1. Course title: SYSTEMS AND SIGNALS
2. Course code S&S

3. Validity of course description: 012/2013

4. Level of studies: MA,MSc programme
5. Mode of studies: intramural studies
6. Field of study: ELECTRONICS AND TELECOMMUNICATION (FACULTY OF AC, E & CS)
7. Profile of studies: general (academic)

8. Course objectives:
The main objective of the course is the supplement and extension of basic knowledge on the theory of analog and digital signals, which allows him understanding and designing any modern analog or digital modulation system. The course introduces basic problems of modern electronic embedded systems, their modeling and design methodologies and appropriate design tools. The problems presented in lecture are practically illustrated in laboratory. The exercises are divided into two groups: first part is performed on hardware sets consisting on assembled circuits, meters, generators, oscilloscopes, power suppliers etc.. The next group of exercises is performed on virtual environment of LabView (National Instruments) software. The main objective of the practical laboratory is to learn students practical and creative work of their own. They have to make appropriate experiments, measurements and prepare reports containing necessary calculations and elaborated conclusions.

15. Pre-requisite qualifications:
It is assumed that a student has sufficient skills and knowledge in mathematics (functions, distributions, complex numbers, integral and differential calculations); circuits theory (phasor method, Laplace transform, transient analysis, electrical filters and frequency characteristics); fundamentals of signal processing (Fourier transform, Z transform, fundamentals of analog signals modulation) and fundamentals of methods of analog and digital circuits design. Additionally students should be familiar with basis of hardware description languages and object-oriented programming in C++.

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>W1</td>
<td>A student has extended knowledge in the field of signal processing algorithms, which allows him understanding and designing any modern analog or digital modulation system.</td>
<td>Exam</td>
<td>Lecture</td>
<td>K2_W01</td>
</tr>
<tr>
<td>W2</td>
<td>A student has deep theoretical knowledge on signals theory and methods of signals processing.</td>
<td>Exam</td>
<td>Lecture</td>
<td>K2_W05</td>
</tr>
<tr>
<td>W3</td>
<td>A student understands designing methods of complex analog digital and mixed systems; knows hardware description languages VHDL, Verilog and system level description language SystemC.</td>
<td>Exam</td>
<td>Lecture</td>
<td>K2_W07</td>
</tr>
<tr>
<td>U1</td>
<td>A student is able to use selected computer aided design tools that enables to prototype and simulate complex electronic systems (Matlab, LabView, ActiveHDL, ModelSim).</td>
<td>Practical laboratory exercises</td>
<td>Laboratory</td>
<td>K2_U17</td>
</tr>
<tr>
<td>U2</td>
<td>A student can propose modifications and refine existing solutions of the modulation systems in LabView environment.</td>
<td>Practical laboratory exercises</td>
<td>Laboratory</td>
<td>K2_U19</td>
</tr>
<tr>
<td>K1</td>
<td>A student is able to think and work creatively, he is active and open to new concepts and ideas.</td>
<td>Practical laboratory exercises</td>
<td>Laboratory</td>
<td>K2_K01</td>
</tr>
</tbody>
</table>

18. Teaching modes and hours
Lecture / BA /MA Seminar / Class / Project / Laboratory
Sem. 1 - 15 h / 0 / 0 / 0 / 15 h

19. Syllabus description:

Basic terms: The concept of signal, analog, discrete and digital signal; Methods of signals description in time and frequency domains; orthogonal series; Fourier transform.

The transient analysis in a transmission line with non-linear circuits: Bergeron method
Transmission properties of linear systems: signals convolution in time and frequency domain, transmission two-port circuits; Transfer function, analysis of electronic systems stability, stability criteria.

Signal graphs, methods of their description, generation of equations, Mason rule; Systems descriptions by use of block diagrams, Relationships between graphs and block diagrams.

Reminder of basic analog modulation systems: AM, AM-SC, SSB, SSB-SC, PM and FM.
Modern methods of pulse modulation: classification of these systems, PAM –natural and ideal sampling, PDM and PPM systems.
Sampling and quantization. Kotelnikov-Shannon theorem. Uniform quantization. Companded quantization; A-law and m-law. Pulse-coded modulation, delta and delta-sigma modulations, differential and adaptive modulation systems, methods of signal coding. Time and frequency division multiple access to the transmission channels (TDMA and FDMA); Problem of resistance to noise and interference of modulation systems; comparison of continuous and pulse modulation systems.
Introduction to discrete signals, Z transform: basic properties, reverse transform, relationship to Fourier transform.


Methods of analysis and synthesis of discrete systems, frequency characteristics, problem of stability of these systems.

Digital modulation systems of sinusoidal carrier. Basic systems of one-bit digital modulations with amplitude shift-keying (ASK), phase shift-keying (PSK) and frequency shift-keying (FSK). Block diagrams and various solutions of synchronous (coherent) and asynchronous (incoherent) broadcasting and receiving systems. Structures of the correlator and adaptive filters. Linear approach to PSK modulation, signal constellation. Difference and adaptive solutions. Coded-mixed division multiple access to the transmission channel (CDMA), QPSK, MSK and GMSK systems. An example of the practical implementation of a modern pulse and digital modulation system – principle of operation of the GSM system: basic assumptions, division multiple access to the radio channel, transmission in the spread spectrum, organization of the transmission etc.

Definition of the term the electronic embedded system (system on chip SoC), description of basic methodologies of embedded systems design: top-down, bottom-up and meet-in-the-middle. Gajski’s Diagram. Language SystemC, Modeling and design on transaction level, the verification of designs.

The Program of the laboratory (all exercises takes 2-hours):

Ex. 1: Introduction to the laboratory, rules and conditions to obtain the credit.
Ex.2: Nonlinear signals transformation.
Ex.3: Pulse amplitude modulation
Ex.4: Introduction to LabView.
Ex.5: Analog modulation systems.
Ex.6: Z transform and the transfer function.
Ex.7: Discrete Fourier transform (DFT).
20. Examination: semester 1

21. Primary sources:

22. Secondary sources:
      (Papoulis A – Signal Analysis, McGraw-Hill, 1977.)
   7. J.Izydorczyk, J.Konopacki – Filtry analogowe i cyfrowe, Wydawnictwo pracowni komputerowej J.Skalmierskiego,  
      Katowice 2003.

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>15 / 30</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>0 / 0</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>15 / 15</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>5 / 10</td>
</tr>
<tr>
<td></td>
<td>Total number of hours</td>
<td>35 / 55</td>
</tr>
</tbody>
</table>

24. Total hours: 90

25. Number of ECTS credits: 3

26. Number of ECTS credits allocated for contact hours: 1

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 1

26. Comments:

Approved:

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