



# Business Mathematical Models: The Enterprise as an RLC Circuit

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In the economic landscape of 2026, traditional double-entry bookkeeping, while necessary for tax compliance, often proves insufficient for real-time strategic planning. Fintech companies in aggressive *scaling* phases are not static entities, but complex dynamic systems. For this reason, the adoption of **business mathematical models** derived from electronic engineering offers a superior perspective for analyzing the health and resilience of an enterprise. In this thought leadership article, we will explore the isomorphism between a company and an RLC electric circuit, demonstrating how differential equations can predict failure or success well before a quarterly report.

## From Static Balance Sheets to System Dynamics

Most CFOs observe the company through static snapshots (Balance Sheet) or linear summations (Income Statement). However, a company is a continuous flow of value. The engineering approach proposes treating the company as a linear time-invariant (LTI) dynamic system, at least as a first approximation. This allows us to use the Laplace transform and frequency domain analysis to understand how the organization reacts to external shocks.

# Electromechanical Isomorphism: Mapping the Company

To build our **business mathematical models**, we must first establish the fundamental equivalences between electrical and financial quantities. Let's imagine the company as a complex circuit powered by the market.

## 1. Voltage (V) = Market Demand

The potential difference that pushes electrons through the circuit corresponds to **Market Demand** (or the active *Total Addressable Market*). It is the driving force that 'pushes' revenue through the organization. If the voltage drops to zero, the circuit shuts down; if it is too high without adequate protections, the system can overheat (unmanaged hyper-growth).

## 2. Current (I) = Cash Flow

Electric current is the flow of charge over time ( $dQ/dt$ ). In our model, current represents **Operating Cash Flow**. It is the speed at which liquidity moves through business processes. A current interruption (cash crunch) stops operations instantly, regardless of the potential (voltage) applied.

## 3. Resistance (R) = Operational Inefficiencies and Variable Costs

In electronics, resistance dissipates energy as heat. In business,  $R$  represents operational friction: transaction costs, supply chain inefficiencies, and slow bureaucratic processes. Here we can introduce a computing metaphor: just as **bloatware** slows down the performance of a **desktop** by consuming resources unnecessarily, redundant business processes increase resistance  $R$ , dissipating the value generated by market voltage before it can

be reinvested. Reducing 'organizational bloatware' means lowering  $R$  and increasing efficiency according to Ohm's law ( $V = R \cdot I$ ).

#### 4. Capacitance (C) = Cash Reserves (Cash on Hand)

A capacitor stores energy in an electric field. A company's cash reserves act exactly like a capacitor: they smooth out current fluctuations (cash flow) and provide rapid energy when the primary source (revenue) has a momentary dip. A company with low capacitance ( $C$ ) is unstable and subject to high 'ripple' (noise) in payments.

#### 5. Inductance (L) = Organizational Inertia and Long-Term Investments

The inductor opposes changes in current. In business, this represents inertia: the difficulty of changing direction quickly (pivot) or the time required for an investment (CAPEX) to start generating a return. Large corporations have high inductance  $L$ ; startups have low  $L$ , allowing for rapid directional changes but with less 'momentum' to overcome obstacles.

### Differential Equations for Financial Stability

Combining these components, we get a series RLC circuit. The system dynamics can be described by a second-order differential equation. If  $q(t)$  is the accumulated liquidity, the equation governing the system is:

$$L \cdot \left(\frac{d^2q}{dt^2}\right) + R \cdot \left(\frac{dq}{dt}\right) + \left(\frac{1}{C}\right) \cdot q = V(t)$$

Where:

- **$L \cdot \left(\frac{d^2q}{dt^2}\right)$** : Represents the impact of structural investments and inertia.

- **$R * (dq/dt)$** : Represents cash dissipation due to operating costs (the resistive burn rate).
- **$(1/C) * q$** : Represents the voltage across liquidity reserves.

The solution to this equation tells us if the system is:

1. **Over-damped**: The company is too slow, too much bureaucracy (high  $R$ ); it doesn't fail but doesn't grow.
2. **Under-damped**: The company oscillates dangerously between liquidity and illiquidity. Typical of aggressive startups.
3. **Critically Damped**: The ideal point of operational efficiency.

## Frequency Response: The Fintech Company Under Stress Test

The true competitive advantage of these **business mathematical models** emerges when we analyze the frequency response. Markets are not constant; they send signals (shocks) at different frequencies.

### Market Shocks and Bandwidth

Imagine a sudden interest rate hike by the ECB. This is a step signal or high-frequency signal. How does the company react?

- **Low-Pass Filter**: A solid company should behave like a low-pass filter. It should let long-term market trends (low frequencies) pass but attenuate daily or monthly volatility (high frequencies).
- **Resonant Frequency**: Every RLC system has a resonant frequency. If market shocks (e.g., supply cycles or reputational crises) hit at the

company's resonant frequency, cash flow oscillations can become infinite, leading to structural bankruptcy even in the presence of a theoretically valid business model.

## **Cost Structure and Quality Factor (Q)**

The Q factor (Quality Factor) of the circuit determines how 'selective' or 'stable' the company is. A high Q implies low losses (low  $\$R\$$ ), but also a risk of prolonged oscillations (ringing) after a shock. A modern Fintech company must balance fixed costs (which contribute to inertia  $\$L\$$ ) and variable costs ( $\$R\$$ ) to optimize its bandwidth. If the bandwidth is too narrow, the company fails to keep up with the market's innovation speed (e.g., the adoption of new technologies like **bluetooth** 6.0 for proximity payments); if it is too wide, the company is unstable and reactive to every bit of market noise.

## **Conclusions: The Engineer as Architect of Value**

Applying electronics principles to business management is not a simple academic exercise. It provides powerful predictive tools. While accounting tells us *where we were*, differential equations tell us *where we are going* and how the system will react to the next obstacle. For the CFOs and CEOs of 2026, understanding their company's 'time constant' or its input 'impedance' regarding new capital is as fundamental as reading an income statement. Eliminating operational 'bloatware' and correctly sizing the liquidity 'capacitor' are the first steps to engineering a future-proof company.

## **Frequently Asked Questions**

**What is meant by the business model as an RLC circuit?**

This approach analyzes the enterprise as a linear dynamic system where financial quantities correspond to electronic components. Market demand acts as voltage and cash flow as current, allowing the use of mathematical equations to predict business health and resilience to shocks much better than simple traditional static balance sheets.

### **How are costs and inefficiencies represented in the mathematical model?**

Operating costs and bureaucratic inefficiencies are equated to electrical resistance that dissipates energy as heat. Just as redundant computing processes slow down a system, high internal resistance reduces available operating liquidity, requiring a greater push from market demand to keep the company running according to Ohm's law applied to business.

### **Why are differential equations useful for financial strategy?**

Differential equations offer a predictive view that double-entry bookkeeping cannot provide, describing the evolution of the system over time. By analyzing variables such as damping, CFOs can understand if the company is too slow and bureaucratic or dangerously unstable, anticipating potential liquidity crises before they appear in quarterly reports.

### **How can resonance threaten a company's stability?**

Resonance occurs when external shocks, such as supply crises, hit the company at its natural frequency of oscillation. This phenomenon can amplify cash flow variations to unsustainable levels, leading to structural failure even with a valid business model. The goal is to design the enterprise to act as a filter that attenuates these volatilities.

## **What is the role of liquidity reserves in electromechanical isomorphism?**

Cash reserves function exactly like a capacitor in an electric circuit, storing energy to smooth out fluctuations. Adequate capacitance allows for absorbing momentary revenue drops and stabilizing payments, ensuring that operations continue smoothly even when market demand voltage undergoes sudden variations.