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Control Systems Engineering by Norman S. Nise: A Comprehensive Guide for Engineering Students

Control systems engineering is a branch of engineering that deals with the design, analysis, and implementation of systems that can regulate their own behavior to achieve desired objectives. Control systems are ubiquitous in modern technology, from robots and drones to cars and planes, from power plants and factories to biomedical devices and smart homes.

One of the most popular and widely used textbooks for learning control systems engineering is **Control Systems Engineering** by Norman S. Nise, a professor emeritus of electrical and computer engineering at California State Polytechnic University, Pomona. The book, now in its eighth edition[^3^], covers the fundamental principles and concepts of control systems theory and practice, with an emphasis on practical applications and real-world examples.

The book is divided into four parts: Part I introduces the basics of control systems, such as modeling, feedback, stability, and root locus. Part II covers the design of control systems using frequency response methods, such as Bode plots, Nyquist plots, and PID controllers. Part III presents the state-space approach to control systems analysis and design, including state feedback, observers, pole placement, and optimal control. Part IV explores advanced topics in control systems, such as nonlinear systems, adaptive control, digital control, and fuzzy logic.

The book is suitable for undergraduate and graduate students of engineering who want to learn the fundamentals and applications of control systems engineering. It is also a valuable reference for practicing engineers who want to refresh their knowledge or update their skills in this field. The book is accompanied by a companion website[^3^] that provides additional resources for instructors and students, such as lecture slides, MATLAB files, solutions manual, quizzes, and videos.

In this article, we will review some of the key features and benefits of **Control Systems Engineering** by Norman S. Nise, and provide some examples of how the book can help students and engineers master the subject of control systems engineering.

Key Features and Benefits of Control Systems Engineering by Norman S. Nise

Some of the key features and benefits of **Control Systems Engineering** by Norman S. Nise are:

- The book is written in a clear and concise style, with a logical and consistent organization. The book uses a step-by-step approach to explain the concepts and methods of control systems engineering, with plenty of examples, figures, tables, and diagrams to illustrate the points.
- The book covers both classical and modern techniques of control systems engineering, with a balanced treatment of both frequency-domain and state-space methods. The book also introduces some of the latest developments and trends in control systems engineering, such as nonlinear systems, adaptive control, digital control, and fuzzy logic.
- The book emphasizes the practical applications of control systems engineering, with numerous case studies and design problems that show how the theory can be applied to real-world situations. The book also provides MATLAB codes and Simulink models for many of the

examples and problems, which can help students and engineers to simulate and test their designs.
- The book is accompanied by a comprehensive companion website that offers a wealth of resources for instructors and students, such as lecture slides, MATLAB files, solutions manual, quizzes, and videos. The website also provides access to an online version of the book, which can be accessed from any device with an internet connection.

Examples of How Control Systems Engineering by Norman S. Nise Can Help Students and Engineers

To illustrate how **Control Systems Engineering** by Norman S. Nise can help students and engineers to learn and apply the concepts and methods of control systems engineering, we will present two examples from the book: one from Part II (Frequency Response Design) and one from Part III (State-Space Design).

Example 1: Frequency Response Design of a Cruise Control System

A cruise control system is a device that automatically maintains a constant speed for a vehicle. The system consists of a speed sensor that measures the actual speed of the vehicle, a controller that compares the actual speed with the desired speed (set by the driver) and generates an error signal, and an actuator that adjusts the throttle position to reduce the error.

The design objective is to design a controller that can achieve a fast response (short rise time), a small overshoot (less than 5%), and a small steady-state error (less than 1%) for a step input of desired speed. The system parameters are given as follows:

- The vehicle mass is 1000 kg.
- The engine torque constant is 0.25 Nm/rad.
- The engine damping constant is 0.05 Nm s/rad.
- The wheel radius is 0.3 m.
- The aerodynamic drag coefficient is 0.4 N/m2.
- The road slope angle is zero.

The book shows how to model the system using differential equations, transfer functions, block diagrams, and Bode plots. The book then shows how to design a proportional-integral-derivative (PID) controller using frequency response methods, such as Bode plots, Nyquist plots, gain margin, phase margin, and bandwidth. The book also shows how to implement the controller using MATLAB and Simulink, and how to evaluate its performance using time-domain and frequency-domain specifications.

Example 2: State-Space Design of an Inverted Pendulum System

An inverted pendulum system is a device that consists of a cart that can move along a horizontal track, and a pendulum that is attached to the cart by a hinge. The system has two inputs: a force applied to the cart by a motor, and a disturbance force applied to the pendulum by an external agent. The system has two outputs: the position of the cart and the angle of the pendulum.

The design objective is to design a controller that can stabilize the system in the upright position (the pendulum angle is zero) despite the presence of disturbance forces. The system parameters are given as follows:

- The mass of the cart is 1 kg.
- The mass of the pendulum is 0

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