Preface

The concept of “systems” can be approached from various directions. For certain groups this concept may mean products, production systems, economy. For others who are strongly bound to the conventional linear world of electrical engineers it mainly means linear systems and control. Mechanical engineers and chemists, biologists are rather interested in nonlinear systems and nonlinear control.

During the development of a relatively new course to be supported by the present book one has to catch the proper role and significance of the subject area of “*System and Control Theory*” in the World’s leading educational institutes. For this purpose the home page of the “*U.S.News & World Report*” [World’s Best Universities, 2010] was studied according to its state in 2010. The search was restricted to the subject area of “*Engineering and IT*”. It was found that the components of this subject area appear under various names in the available curriculum descriptions of the 12 leading institutions. Let us see some examples as follows:

1. *Massachusetts Institute of Technology (MIT), United States*: “dynamic systems and Control”, “advanced linear Control systems”, “multivariable Control systems”, and “dynamics of nonlinear systems”; the main subject area of the curricula are related to *linear systems and methods*, only the last course pays emphasized attention to nonlinear phenomena; from this point of view the “Nonlinear Systems Laboratory Homepage” of MIT is very illuminating [MIT Nonlinear Systems Laboratory, 2011] that refers to two books of fundamental significance mainly in nonlinear control

[Slotine et Li, 1991] and especially in robotics [Asada et Slotine, 1986] besides journal publications made by the fellows of the Lab in the last decades.

2. *Stanford University, United States*: “Introduction to Linear Dynamical Systems” with an introduction to applied linear algebra and linear dynamical systems, with applications to circuits, signal processing, communications, and control systems.
3. *University of California, Berkeley (UCB), United States*: the subject area is distributed over a great variety of courses as “Feedback Control Systems” (in Electrical Engineering but it is also listed amongst the courses of Mechanical Engineering), “Nonlinear Systems-Analysis, Stability and Control”, “Stochastic Systems: Estimation and Control”, “Vehicle Dynamics and Control” (in Mechanical Engineering), “Model Predictive Control”, “" Advanced Control Systems I and II”, “Multivariable Control System Design”, “Control of Nonlinear Dynamic Systems”, “Predictive Control for Linear and Hybrid Systems”, “Dynamic Control of Robotic Manipulators”, “Hybrid Systems and Intelligent Control”, “Topics in Control, Modeling and Optimization”.
4. *California Institute of Technology (Caltech) United States*: the 650 pages long description of the various courses contains the topic of “Information Science and Technology”; the detailed contents of this material as well as their laboratory background far exceeds our possibilities.
5. *Imperial College London, United Kingdom*: also distributes the subject area over a great variety of courses as “Process dynamics and control”, “Control engineering ”, “Stability and control of non-linear systems”, “Design of linear multivariable control systems”, “Identification and adaptive control”, “Predictive control”, “Spectral estimation and adaptive signal processing”.
6. *ETH Zurich (Swiss Federal Institute of Technology), Switzerland*: “Linear System Theory”, “Signal and Information Processing: Modeling, Filtering, Learning”, “Seminar in Systems and Control”.
7. *Carnegie Mellon University (CMU), United States*: “Chemical Engineering Process Control”, “Introduction to Feedback Control Systems”, “Signals and Systems”, “Fundamentals of Control”, “Feedback Control Systems”, “Mechanical Systems Experimentation”.

As it can be seen certain curricula definitely addresses the needs of "specialists" in control. On this reason they deliver very well constructed fundamental and special courses for the needs of specialists.

In contrast to that Students of Óbuda University will not be "control specialists". They rather need some "general erudition and literacy" in system theory and control. These lecture notes are written for the use by students dealing with *Information Technology* as well as with *Mechanical Engineering*.

Since cultivating science is the common part of the cultural activities of the societies science is in interaction with our other activities. Superficial interpretation and generalization of certain scientific results may create great and often unrealistic expectations in the society. These expectations also react to the development of science: influence the researchers in planning their activities, determining their goals, etc. As a consequence the history of science also seems to be rather a kind of battle than discussion between the upholders of various ideas. We can recall how frequently happened in the history (either in physics or in technical fields) that self-confident practitioners of certain scientific subject areas declared that the "state of perfection" has been achieved/well approached. Prigogine and Stengers in [Prigogine et Stengers, 1986] joyously refer to Laplace's statement on the "triumph" of Classical Mechanics: "*No other Newton will be born since we have only a single World to discover and understand.*" "*In the 19th century Physics was assumed to achieve its final stage of development. About the end of the 20th century the famous theoretical astrophysicist, S. Hawking declared that Physics achieved the final possible point of its development and the task of the near future can be only the verification of its theories by numerical computer simulations.*"

In their rather philosophical work on the present state of science Prigogine and Stengers wrote in [Prigogine et Stengers, 1986] that "*We should like to depict the issue according to its present state of the art not forgetting how imperfect canvases we have and how many unforeseen new problems may arise due to our present theories.*" The present work wishes to be conform with their approach.

The great technical development during and after the 2nd World War brought the very illustrative development of the description and control of linear (either discrete or continuous time) systems. This success generated a kind of hype as far as "completeness" and "perfectness" of the linear description of the World is concerned. However, during the economic boom following the 2nd World War abundance of production machines were put into operation. Efficient utilization of such a complicated equipment made the need for novel mathematical methods arise.

An illustrative example of battles of philosophical nature is the long historical contradiction between the devotees of the "*deterministic*" and the "*stochastic*" models of Nature. In the picture outlined by Prigogine the "contradiction" between the "*deterministic*" and "*stochastic*" disappears.

To proceed in this line at first the system concept of our first well elaborated theory, i.e. that of **Classical Mechanics** will be considered and studied. As special cases linear systems can be considered within this picture. Following that the description of systems of huge number of independent variables will be considered in the near equilibrium state. This very interesting subject area that can be recognized as **Classical Thermodynamics** tells us how we can use only a few variables instead of the order of magnitude of about 10^{23} for the general description of the behaviors of such systems. Finally we should like to tackle the problem of dynamical systems being far from the state of their equilibrium by the use of the models of certain chemical reactions. The basic principles of linear and nonlinear control will also be summarized.

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