

FUNDAMENTALS OF AI-AUGMENTED ENGINEERING

Chapter 6 / Lab-6 Lab Extension Challenge Report

Same Method, Two Records — What Changed, and Why?

LAB EXTENSION CHALLENGE — INDIVIDUAL SUBMISSION

Individual submission: The main Chapter 6 / Lab-6 laboratory is performed collaboratively. This Extension Challenge is completed and submitted individually so that every student independently practises the COMMIT → REVEAL → COMPARE → EXPLAIN workflow and the evidence-before-explanation habit developed during the team lab.

You may discuss concepts with classmates and may use an AI critic as directed in Section 6, but you must independently run both Lab 6 programs on the instructor sample file, record your own committed predictions, build the comparison, and make your own engineering judgment. No equipment is needed — the beam and the phone stay in the laboratory; the comparison uses your team's Lab 6 report and the instructor's sample record.

The purpose is NOT to decide which record is "better". Two real experiments were run on two phones, two attachments, two releases. The purpose is to find what changed between them, and to say what evidence shows it. You may begin during the laboratory period or complete it outside the laboratory. Suggested assessment: 10 points (rubric in Section 8).

Student Information

Student name	
Student ID (if applicable)	
Date	
Lab section (if applicable)	
Team whose Lab 6 report is used	

How to use this template: replace every gray italic guide with your own evidence and reasoning, and delete nothing else. This is a compact challenge — not another full laboratory report. Evidence first, explanation second. The final section is where you take responsibility for your work.

THE INSTRUCTOR SAMPLE FILE phyphox-accel-20s.xlsx IS USED HERE ON PURPOSE — AS A CONTROLLED REFERENCE DATA SET. IT NEVER REPLACES YOUR TEAM'S DATA IN THE MAIN LAB REPORT.

1. Committed Predictions

RECORDED BEFORE RUNNING THE SAMPLE DATA — DO NOT EDIT AFTERWARD.

Before you open the instructor file, predict — from what you know about your own experiment and about the sample record as described in the lab deck (about 2,000 rows, about 100 measurements per second, 20 s, a different phone, a different attachment and release). Wrong is fine; uncommitted is not.

Prediction	Your commitment	One-line reason
P1 — Sampling rate of the sample record compared with ours	☐ higher ☐ about the same ☐ lower	
P2 — Vibration frequency f_d of the sample record compared with ours	☐ higher ☐ about the same ☐ lower	
P3 — Decay constant λ of the sample record compared with ours	☐ larger ☐ about the same ☐ smaller	
P4 — Which Program 1 challenge will straight-line interpolation handle better on the sample record?	☐ peak ☐ zero crossing ☐ same	
P5 — Which single factor do you predict will explain most of the difference between the two records?	☐ phone / sampling ☐ attachment ☐ release ☐ beam response ☐ noise	

2. Inputs Held Fixed — Your Team's Lab 6 Results

Copy these from your team's Lab 6 report exactly — they are the reference for every comparison below. Nothing here is recomputed.

Quantity (from the Lab 6 report)	Your team's value · units	Report section
Phone used (make / model)		§1
Number of rows · duration · sampling rate	_____ · _____ s · _____ per s	§1.2
Largest Z acceleration in the record	_____ m/s ²	§1.2
Program 1 — mean absolute error, PEAK challenge	_____ m/s ²	§2
Program 1 — mean absolute error, ZERO-CROSSING challenge	_____ m/s ²	§2
Program 2 — mean absolute error, EARLY region	_____ m/s ²	§3
Program 2 — mean absolute error, LATE region	_____ m/s ²	§3
Period of oscillations T	_____ s	§4
Measured damped frequency f_d	_____ Hz	§4
Decay constant λ	_____ s ⁻¹	§4
Estimated damping ratio ζ (and %)	_____ (_____ %)	§4
Decay-model R^2	_____	§4

This follows the same terminology as in the lab report:

- T : consider several cycles, then $T = \#cycles / (in \Delta t \text{ time interval})$
- Damped vibration frequency, f_d (Hz) — measured oscillation frequency, $f_d = 1/T$
- Decay constant, λ (s⁻¹) — from $A(t) = A_0 e^{\{-\lambda t\}}$
- Estimated damping ratio, ζ — $\zeta \approx \lambda / (2\pi f_d)$

- Exponential-fit quality, R^2 — closer to 1 indicates a better fit

3. The Same Workflow on the Sample Record — Commit, Reveal, Record

Put *phyphox-accel-20s.xlsx* in the folder with the two programs and run Program 1, then Program 2, exactly as in lab: read the challenge tables, calculate the straight-line predictions by hand, ENTER them, then REVEAL. Committed values are copied as typed. Record the printed results below; keep the five saved figures (they overwrite the lab figures if they are in the same folder — use a separate folder).

Quantity (from your run on the sample file)	Sample-record value · units
Number of rows · duration · sampling rate	_____ · _____ s · _____ per s
Largest Z acceleration in the record	_____ m/s ²
Program 1 — PEAK challenge: bounding measurements (t ₁ , a ₁), (t ₂ , a ₂)	(_____, _____) (_____, _____)
Program 1 — PEAK: your five committed predictions (m/s ²)	_____ · _____ · _____ · _____ · _____
Program 1 — PEAK: mean absolute error (as printed)	_____ m/s ²
Program 1 — ZERO CROSSING: your five committed predictions (m/s ²)	_____ · _____ · _____ · _____ · _____
Program 1 — ZERO CROSSING: mean absolute error (as printed)	_____ m/s ²
Program 2 — EARLY region: three committed predictions · mean absolute error	_____ · _____ · _____ · MAE _____ m/s ²
Program 2 — LATE region: three committed predictions · mean absolute error	_____ · _____ · _____ · MAE _____ m/s ²
Measured damped frequency f _d · decay constant λ · estimated ζ · R ²	_____ Hz · _____ s ⁻¹ · _____ · _____

One substitution written out in full, to show the predictions were yours (any one missing time): $a(t) = \text{_____} + (\text{_____} - \text{_____}) \cdot (\text{_____} - \text{_____}) / (\text{_____} - \text{_____}) = \text{_____} \text{ m/s}^2$

4. The Comparison — Evidence Before Explanation

Fill the table from Sections 2 and 3 only. The last column is a number or a ratio, not an opinion. Then place the two decay-model figures side by side — your team's *Lab6_Decay_Exponential_Model.png* and the one from the sample run — and the two peak-validation figures. No new code is required.

Quantity	Your team's record	Instructor sample record	Difference or ratio
Sampling rate (per s)			
Largest Z acceleration (m/s ²)			
Damped frequency f _d (Hz)			
Decay constant λ (s ⁻¹)			ratio λ _{team} / λ _{sample} = _____

Quantity	Your team's record	Instructor sample record	Difference or ratio
Estimated damping ratio ζ (%)			
Decay-model R^2			
Program 1 MAE — peak (m/s^2)			
Program 1 MAE — zero crossing (m/s^2)			
Program 2 MAE — early (m/s^2)			
Program 2 MAE — late (m/s^2)			

FIGURES — SIDE BY SIDE

Left: your team's decay-model figure · Right: the sample-record decay-model figure. Below: the two peak-validation figures. Same axes labels; note the different scales.

Caption: (what does this figure show, in one sentence?)

*Before reading on: which of your committed predictions P1–P5 survived contact with the table?
 _____ Which did not? _____*

5. Interrogate the Differences — What Changed, and Why

For each factor, first write the EVIDENCE — a row of the Section 4 table or a feature of the figures — and only then the explanation. A factor with no evidence gets "no evidence either way", not a story. Interpolation errors are compared relative to the local amplitude as well as in m/s^2 : a larger error on a larger signal is not automatically a worse result.

Factor	Evidence (table row / figure feature)	What it changed — and how you know
Sampling / phone (rate, resolution, noise floor)		
Phone attachment (mass, stiffness, rattling)		
Beam release (initial amplitude, timing, cleanliness)		
Beam response (frequency, decay — clamp, free length, added mass)		
Noise / scatter (point-to-point variation vs the quantity estimated)		

The one comparison that mattered most, in two or three sentences — and the one difference you cannot explain from the evidence you have:

6. AI Critic — Explain the Difference, Then Audit the Explanation

AI is used AFTER your own comparison. Give any capable AI assistant (your engineering critic) the following prompt with your own numbers filled in — the Section 4 table, nothing else:

"Here are results from two real cantilever-beam vibration experiments recorded with two different smartphones using phyphox Acceleration (without g): [paste the Section 4 table]. The same straight-line interpolation was applied to withheld measurements in both records, and the same exponential decay model was fitted. Identify the differences supported by these data and suggest possible explanations. Clearly distinguish what the numbers directly support from what is only a hypothesis. Say clearly which of your explanations are supported by the numbers I gave you and which are assumptions. Do not invent data, do not recompute anything, and do not tell me which experiment is better."

AI's explanation — concise summary of its main claims (not the whole conversation):

Audit the explanation

Question	Your finding
Which of its claims are supported by a row of YOUR table? (list them)	
Which claims are assumptions it did not label as assumptions?	
Did it invent a cause with no evidence in the table (for example, a specific phone fault or a "better" experiment)?	
Did it respect the instruction not to rank the experiments?	
Did it treat the interpolation errors relative to amplitude, or only in m/s ² ?	

AI explanation verdict: ☐ ACCEPT ☐ MODIFY ☐ REJECT Why?

The ONE change that would make its explanation defensible:

Critical evaluation does not require disagreement — an AI explanation that names its assumptions and points at your numbers may be ACCEPTED after you check it. The question is whether the EVIDENCE it cites is yours.

7. Engineering Judgment — Same Method, Two Records

In three to five sentences: (1) Which differences between the two experiments are most strongly supported by the evidence, and which possible causes remain uncertain? (2) Did straight-line

interpolation behave the same way on both records — where it worked and where it did not — and what does that say about the method versus the data? (3) If your team ran Lab 6 again, what ONE change would you make to the physical experiment, and what evidence would tell you it helped?

Same rule on two records → different numbers → the difference is evidence about the EXPERIMENTS, not a verdict on the method. AN ESTIMATE IS NOT A MEASUREMENT — LABEL IT.

8. Suggested Assessment Rubric — 10 Points

Criterion	Points
Committed predictions P1–P5 (recorded before running the sample data)	1
Sample-record run: committed values as typed, results recorded, one substitution shown	2
Comparison table — complete, with side-by-side figures	2
Interrogation — evidence before explanation for each factor	2
AI audit — ACCEPT / MODIFY / REJECT with evidence	2
Engineering judgment — ranked causes and one defensible improvement	1
TOTAL	10

9. Human Review & Approval

"I reviewed the sample-record run, the committed predictions, the comparison table and figures, the AI contribution, the audit, and the engineering conclusion in this extension. I accept responsibility for the submitted engineering work."

Human reviewed and approved.

Would you confidently put your name on this comparison? Sign only when the answer is yes.

Student name · Signature · Date

AI assists. Humans verify. Humans decide. Humans approve.