1. Course title: SYSTEM IDENTIFICATION
2. Course code


4. Level of studies: 2nd cycle of higher education

5. Mode of studies: intramural studies

6. Field of study: MACRO COURSE (FACULTY SYMBOL) RAU

7. Profile of studies: All-academic

8. Programme: AUTOMATIC CONTROL

9. Semester: 1

10. Faculty teaching the course: Institute of Automatic Control, RAu1


12. Course classification: common

13. Course status: compulsory

14. Language of instruction: English

15. Pre-requisite qualifications: Fundamentals of system dynamics, matrix operation, probability and statistics, numerical methods. It is assumed that student starting this course has ability to use computers and Matlab.

16. Course objectives: The aim of the course is to present the main problems of theory and practice of system identification. The course concerns identification of parametric and non-parametric dynamic models.

17. Description of learning outcomes:

<table>
<thead>
<tr>
<th>Nr</th>
<th>Learning outcomes description</th>
<th>Method of assessment</th>
<th>Teaching methods</th>
<th>Learning outcomes reference code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge and comprehension of identification experiment, data processing, model structure and model validation</td>
<td>EP</td>
<td>WM</td>
<td>K_W10</td>
</tr>
<tr>
<td>2</td>
<td>Knowledge and comprehension of parameter estimation of static and dynamic models and, their properties and limitations</td>
<td>EP</td>
<td>WM</td>
<td>K_W11</td>
</tr>
<tr>
<td>3</td>
<td>Skills in static and dynamic system identification</td>
<td>CL, PS</td>
<td>L</td>
<td>K_U15</td>
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<tr>
<td>4</td>
<td>Skills in model validation</td>
<td>CL, PS</td>
<td>L</td>
<td>K_U15</td>
</tr>
<tr>
<td>8</td>
<td>Ability to cooperate and work in a team taking on different roles.</td>
<td>PS, OS</td>
<td>L</td>
<td>K_K03</td>
</tr>
</tbody>
</table>

18. Teaching modes and hours

Lecture / BA /MA Seminar / Class / Project / Laboratory: 45 / 0 / 0 / 30

19. Syllabus description:

Semester: 1

Lecture:

Introduction: Ways of modelling; Identification Problem; Common terms used in system identification; Static and dynamic models: signals and systems; How to interpret the noise source; Variants of model description, Terms to characterize the dynamic model properties: Impulse response, Step response, Frequency response, Zeros and poles; Basic steps in system identification.

Least Squares: Linear regression, LS estimates; Statistical properties - bias, variance, covariance, Noise-variance estimation.

Linear Time Invariant discrete-time systems: Models of LTI systems and signals; One step ahead prediction; Methods of Parameter Estimation: LS, Maximum Likelihood, Instrumental Variable Method, Choice of Instruments.


Identification Experiment: Input Design; Spectral properties, Persistent Excitation, Selection of the sampling interval.

Model structure determination: Order selection, Model validation, Examples.

MISO and MIMO Systems.
Recursive estimation; Recursive LS; Time-varying systems; LMS algorithm.
Identification of nonlinear systems: Neural Networks; General aspects of Black-box models; Grey-box models; Special issues for non-linear models.
Examples of system identification.

Laboratory:
1. Least squares method
2. Nonparametric models
3. Step response and FIR
4. ARX models
5. Real-world process identification
6. Time - varying models

20. Examination: yes

21. Primary sources:

22. Secondary sources:

23. Total workload required to achieve learning outcomes

<table>
<thead>
<tr>
<th>Lp.</th>
<th>Teaching mode</th>
<th>Contact hours / Student workload hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lecture</td>
<td>45 / 20</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>0 / 0</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>30 / 40</td>
</tr>
<tr>
<td>4</td>
<td>Project</td>
<td>0 / 0</td>
</tr>
<tr>
<td>5</td>
<td>BA/MA Seminar</td>
<td>0 / 0</td>
</tr>
<tr>
<td>6</td>
<td>Other</td>
<td>15 / 30</td>
</tr>
<tr>
<td></td>
<td>Total number of hours</td>
<td>90 / 90</td>
</tr>
</tbody>
</table>

24. Total hours: 180

25. Number of ECTS credits: 6

26. Number of ECTS credits allocated for contact hours: 3

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 3

26. Comments:

Approved:

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(date, Instructor’s signature) (date, the Director of the Faculty Unit signature)