System modelling and identification - opis przedmiotu

Informacje ogólne

Nazwa przedmiotu	System modelling and identification
Kod przedmiotu	11.9-WE-AutD-SysModeliIdentyf.-Er
Wydział	Wydział Informatyki, Elektrotechniki i Automatyki
Kierunek	WIEiA - oferta ERASMUS / Automatyka i robotyka
Profil	-
Rodzaj studiów	Program Erasmus drugiego stopnia
Semestr rozpoczęcia	semestr zimowy 2018/2019

Informacje o przedmiocie

Semestr	1
Liczba punktów ECTS do zdobycia	7
Typ przedmiotu	obowiązkowy
Język nauczania	angielski
Sylabus opracował	• dr hab. inż. Andrzej Janczak, prof. UZ

Formy zajęć

Forma zajęć	**Liczba godzin w semestrze (stacjonarne)**	**Liczba godzin w tygodniu (stacjonarne)**	**Liczba godzin w semestrze (niestacjonarne)**	**Liczba godzin w tygodniu (niestacjonarne)**	**Forma zaliczenia**
Wykład	30	2	-	-	Egzamin
Laboratorium	30	2	-	-	Zaliczenie na ocenę

Cel przedmiotu

To provide fundamental knowledge in system identification, including: input signal selection, model order selection, non-recursive and recursive identification methods.

To develop skills in building system models based on structure knowledge and input-output measurements, including nonparametric identification methods, parametric identification methods, neural networks and fuzzy models.

Wymagania wstępne

Signals and dynamic systems, Control engineering, Artificial intelligence methods

Zakres tematyczny

Introduction. Plants and their models. Model using. System identification and mathematical modelling. Equivalence of models and model equivalence criteria. Parameter estimation. Identifications error definitions. Building system models based on structure knowledge and measurements. Identification algorithm scheme.

Nonparametric identification methods. Transient states analysis. Frequency identification methods. Correlation methods. Power spectrum analysis.

Least squares method. Linear static models. Least squares problem. Normal equations**.** Analysis of least squares estimator. Best linear unbiased estimator. Confidence intervals of parameter estimates. Model complexity. Finding the least squares solution with orthogonal-triangular decomposition. Recursive least squares algorithm.

Models of dynamic systems. Model classification. General structure of linear model. AR, AR, MA, ARMA, FIR, ARX, ARMAX, OE, and Box-Jenkins models. Multi-input multi-output models. Nonlinear models. Wiener and Hammerstein models. Volterra and Kolmogorov-Gabor models. State-space models. Model structure selection.

Input signals. Deterministic signals. Stochastic signals. Input signals used in system identification. Persistent excitation condition.

Prediction error method. Simulation and prediction. Optimal predictors. Least-squares estimation of ARX model parameters. Parameter consistency problem. Instrumental variables method. Choice of instrumental variables. Prediction error method.

Recursive identification. Properties of recursive identification algorithms. Recursive least squares method. Exponential forgetting. Recursive instrumental variables method. Recursive prediction error method. Parameter adaptation of self-tuning controller.

Closed-loop identification. Identifiability of closed-loop systems. Direct identification methods. Indirect identification methods. Influence of feedback loop on estimation accuracy.

Modeling of static and dynamic nonlinear systems using neural networks and fuzzy models. Neural network models of static and dynamic nonlinear systems. Learning algorithms. Generalization.

Neural network model testing and validation. Optima architecture selection. Fuzzy logic. Fuzzy models. Mamdani, Takagi-Sugeno-Kang and Tsukamoto inference methods. Neuro-fuzzy models. Parameter optimization. Rule base optimization. Operator optimization. Examples of neural network and fuzzy modelling.

Metody kształcenia

Lecture, laboratory exercises.

Efekty uczenia się i metody weryfikacji osiągania efektów uczenia się

Opis efektu	Symbole efektów	Metody weryfikacji	Forma zajęć
Knows principles of linear dynamical system identification with neural networks and fuzzy systems		• test	• Wykład • Laboratorium
Can construct models of linear dynamical systems using the prediction error method		• test	• Wykład • Laboratorium
Can construct models of linear systems using the least squares method		• test	• Wykład • Laboratorium
Knows definitions of systems identification, mathematical modeling and general system identification algorithm		• test	• Wykład • Laboratorium
Knows principles of linear dynamical system identification with predication error method		• test	• Wykład • Laboratorium
Can construct models of linear dynamical systems using the transient response analysis		• test	• Wykład • Laboratorium
Knows principles of linear dynamical system identification with recurrent methods		• test	• Wykład • Laboratorium
Knows principles of linear dynamical system identification with instrumental variables method		• test	• Wykład • Laboratorium
Can construct models of dynamical linear systems using the instrumental variables method		• test	• Wykład • Laboratorium
Knows principles of linear dynamical system identification with least squares method		• test	• Wykład • Laboratorium
Knows linear dynamical systems classification, general model structure, AR, MA, ARMA, FIR, ARX, ARMAX, OE and Box- Jenkins models		• test	• Wykład • Laboratorium

Warunki zaliczenia

Lecture – the main condition to get a pass are sufficient marks in written or oral tests conducted at least once per semester.

Laboratory – the passing condition is to obtain positive marks from all laboratory exercises to be planned during the semester.

Calculation of the final grade: lecture 50% + laboratory 50%

Literatura podstawowa

1. Ljung L.: *System identification. Theory for the User*. Prentice Hall, Upper Saddle River, 1999

2. Nelles O.: *Nonlinear System Identification*. *From Classical Approaches to Neural Networks and Fuzzy models*. Springer, New York, Berlin, Heidelberg, 2001

3. Soderstrom T., Stoica P.: *System Identification*. Prentice Hall, Upper Saddle River, 1994

Literatura uzupełniająca

1. Norgaard M., Ravn O., Poulsen N.K., Hansen L.K.: *Neural Networks for Modelling and Control of Dynamic Systems*. Springer, London, 2000

Uwagi

Zmodyfikowane przez dr hab. inż. Wojciech Paszke, prof. UZ (ostatnia modyfikacja: 29-04-2020 12:07)