



AI First Engineering

FUNDAMENTALS OF AI-AUGMENTED ENGINEERING: A Conversational Approach

CHAPTER 8

LAB-8 EXTENSION: Individual Report Template

Balance the Bridge — A Computational Design Challenge

Optional, individual and separately graded. Every result in this report is a model prediction; nothing here has been built or measured.

Student name	
Course / section	
Lab 8 group / station	
Date submitted	

MODEL › COMPUTE › DESIGN › VERIFY › ASSESS ROBUSTNESS
THINK › PSEUDOCODE › AI › CODE

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1. Inputs

Input	Value	Unit	Source
R1		k Ω	
R2		k Ω	
R3		k Ω	
R4		k Ω	
R5		k Ω	
R6		k Ω	
Vs (C)		V	
V1, V2, V3 measured in Lab 8 Stage C		V	

Source: "group measured (Lab 8)" or "reference dataset (nominal)". If you used the reference dataset, say why.

2. Predictions (Part A) — written before any computation

A1. Direction of current in R7; will V1 and V3 rise or fall? Physical reason.

A2. Which entries of A change, which stay the same, and does b change?

A3. Should R7 be smaller or larger than 4.7 k Ω to make $I_5 = 0$? Why?

3. Bridged Model (Part B)

KCL at V1 and V3 with R7 included; explain why the V2 equation is unchanged.

Bridged A and b, symbolically. Mark every changed entry and explain its sign.

Symmetry and diagonal-sum check:

4. Reference Design R7 = 4.7 kΩ (Part C)

Quantity	Unbridged (Stage C model)	Bridged, R7 = 4.7 kΩ	Change
V1 (V)			
V2 (V)			
V3 (V)			
I7 (mA)	0		
I5 (μA)			
max r_num (mA)			—

Optional cross-check (not graded): reduce your bridged A and b in the Gauss-Jordan Stepper (lab.aifirstengineering.org/numerical-methods/gauss-jordan, Decimals mode) and confirm it reproduces the bridged V . If it does not, the error is in your matrix, not in MATLAB. KCL check at $V3$ (the three currents leaving $V3$, with numbers):

Compare with your Part A predictions. Which node moved most, and why?

5. Sweep and Design Choice (Part D)

Figure 1: I_5 (μA) against R_7 ($k\Omega$, log axis). Insert here, with labelled axes.

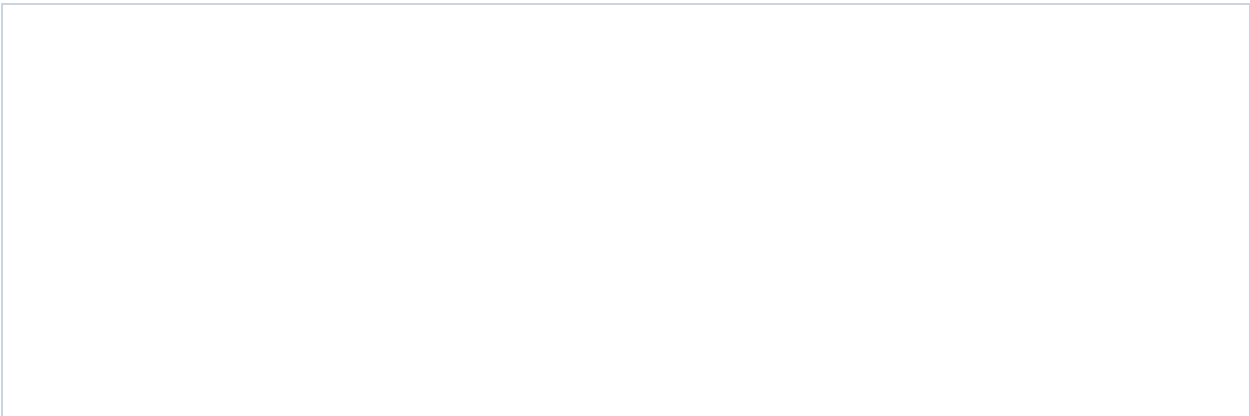
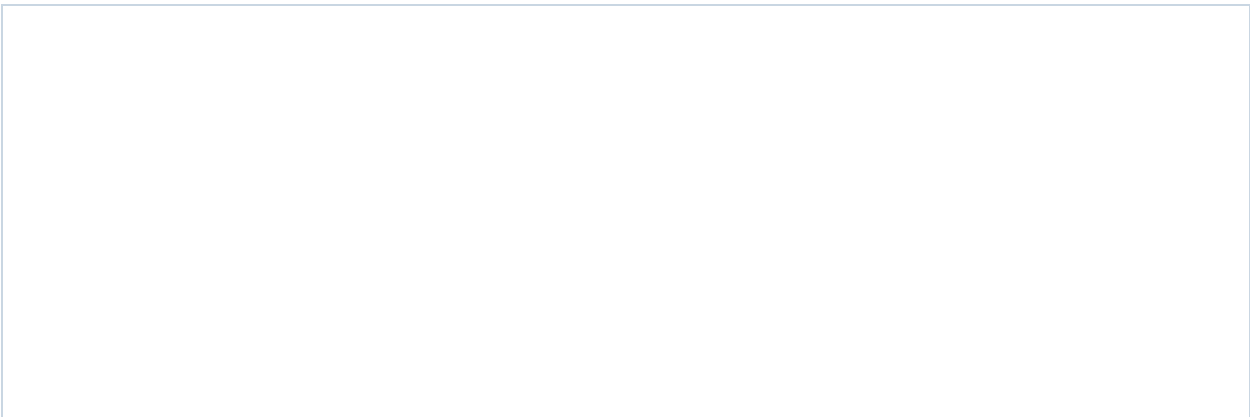


Figure 2: V_2 and V_3 against R_7 . Insert here.



Result	Value	Method
R7* ($I_5 = 0$), 4 significant figures		

CANDIDATE E12 VALUES

E12 R_7 ($k\Omega$)	I_5 (μA)	$ V_2 - V_3 $ (mV)	Notes

Selected R7 and justification (two or three sentences):

6. Independent Verification (Part E)

E1. Hand derivation of the balance condition (show each step), its value with your inputs, and the comparison with $R7^*$ from the sweep.

E2. Which resistors are absent from your formula, and why can they not affect the balance point?

E3 LIMITING CASES

Limiting case	V1 (V)	V2 (V)	V3 (V)	Physical explanation
R7 = 1e9 kΩ				
R7 very small (state value)				

E4. Conservation checks for your chosen $R7$ (KCL at each node; source current vs. total current to ground):

7. Robustness and Limits (Part F)

F1 ONE-AT-A-TIME TOLERANCE, CHOSEN E12 R7

Resistor changed	I5 at -1 % (μA)	I5 at +1 % (μA)	Sign of I5 changes?
R3			
R4			
R6			
R7			
(none — nominal)		—	—

Explain the sign result using your balance formula. (Optional: Monte Carlo result — fraction of trials with $I5 > 0$.)

F2. What do your Lab 8 Stage C measurements say about trusting this model — and what do they NOT say about the bridged circuit?

F3. Validation plan (written only): what you would build and measure, and what result would count as evidence that $I5 \approx 0$. Use the Lab 8 sensitivity results to judge what a hand-held meter could detect.

F4. At least three model assumptions and how each could shift the real balance point.

8. AI Use and Verification Record

Task	What you asked	What you accepted / changed / rejected
Sweep / plotting / fzero code		
Balance-condition derivation (after your own)		
Other		

AI TEAMMATE Verified AI claim (required)

One substantive claim an AI made, how you checked it independently, and whether it was correct.

9. Design Recommendation

Write a short memo (120–200 words) to an engineer who must decide whether to build this design. State the recommended R7, the expected I5 and how sensitive it is, the evidence behind it, and what has NOT yet been shown. Do not describe the design as tested or validated.

10. Integrity Statement

SIGN Sign before submitting

I completed this extension individually. The only data I used were my Lab 8 group's measured values or the reference dataset, as stated in Section 1. All results are model predictions; none are presented as measurements. AI use is fully recorded in Section 8.

Signature: _____ Date: _____

11. Grading Rubric (30 points)

Criterion	Full credit looks like	Pts
Predictions and inputs	Part A answered before computing, with physical reasons; inputs and source stated	3
Bridged model	Correct KCL; changed entries identified with correct signs; symmetry explained	5
Reference design	Correct V, I7, I5, r_num; KCL check at V3 shown; comparison with predictions	4
Sweep and design choice	≥ 200 log-spaced points; labelled plots; R7* to 4 s.f.; E12 candidates; justified choice	5
Independent verification	Balance condition derived by hand and matches sweep; absent resistors explained; limits; conservation	6
Robustness and limits	Tolerance table with sign discussion; F2 distinguishes model check from validation; plan; assumptions	4
AI record and recommendation	One AI claim verified; memo clear and honest about what is not yet shown	3
Total		30

Grading is on reasoning and evidence. Because inputs differ between groups, there is no single correct R7; your answers are checked against your own stated inputs. Any claim that the design was built, measured or validated loses the robustness credit.*

INSTRUCTOR / TA USE

Points awarded	Grader	Comments