

Lecture Module - Alternate Model Forms

ME3050 - Dynamic Modeling and Controls

Mechanical Engineering

Tennessee Technological University

Topic 1 - Equivalent Models

Alternate Model Forms

- Equivalent Model Concept
- Differential Equations
- Transfer Functions and Block Diagrams
- State-Space (Variable) Models
- Computer Models

Equivalent Model Concept

A mathematical model is an expression derived from basic principles that describes a physical or simulated system.

Models appear in different forms.

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Each form has its own advantages and disadvantages. We can convert one form into another, with differing degrees of difficulty. - Palm

Equivalent Model Concept

Standard Form of an ODE

Ordinary Differential Equations are written in the following form.

$$a_n \frac{dy^{(n)}}{d^{(n)}x} + a_{n-1} \frac{dy^{(n-1)}}{d^{(n-1)}x} + \dots + a_2 \frac{dy^2}{d^2x} + a_1 \frac{dy}{dx} + a_0 y = f(x)$$

The apostrophe is commonly used for the derivative.

$$a_n y^{(n)} + a_{n-1} y^{(n-1)} + \dots + a_2 y'' + a_1 y' + a_0 y = f(x)$$

The overdot notation implies that time is the independent variable.

$$a_2 \ddot{y} + a_1 \dot{y} + a_0 y = f(t)$$

Differential Equations

Transfer Functions and Block Diagrams

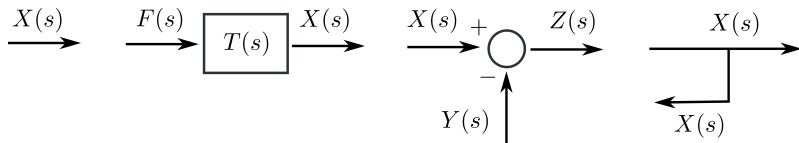
The transfer function is a way of describing a system that can be used to analyze the system response to an external input with the assumption of zero initial conditions.

$$T(s) = \frac{X(s)}{F(s)}$$

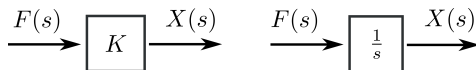
Does this look familiar? How can we find the transfer function?

Transfer Functions and Block Diagrams

A block diagram is a visual representation of the transfer function concept. Here are the four basic symbols.

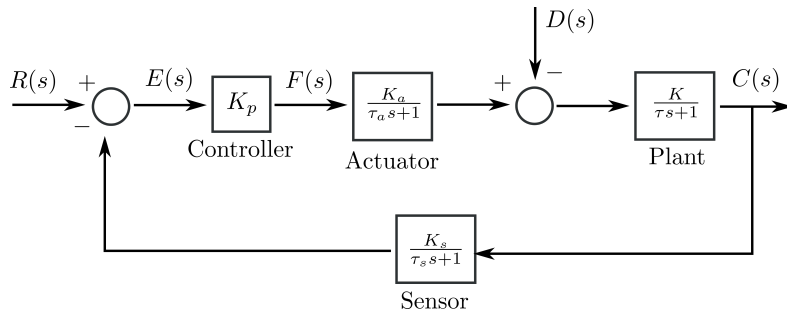


Mathematical operations can be represented as block diagrams.



Transfer Functions and Block Diagrams

Complex systems can be described by block diagrams.



State-Space (Variable) Models

Computer Models