

Automatic Control Engineering



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Automatic Control Engineering

Chapter One

Introduction

1. The Course Outline

Course Detail

Introduction to Control Systems

(Requirements, Definition, Classification, History)

Modeling of Dynamic Systems

(Transfer Function, Block Diagram, Signal Flow Graph)

Time Domain Analysis of Control Systems

(Singular Functions, Typical Inputs, First Order Systems, Second Order Systems, Characteristic Equation, Stability Concept, S-Plane, Routh-Hurwitz Criteria)

The Effect of Parameter Changes (Root Locus Technique)

(Poles & Zeros, Root Loci, Amplitude and Phase Conditions, Evan's Rules, Using Root Locus in Designing of Control Systems)

State Space Analysis of Control Systems

(The Concept of State, State Space Modeling, Solution of State Equation, State Transition Matrix, Eigenvalues, Characteristic Equation, State Space & Transfer Function)

Frequency Response

(Sinusoidal Input Signals, Phase & Amplitude Margins, Absolute & Marginal Stability, Nyquist Diagram, Nyquist Stability Criteria, Bode Plot, Building Transfer Functions from Experimental Data using Bode Plot)

Digital Control Systems

(Digital Mathematical Models, Transfer Functions, State Space Models, Difference Equations, Analysis of Digital Control Systems)

CAD in Control Engineering

(CAD Software, MATLAB, MATLAB Control Toolbox)

Industrial Control Systems (Option)

(PID Controllers, Sensors, Actuators)

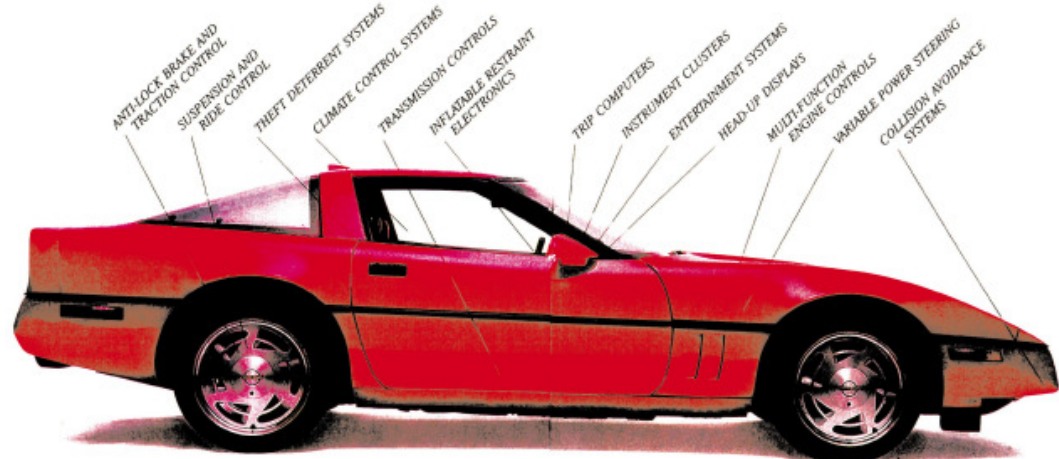
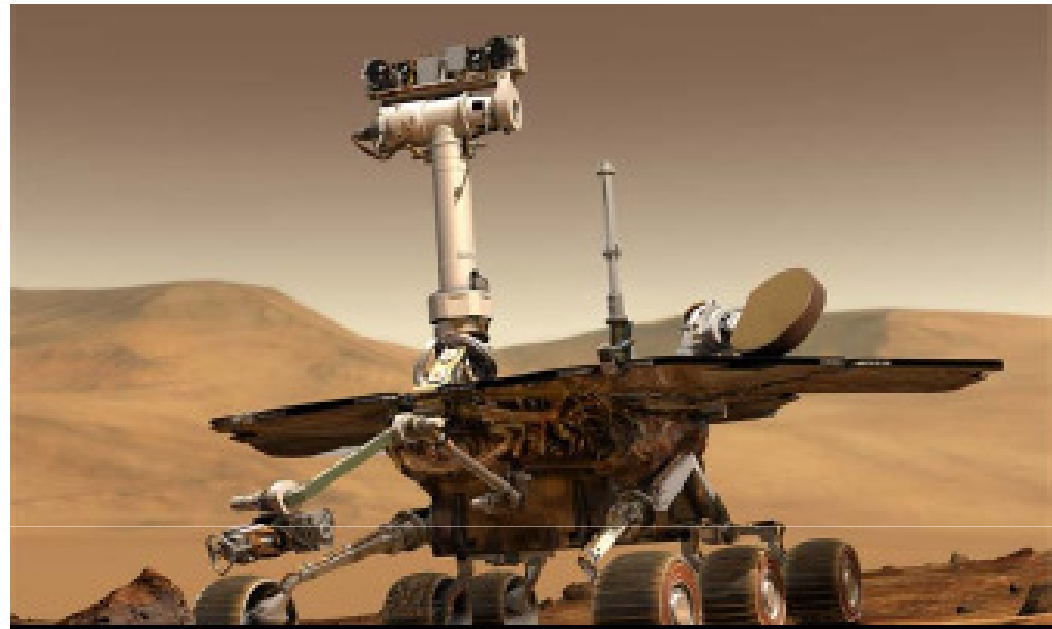
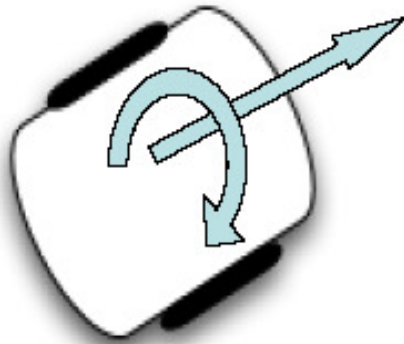
Prerequisites : Laplace Transform, Z transform, Linear Algebra,
MATLAB.

Reference Books:

Kuo, B.C., "Automatic Control Systems",Prentice Hall,2004,
ISBN- 0471 49694 4

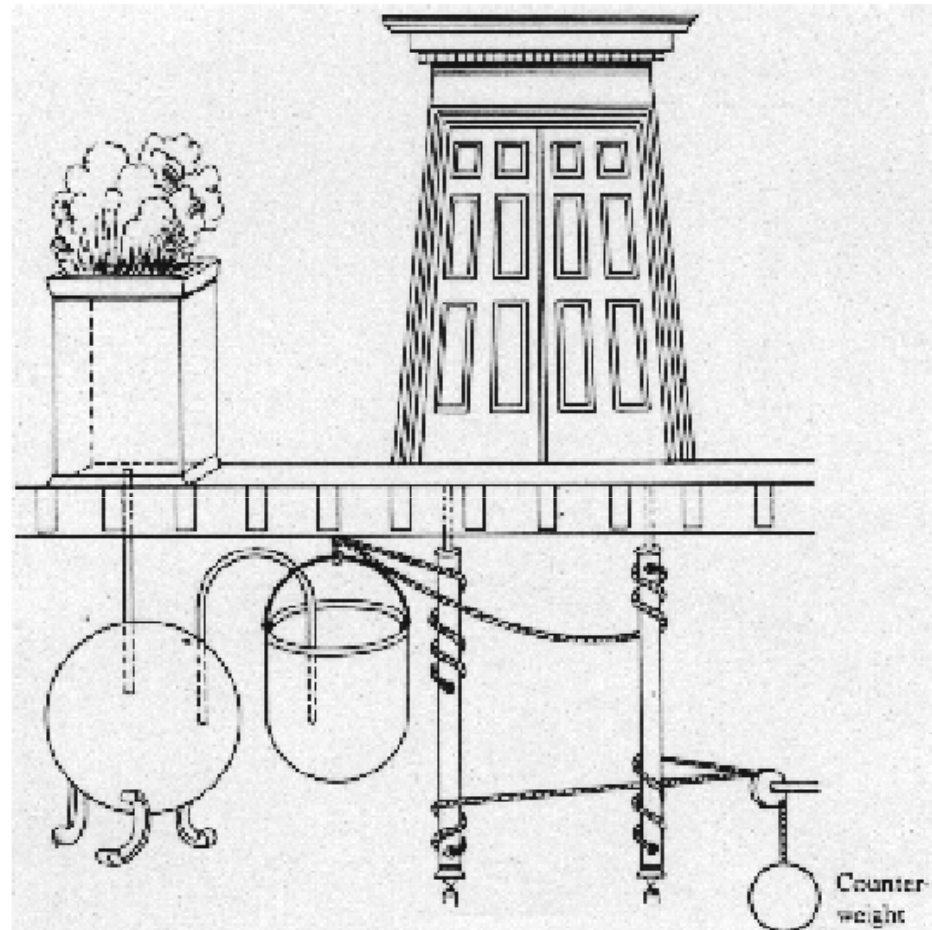
Tatsuhiko OGATA, "Modern Control Engineering", Pearson
Education Asia, 2002, ISBN 81-7808-579-8.

Examples



Examples

The hero device for opening temple



2. Definitions

Control systems are an integral component of any industrial society and are necessary to provide useful economic products for society.

Control engineering is based on the foundation of feedback theory and linear system analysis, and integrates the concepts of network theory and communication theory. Therefore, control engineering is not limited to any engineering discipline but is equally applicable for aeronautical, chemical, mechanical, environmental, civil, and electrical engineering. For example, quite often a control system includes electrical, mechanical, and chemical components.

Furthermore, as the understanding of the dynamics of business, social and economical systems increases, the ability to control these systems will increase also.

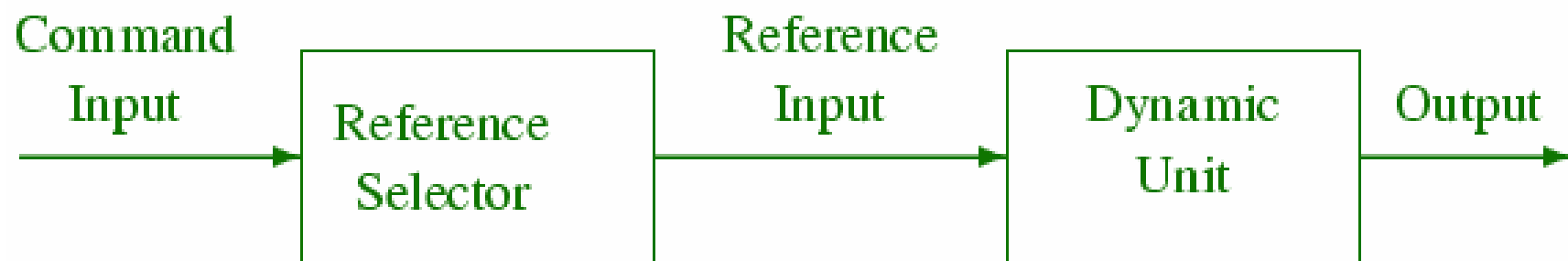
Definition +

A control system is an interconnection of components forming a system configuration that will provide a desired response. The automatic toaster, the thermostat, the washer and dryer, the air conditioner, the computer, the microprocessor, the space vehicles, the robots are some of the familiar control systems.

The methods used to accomplish the control objectives can be classified, very generally, as open-loop controls and closed-loop or feedback controls.

Open-loop control systems

Systems in which the output quantity has no effect upon the input quantity are called open-loop control systems. Open-loop controls are, in general, calibrated systems. An open-loop control system utilizes a controller or control actuator in order to obtain the desired response.

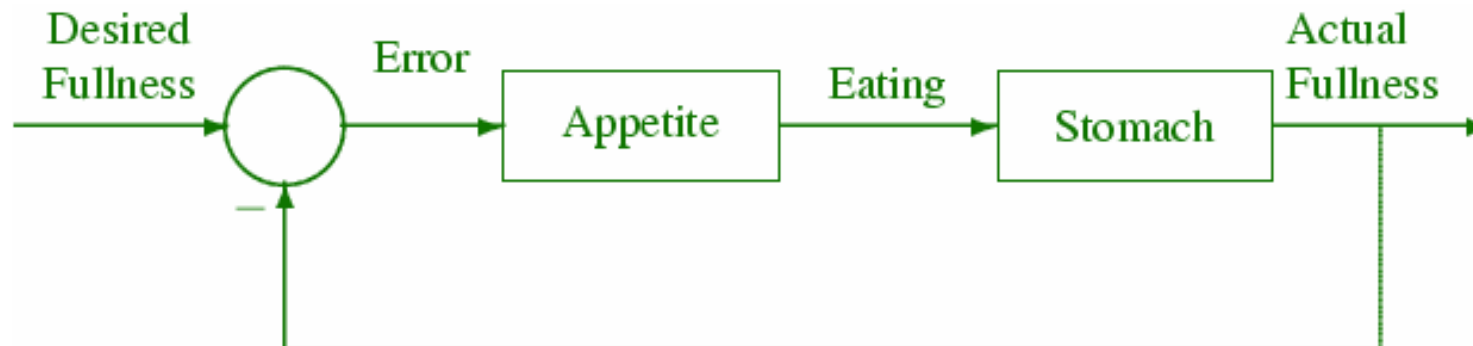


Functional Block Diagram of an Open-Loop CS

Closed-loop control system

Systems in which the output has an effect upon the input quantity are called closed loop control systems. The feedback action controls the input to the dynamic unit. Closed-loop or feedback controls operate according to a very simple principle:

1. Measure the variable to be controlled.
2. Compare the measured value with the desired (commanded value) and determine the difference (*error*).
3. Use this difference (amplify *if necessary*) to adjust the controlled variable so as to reduce the difference (*error*).



Functional Block Diagram of an eating an Appetite

3. System Classification

Feedback control systems may be classified in a number of ways, depending upon the purpose of the classification.

Static or Dynamic Systems: Static systems are composed of simple linear gains or nonlinear devices and described by algebraic equations, and dynamic systems are described by differential or difference equations.

Continuous-time or Discrete-time Systems: Continuous-time dynamic systems are described by differential equations and discrete-time dynamic systems by difference equations.

Linear or nonlinear Systems: Linear dynamic systems are described by differential (or difference) equations having solutions that are linearly related to their inputs. Equations describing nonlinear dynamic systems contain one or more nonlinear terms.

System Classification +

Time-varying and Time invariant Systems: - **Time-varying** dynamic systems are described by differential (or difference) equations having one or more coefficients as functions of time. Time invariant (constant-parameter) dynamic systems are described by differential (or difference) equations having only constant coefficients.

4. The Scope of The Course

The scope of this course is limited to a consideration of linear, lumped parameter, continuous-time invariant, dynamic systems having only deterministic parameters and input. Dynamic systems may often be linearized about either static or dynamic operating points. *Static operating points*, referred to as *equilibrium points*, occur from the application of a constant input, such as a constant force or a constant voltage. *Dynamic operating points* occur when the input varies with time to yield a nominal response as a function of time. Examples are a nominal flight path of an aircraft and a nominal trajectory.