Syrian Arab Republic

Higher Institute for Applied Sciences and Technology

HIAST

Course Specification Document

Title	Systems Modelling and Identification

Credits	3.5 ECTS

Aims	This course aims to provide the student with knowledge related to modeling various systems, enabling him to use those models to characterize their behavior, analyze them, simulate their operation and perform systems identification by matching the values of their parameters according to their operation domain.

Intended learning outcomes

On successful completion of this course, the student will be able to:

- Calculate the model of physical systems (electrical or mechanical) according to their work domain, input signals, interacting environment, and the purpose of the study conducted on them.
- Identify graphical identification methods starting from measured quantities of the system's input and output (its state) after proposing a suitable initial model.
- Comprehend how to perform identification of random systems (subject to noise); both during their operation and by using offline data with different least squares methods.
- Implement mathematical and physical theoretical concepts to study real systems.
- Apply mathematical models using the computer to obtain operational mode.

Syllabus

- **General introduction:** Static and dynamic modeling, the concept of model, modeling and identification, state representation for analog and discrete systems.
- **Modeling of various systems:** Models of holonomic translational motion mechanical systems, models of rotational mechanical systems, models of nonholonomic mechanical systems, models of electrical and hydropneumatic systems, models of hybrid systems.
- **Linking modeling to graphical identification methods:** The concept of the operating point, application to a first-order system.
- **Graphic identification methods:** Ziegler-Nichols method, Broida method, Naslin method, inflection point method, Strejc method, Strejc method modified by Naslin, Spikin method.
- **Linking graphical identification methods to the least squares method:** Formulation of the Sipkin method in the standard form of the least squares method, application to identification and estimation.
- **Linear offline least squares method based on previously stored information:** Mathematical formulation (general linear solution to the least squares problem, matrix solution to the least squares problem, introducing weighting into an identification process, deriving a scalar with respect to one of its component vectors, introducing weighting into the matrix solution), statistical properties for estimation using the least squares method, model selection method, applications.
- **Real-time iterative least squares method online:** Mathematical formulation, applications.

- **Random systems identification:** An introduction to the types of noise, the generalized least squares method, the intermediate variable method, the expanded matrix method.
- **Nonlinear identification methods:** Introduction to optimization, introduction to methods for searching for a minimum solution, intuitive or experimental methods: Gauss - Hooke & Jeeves, iterative analytical methods: Newton's method, Gradient method, mixed (hybrid) methods - identification on levels, searching for a minimum solution in the presence of equality-type conditions.