



MiniLab_LPF — Exercises Index

This index tracks all exercises across **Phase 1–4**.

Each task links back to the relevant script (in `exercises/`) or notes.

Mark checkboxes ✓ as you complete them.

Phase 1 — Signal Generation & Noise

☐ **SNR Sweep** → `exercises/exercises_phase1.py`

- IQ with SNR = [0, 10, 20, 30, 40] dB
- PSD comparison (noise floor rises)

☐ **Duration Sweep**

- Durations = [0.005, 0.01, 0.05] s
- Longer = better FFT resolution

☐ **Frequency Sweep**

- f = [500, 1000, 2000] Hz
- PSD peak shifts correctly

☐ **Selective Noise (I-only vs Q-only)**

- Add Gaussian noise to only I, then only Q
 - Compare PSD & time waveforms
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Phase 2 — FIR Low-Pass Filter Design

☐ **Filter Order Variation** → `exercises/exercises_phase2.py`

- Orders = [31, 63, 127]
- Compare transition width & stopband

☐ **Cutoff Frequency Experiment**

- Cutoff = [0.1, 0.2, 0.3] × Nyquist
 - Bandwidth tradeoffs
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Phase 3 — Filtering & Analysis

- ☐ **lfilter vs filtfilt** → `exercises/exercises_phase3.py`
 - Compare delay & artifacts
 - ☐ **SNR Before vs After Filtering**
 - Measure improvement in-band
 - ☐ **Group Delay Measurement**
 - Expect $\approx N/2$ for FIR
 - ☐ **Attenuation Measurement**
 - Stopband attenuation via $20 \cdot \log_{10}(|H(f)|)$
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Phase 4 — Advanced / Optional

- ☐ **QPSK Symbol Filtering** → `exercises/exercises_phase4.py`
 - Constellation before/after
 - ☐ **BER vs SNR Curve**
 - Sweep SNR, plot BER vs theory
 - ☐ **Real SDR Data Test** (optional)
 - RTL-SDR/HackRF capture
 - ☐ **Reproducibility Checklist**
 - Save params, seeds, coeffs, results
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🔑 These **14 exercises** form the complete **MiniLab_LPF training pipeline**.

Keep results (plots, notes) in the `exercises/plots/` folder.

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### Folder Structure Recap
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MiniLab_LPF/

|— Phase1_SignalGeneration/

|— Phase2_FilterDesign/

|— Phase3_FilteringAnalysis/

- |— Phase4_Advanced/
- |— exercises/ # all exercise scripts
 - | |— exercises_phase1.py
 - | |— exercises_phase2.py
 - | |— exercises_phase3.py
 - | |— exercises_phase4.py
 - | |— plots/
- |— docs/
 - | |— Phase1_notes.md
 - | |— Phase2_notes.md
 - | |— Phase3_notes.md
 - | |— Phase4_notes.md
 - | |— Exercises_index.md ✓
- |— [README.md](#)

