

Introduction to Problem Solving in

Introduction to Problem Solving in Electronics

Electronics

Designed as a quick-reference guide for students, hobbyists, and anyone new to electronic design.

1. Why Problem Solving Matters

Reason	What It Means for You
Reliability	Devices must work under all expected conditions.
Safety	Prevent overheating, electric shock, or fire hazards.
Cost Efficiency	Fewer redesigns → lower component and labor costs.
Innovation	Systematic analysis uncovers new design opportunities.

2. The General Workflow

- 1?? Define the problem
- 2?? Gather information
- 3?? Model the system
- 4?? Generate possible solutions
- 5?? Simulate / prototype
- 6?? Test & verify
- 7?? Refine or iterate

2.1 Define the Problem

- **Goal statement** – e.g., “Create a 5V regulated supply that can deliver 2A.”
- **Constraints** – size, cost, power budget, temperature range, regulatory standards.
- **Success criteria** – measurable metrics (efficiency >85%, ripple <10mV, etc.).

2.2 Gather Information

- Datasheets, application notes, reference designs.
- Existing schematics or PCB layouts.
- Environmental data (ambient temperature, humidity, vibration).

2.3 Model the System

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- **Analytical** – use Ohm's law, Kirchhoff's laws, transfer functions.
- **Graphical** – Bode plots, load lines, truth tables.
- **Numerical** – SPICE, MATLAB/Simulink, Python (NumPy, SciPy).

2.4 Generate Solutions

- Brainstorm multiple topologies (e.g., buck vs. buck?boost).
- List component options (IC families, passive values).
- Sketch block diagrams and rough schematics.

2.5 Simulate / Prototype

Tool	Typical Use
LTspice / PSpice	Circuit?level transient, AC, DC analysis.
Altium Designer / KiCad	PCB layout and DRC checks.
Breadboard / Perfboard	Quick hardware validation.
Evaluation boards	Test ICs with minimal external parts.

2.6 Test & Verify

- **Functional tests** – does the circuit turn on? Does it meet spec?
- **Parametric tests** – measure voltage, current, frequency response, EMI.
- **Stress tests** – temperature cycling, overload, long?duration run.

2.7 Refine or Iterate

- Adjust component values, add filtering, improve layout.
- Re?run simulations and re?test until all criteria are satisfied.

3. Core Problem?Solving Techniques

Technique	When to Use	Key Steps
Ohm's Law & Power Calculations	Simple biasing, resistor sizing.	$(V = IR)$, $(P = VI)$.
Thevenin/Norton Equivalents	Reduce complex networks to a source + resistance.	Find open?circuit voltage, short?circuit current, then (R_{th}) .

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Technique	When to Use	Key Steps
Load Line Analysis	Transistor bias, linear region operation.	Plot device I _D curve + circuit line, find intersection.
Frequency Domain Analysis	Filters, amplifiers, stability.	Derive transfer function, plot Bode, check phase margin.
Design of Experiments (DoE)	Optimize multi-parameter designs.	Choose factors, run a fractional factor