪ readPressure()

    - ▪ readCurrent()

    - ▪ readVibration()

    - ▪ eev_control()

    - ▪ compressor_pwm_control()

    - ▪ fan_pwm_control()

- Simulate sensor data (fake values)

- Push fake data to Firebase/MQTT to test dashboard

- Build the entire code structure ready for hardware

Deliverables:

- Running firmware that sends fake readings to cloud

- Dashboard showing dummy data (temp, humidity, pressure, etc.)

DAY 4 — RECEIVE HARDWARE + Basic Setup Starts

Start as soon as components arrive.

Tasks:

- Unbox & inspect all hardware

- Test ESP32 connection to laptop

- Install all required Arduino/PlatformIO libraries

- Check power supplies, wires, enclosure, etc.

- Prepare your working area for real hardware integration

DAY 5 — Temperature & Humidity Sensors

Tasks:

- Connect DS18B20 & DHT22

- Test temperature & humidity readings

- Replace fake cloud data with **real sensor data**

- Integrate averaging filters

- Graph temp/humidity live in dashboard

DAY 6 — Door, Vibration & Current Sensors

Tasks:

- Connect magnetic reed switch

- Connect SW-420 vibration sensor

- Connect INA219 current/power sensor

- Integrate into firmware

- Update dashboard with real vibration + current data

DAY 7 — Pressure Sensors Integration (Advanced)

Tasks:

- Connect high-side pressure transducer (0–500 psi)

- Connect low-side pressure transducer (0–150 psi)

- Calibrate ADC values → PSI conversion

- Push pressure data to cloud

- Add pressure-based alerts (overpressure, leakage patterns)

DAY 8 — ESP32-CAM Setup

Tasks:

- Set up ESP32-CAM

- Add lighting (LED strip)

- Test image capture

- Upload images to cloud storage

- Link image URLs to database

DAY 9 — EEV + Stepper Driver Wiring

Tasks:

- Connect DRV8825/A4988

- Wire 4-stepper coils to EEV

- Test:
    - OPEN valve
    - CLOSE valve
    - Step counting
- Add EEV calibration routine

DAY 10 — EEV Control Algorithm

Tasks:

- Write superheat-based EEV control

- Implement:
    - Fast-opening logic (load spike)
    - Fine-tuning logic
    - Minimum superheat protection
- Test with simulated pressure/temp values first

DAY 11 — Compressor Control (Inverter/PWM)

Tasks:

- Connect inverter module control input to ESP32

- Generate PWM signals

- Map cooling load → compressor RPM

- Add safety cutoffs:

  - Overcurrent

  - High discharge temp

  - High pressure

DAY 12 — Condenser Fan PWM Control

Tasks:

- Connect fan driver

- Map condensing pressure → fan RPM

- Update firmware to sync fan with compressor load

DAY 13 — Full Refrigeration Loop Optimization

Tasks:

- Combine:

  - Pressure

  - Temperature

  - Superheat

  - Subcooling

  - Load-based RPM

  - EEV modulation

- Build complete cooling optimization loop

- Test responses under different simulated load conditions

DAY 14 — Cloud Alerts + SMS/Email

Tasks:

- Add triggers:
    - Overpressure
    - Excess current
    - High temp
    - Frequent door opening
- Implement email/SMS alert system
- Test alerting with simulated issues

DAY 15 — ESP32-CAM Inventory AI (Basic)

Tasks:

- Implement basic image upload
- Set up backend directory for AI models
- Label 10–20 sample freezer items
- Prepare dataset for training (YOLO/TF)

DAY 16 — ML/AI Setup

Tasks:

- Train a basic item-detection model (YOLOv8/YOLOv9)
- Integrate backend API
- Connect AI output to inventory database

DAY 17 — Full System Integration

Combine everything:

- Sensors
- EEV
- Compressor
- Fan
- Cloud
- Dashboard

- ESP32-CAM

- AI results

Run full automated cycle with real data.

DAY 18 — Stress Testing

Tasks:

- Test 24-hour continuous operation

- Try:

  o Opening door

  o Creating warm load

  o Fan speed changes

  o EEV adjustments

  o Compressor RPM changes

- Track cloud logs and ensure no disconnects

DAY 19 — Optimization + Bug Fixing

Tasks:

- Adjust PID values

- Smooth sensor noise

- Tune EEV steps per degree of superheat

- Fix dashboard elements

- Improve code stability

DAY 20 — Final Documentation & Report

Tasks:

- Write final report

- Add diagrams, graphs, cloud screenshots

- Add AI inventory results

Essential Hardware (Core System)

Microcontroller & Power

- ESP32 Development Board (ESP32-WROOM) – Wi-Fi/BLE, 5V USB input, 3.3V logic

- DC-DC Buck Converter (12/24V → 5V) – Output: 5V/2A

- SMPS Power Adapter – 12V or 5V, 2A–3A

Environmental & Operational Sensors

- DS18B20 Waterproof Temperature Sensor – Digital 1-Wire, −55°C to +125°C, ±0.5°C

- DHT22 Humidity & Temperature Sensor – Digital, 0–100% RH, −40°C to +80°C

- Magnetic Reed Switch (Door Sensor) – NO/NC, magnetic contact

- SW-420 Vibration Sensor Module – Analog/Digital output

- INA219 Current/Power Sensor – I²C, 26V max bus voltage, ±3.2A current

Basic Control & Actuation

- 5V Relay Module (Optocoupler isolated) – 10A rating

- Solid State Relay SSR 25A/40A (optional) – Input: 3–32V DC, Output: AC load

Safety & Power Protection

- Fuse Holder + Fuses – 1A/2A

- MOV / TVS Diode – Surge protection

- Screw Terminal Blocks – 2-pin/3-pin

Enclosure, Wiring & Mounting

- ABS/Plastic Enclosure – ~15×12×7 cm

- Cable Glands PG7/PG9 – Waterproof

- Heat Shrink Tubing Pack

- AC Wires & Connectors

- M3 Screws, Nuts & Nylon Spacers

- Waterproof Sensor Cable Extensions

Prototyping Components

- Breadboard

- Perfboard / Custom PCB

- Jumper Wire Set

Advanced/Optional Hardware (Full System)

- Refrigeration Optimization

- High-Side Pressure Transducer – 0–500 psi, 0.5–4.5V output

- Low-Side Pressure Transducer – 0–150 psi, 0.5–4.5V output

- NTC/PT100/DS18B20 Line Temp Sensors – For suction/discharge lines

- Expansion Valve & Speed Control

- Electronic Expansion Valve (EEV) – Stepper-based

- A4988/DRV8825 Stepper Motor Driver – 8–35V input

- Variable Speed Compressor Interface Module – PWM/Analog control

- PWM Condenser Fan Controller / DC Fan Driver – PWM input

Inventory & Vision

- ESP32-CAM / OV2640 Camera Module

- QR Code Scanner Module (USB/Serial)

- LED Light Strip (Freezer Interior)

- Camera Waterproof Housing

- Additional Add-Ons

- OLED Display 0.96" (I²C)

- DS3231 RTC Module

- 5V Buzzer Module

- External Wi-Fi Antenna for ESP32

- IP65 Waterproof Sensor Housing