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# Application of Operational Calculus and Laplac Exchanges to Electrical Mechanics

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**Abstract:** Operational calculus and Laplace substitution are powerful tools in the analysis of electrical mechanics and control systems, simplifying mathematical models of systems and adapting them to the calculation of specific responses. These methods are widely used to reduce technical errors, improve system efficiency and optimize.

**Key words:** operational calculus, Laplace transform, electricity, dynamics, mechanics, time, circuit, spring, impulse, frequency, amplitude, voltage.

Operational calculus and Laplace replacement methods electricity in mechanics and management in systems important place holds. These are methods using complicated dynamic systems learning and their work analysis to do it becomes easier. Below this mathematician of methods electricity to mechanics how app to be done about main data is quoted:

**1. Operation account essence.**

Operational calculus (Laplace replacement through) complex differential equations simple algebraic to Eqs turns This is the method of systems dynamic behavior analysis especially when doing electricity and mechanic components mutually depends has been cases is used.

**Applications:**

- ✓ Electric of chains time according to changes study.
- ✓ Dynamic systems for time responses (impulse, transfer function) to determine.
- ✓ Filters and of amplifiers frequency characteristics count.

**2. Laplace replacement and his importance.**

Laplace replacement of the system time in the field complexity reducing it frequency in the field analysis to do enable gives He usually is differential equations through expressed systems easier analysis in doing is used.

**Main uses:**

1. **Electric chains**:
- ✓ RLC circuits time according to analysis to do.
- ✓ Tok and tension impulse the answers count.
- ✓ Conductivity functions to determine.

2. **Mechanic systems**:
- ✓ Interrupters and of springs characteristics research to do.
- ✓ Vibration and resonance count.

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3. **Electromechanic systems**:

- ✓ Electric engines, generators and of sensors dynamic the answers evaluation.
- ✓ Management systems stagnation and balance check.

**3. Operation account and electricity of mechanics together application.**

**a) Electricity in mechanics transition processes analysis to do.**

Electric mechanics in systems (for example, engine control ) switch processes (current, voltage or of speed time according to transformation) Laplace replacement through is studied. This is a transition processes complicated differential equations in the form of is given, but Laplace method with them simple to linear algebra equations rotate can.

**b) of the system impulse and frequency answers.**

Electric mechanic in systems:

- ✓ Impulse the answer is to the system one one-time signal effect when his answer.
- ✓ Frequency the answer is the system different in frequencies access signals relationship.

These are the answers Laplace in the field permeability through the function (Transfer function). is determined.

**c) Electricity machines modeling.**

Electric for machines (engines, generators). equations Laplace in the field system is modeled dynamics analysis will be done. For example:

- ✓ Engine torque- speed behavior.
- ✓ of the generator voltage-stability features.

Example: A simple RLC circuit Laplace in exchange analysis.

an RLC circuit equation:

$$L\frac{di(t)}{dt} + Ri(t) + \frac{1}{C}\int i(t)dt = V(t);$$

Using the Laplace transform:

$$LsI(s) + RI(s) + \frac{1}{sC}I(s) = V(s).$$

It's simple algebraic to expression is converted to, and of the system impulse the answer or exit voltage (or find the current) can.

Conclusion. Operational account and Laplace replacement electricity mechanics and management systems analysis in doing strong tool is, of systems mathematician models simplification and them certain the answers to count adapts These are methods technical errors reduce, system efficiency increase and optimization for wide is used.

Below **operational account and Laplace replacement** using electricity to mechanics about problems solve for examples is quoted:

Example 1: A simple RLC circuit analysis to do.

**Given:** $R = 10\,\Omega, L = 2\,H, C = 0.5\,F$. To the chain $50\,V$ amplitude one phased tension $V(\,t) = 50\,u(t)$ given Tok Find $i(t)$.

**Solution:**

1. **Initial equation**:

$$L\frac{di(t)}{dt} + Ri(t) + \frac{1}{C}\int i(t)dt = V(t).$$

Variables Laplace to the field we will spend:

$$LsI(s) + RI(s) + \frac{1}{sC}I(s) = V(s).$$

2. **Laplace to replace we use**:

$$2sI(s) + 10I(s) + \frac{1}{0.5s}I(s) = \frac{50}{s}.$$

In this $V(s) = 50/s$, and expression let's simplify:

3. **Tok for $I(s)$. identify**:

$$I(s)\left(2s + 10 + \frac{2}{s}\right) = \frac{50}{s},$$

$$I(s) = \frac{50}{s(2s^2 + 10s + 2)}.$$

4. **Again time to the field transfer**:

This is an expression partially to pieces is separated and inverse Laplace replacement using $i(t)$ found:

$$i(t) = Ae^{-\alpha t}\sin(\omega t + \varphi)$$

Here $\alpha, \omega$, and $A$the parameters are derived from system properties. (The complete answer is determined by numerical calculation).

Example 2: Engine torque- speed attitude analysis to do.

**Given:** Electric of the engine equation:

$$J\frac{d\omega(t)}{dt} + B\omega(t) = T_{in}(t).$$

In this:

- ✓ $J = 0.01\, kg\backslash cdotpm^2$: moment of inertia,
- ✓ $B = 0.1\, N\backslash cdotpm\backslash cdotps/rad$: viscosity coefficient,
- ✓ $T\_in(t) = 2u(t)$: input torque.

of the engine corner speed $\omega(t) -$ find the.

**Solution:**

1. **Laplace to the field we will spend**:

$$Js\Omega(s) + B\Omega(s) = \frac{2}{s}$$

2. **Linear equation**:

$$\Omega(s)(Js + B) = \frac{2}{s},$$

$$\Omega(s) = \frac{2}{s(Js + B)}.$$

3. **Numeric values we put**:

$$\Omega(s) = \frac{2}{s(0.01s + 0.1)} = \frac{200}{s(0.01s + 1)}.$$

4. **Inverse Laplace replace**:

Partially to pieces we distinguish:

$$\Omega(s) = \frac{200}{s} - \frac{200}{0.01s + 1}.$$

Time to the field we will spend:

$$\omega(t) = 200 \cdot (1 - e^{-100t})\ rad/s.$$

**Result:**

Angle speed time pass with 200 rad/ s approaches.

Example 3: Electromechanical permeability function.

**Given:** of the system conductivity function:

$$H(s) = \frac{10}{s^2 + 5s + 10}.$$

His impulse the answer $h(t) -$ find the.

**Solution:**

1. **Laplace from the table we use**: Conductivity function partially to the faction we separate or Laplace to the analysis according to:

$$H(s) = \frac{10}{(s + 2.5)^2 + 5.75}.$$

2. **Inverse Laplace Substitution**: This is a sinusoidal response as we write:

$$h(t) = 10e^{-2.5t}\sin(\sqrt{5.75}t).$$

**Result:** Impulse the answer time according to exponent in the form of a decaying sine will change.

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