EML 4930, Section 7569: System Identification

Course syllabus, Fall 2008

Dr. Prabir Barooah

Meeting time: 11:45 am - 12:35 p.m. (period 5), Monday/Wednesday/Friday.
Meeting Room: MAE-A 327.
Instructor office hours: 4:05- 4:55 p.m. (period 9), Monday/Wednesday/Friday.
Office: MAE-A 322.
email: pbarooah at ufl dot edu
Course website: `http://humdoi.mae.ufl.edu/~prabirbarooah/EML4930F08.html`

Pre-requisite: EML 4312. In addition, the course requires very strong mathematical skills.

Computer requirement: Home work problems and projects will require MATLAB. Students may want to purchase the student version of MATLAB, as departmental computer resources are limited. Not being able to get on a computer is not a valid excuse for late work.

Course goal: To design a controller one usually needs a mathematical model of the process to be controlled, which determines how the measured output signals are related to the inputs. Frequently, physical processes governing the behavior of the plant are too complex to allow deriving a mathematical model of the plant from first principle. even if possible, the resulting models may become too complicated to be of any help in designing a control system. In such case, one usually wants to "identify" a simple model of the plant that describes its behavior with some degree of precision. For example, although the relationship between the disturbance acting on the wheels of a vehicle and the acceleration experience by the driver may be quite complex, one could try to capture that by a second order transfer function (a mass-spring-damper system). The task then is to identify the parameters of the model from experimental data. In the car example, it means identifying the values of the inertia, spring constant and the damping coefficient that best explains the observed data, which consist of the input signal acting on the suspension and the acceleration measured at the driver's seat. System identification refers to the general process of identifying a mathematical model of a dynamical system from measured data. In practice, identification is frequently the first step in designing control systems.

This course will cover some basic techniques of system identification for linear systems. Since data is often collected using a computer control system, we will first study in detail discrete time linear dynamical systems. The rest of the course will be concerned with identification techniques for discrete time systems. The utility of these identification techniques will be illustrated with examples from aerospace and mechanical engineering applications.

Topics to be covered: (not necessarily in this order) Review of Laplace transform, continuous time transfer functions. Z-transform, discrete time transfer function.

Response to sine waves of linear time invariant systems. Frequency response of LTI systems, Bode plots.

Parametric identification. : least squares solution of linear equations and its application to parameter estimation of dynamical systems from input-output data. ARX models and their identification using least squares. Geometric interpretation of the method of least squares. ARX models. Signal selection for identification.

Non-parametric identification. Experimental determination of frequency response. Time domain and frequency domain identification. Choice of test signals for identification.

State-space description of LTI systems (continuous as well as discrete). Discrete time state space description of continuous time LTI models. Parametric identification of state space models.

Adaptive, or on-line, parametric identification. Identifiability, persistency of excitation.

Non parametric identification with random signals. Second order statistics of signals, relationship between frequency response and second order statistics of inputs/outputs.

(If time allows) Subspace identification methods.

Credits: 3. Letter grade.

Evaluation criteria: grades will be based on homework/quizzes(40%), one midterm (20%) and a final project (40%). If a homework assignment is turned in late, 20% of its points will be deducted for every day of delay.

Class attendance: attendance in class is not mandatory. However, you are expected to know all material covered in class. Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation. Furthermore, the unannounced Pop quizzes will not have any make-up option. Students who miss such quizzes will receive zeros for that grade.

Make up exam If you have to miss and exam, you must see the instructor and make arrangements in advance unless an emergency makes this impossible.

Academic honesty All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. Academic honesty is therefore taken quite seriously in this class.

Homework assignments are for your benefit. The only way to learn the material covered in class well is to apply it to solve problems, and home-works give you an opportunity to do so. If you turn in someone else's work as your home-works, you lose this valuable opportunity. That said, collaboration on homework problems, provided its purpose is to advance your understanding and not your grade alone, can be beneficial. Such collaboration is allowed, unless it is explicitly prohibited on certain assignments. In any case, you must write up your own homework independently. On problems involving MATLAB programming, you should write your own program.

Textbook: There is **no required textbook** for this course. Typeset notes will be provided for most of the material covered in the class, which can be downloaded from the course website.