1. Desired Needs Leading to Final Design Objectives
   - Low-cost ECG (1,000−10,000 clinical systems are too expensive for classrooms)
   - Portability and ease of use for outreach with multiple student volunteers
   - Clear waveforms allowing students to identify P, QRS, and T components
2. Major Constraints on the Design
   - Safety: 5V USB power; 3D-printed enclosure prevents electrical contact; not for clinical use
   - Risks: Motion artifacts degrade signal; Butterworth filter may attenuate small P waves; limited to one junior class demo due to time
   - Global Impact: Affordable ECG technology could benefit under-resourced STEM classrooms
   - Manufacturability: Custom PCB would improve reproducibility over breadboard; component cost under $50
   - Quality Control: Validated against PhysioNet MIT-BIH database; Butterworth selected for consistent performance
3. Major Engineering Standards
   - Components: No formal medical standards applied (educational, non-diagnostic device)
   - Performance: IEC 60601 would apply for clinical use; leakage current limits (<10 µA) informed isolation design
   - New standards: Proposed standard for educational biomedical demonstration devices including signal clarity and safety requirements
4. Ethical, Environmental, Societal Concerns
   - Ethical: Clear "educational only" labeling prevents misuse as diagnostic tool
   - Environmental: Reusable electrodes reduce waste; 3D-printed enclosure uses minimal plastic
   - Societal: Low-cost design increases STEM accessibility for schools with limited budgets
5. Active Teamwork and Leadership
   - Regular team meetings allowed all members to propose design ideas
   - Hardware, enclosure, and software tasks delegated among members
   - Weekly milestones tracked to meet week 9 deadline for outreach
   - Peer review of code and circuits improved reliability; TA feedback guided revisions
6. Motivating Factors for Learning, Initiative, Persistence
   - Compared five filters (Chebyshev, adaptive LMS, bandpass, Kalman, Butterworth) requiring research into DSP and PhysioNet
   - Independently introduced all filtering methods to team; suggested MIT-BIH database; proposed Java as future MATLAB alternative
   - Initial LM741/AD622 breadboard design failed due to noise; transitioned to AD8232 modules; Kalman required extensive tuning; wrote initial code for each filter to determine best performer
7. Most Innovative & Entrepreneurial Ideas
   - Systematic filter comparison using PhysioNet data to justify Butterworth selection
   - Wrote initial filter code to test every method (Chebyshev, LMS, bandpass, Kalman, Butterworth) and compare which produced the cleanest waveform
   - Future Java migration to eliminate MATLAB licensing costs for schools