Approved by: ……..

Dean

Date.....

SOFIA UNIVERSITY "ST. KLIMENT OHRIDSKI"

Faculty of Physics

Subject area: *(code and name)*

BSc Program: *(code and name)*

P	H	H	1	2	0	1	1	7

S Y L L A B U S

A	0	1	5

Course: *Basics of Electronics*
(Основи на електрониката)

Lecturer: Assoc. Prof. Plamen Dankov

Academic work	Components	Acad. hours
In-class work	Lectures	30
	Seminars	0
	Practical exercises (school internships)	0
Total in-class work		**30**
Out-of-class work	Solving homework from the lecture course (1st part) at home Self-study topics from entire syllabus, solving sample tests and individual tasks	5
	Preparation for the control work No. 1 in the middle of the semester	10
	Preparation for the control work No. 2 at the end of the semester	10
	Study of the literature and the electronic editions for the course	5
Total out-of-class work		**30**
TOTAL ACADEMIC WORK		**60**
ECTS credits in-class work		**1**
ECTS credits out-of-class work		**1**
TOTAL ECTS CREDITS		**2**

№	Grade components	% of the grade
1.	Written control work No. 1 (according to a template) on the 1st part of the syllabus (5 individual tasks by a lot)	50
2.	Homework: two written notes (up to 3-4 pages; smart summarizing) on two topic from the 2nd part of syllabus (by a lot)	20

3.	Test from the 2nd part of the syllabus (6 individual tasks by a lot)	20
4.	Final exam - discussion on the three forms of evaluation and finalization of the common assessment	10

Outline of the course:

The course "Basic of Electronics" is a mandatory course. It offers students the opportunity to get acquainted with the basics of RF electronics, passive and active electronic elements, circuits and devices, electrical signals and their processing, logical elements and digital electronics, modern electronic technology at a sufficiently modern level. The course is continuously enriched with new information, but in the main it aims to give the students of the physical specialties the necessary knowledge base in this field and in its informative superstructure above it - the modern level, the technology, the applications and the new ideas in this area.

The course is fully based on multimedia. The students who visit it can receive the materials from it in an electronic format. The lecturer has also electronics materials from other courses for science students at two other world universities. They can be used in preparation for the written exam.

Laboratory exercises to the course is conducted and evaluated separately. It complements the curriculum on the practical training of students with similar or even new experimental themes.

Preliminary requirements:

The course starts with introducing all the concepts needed to study the subject matter in the program. Basic knowledge of mathematics is required: solving of algebraic equations and systems of algebraic equations, finding of derivatives and integrals, complex numbers, trigonometric functions, vectors, ordinary differential equations, matrix calculus, Fourier transforms and other basic mathematical operations.

Key competences acquired:

After the successful completion of the course each student is expected to be able to:

- Understand and freely comment on the basic concepts in the field of RF and DC electronics and the modern technology of electronic components and integrated circuits;
- Being familiar with the basic properties and features of modern baseband signals, modulations, coding and other advanced signal processing methods.
- To know the basic electronic elements (components), circuits and devices and their properties, actions, parameters and applications;
- To be able to solve and design simple electronic devices (RLC circuits, filters, amplifiers, generators, etc.) based on simple formulas and / or available free software
- Have an idea of the modern technology of integrated circuits and trends in computer, communication and measuring electronics.

Lectures plan

№	Topic:	Acad. hours
	Lectures	**30**
	Introductory part (elements, models, technology and measurement)	
I	1.1 RF electronics. The most important areas of applications of radio electronics today. 1.2 Physic bases of RF electronics. Basic processes, dimensions and physical models. 1.3 Materials in the RF electronics - dielectrics, metals, semiconductors. Thin layers. Metamaterials. Nanomaterials. 1.4 RF electronic elements and their source models (batteries, accumulators, current and voltage generators), resistors, capacitors, coils. Memristors. Active elements - diodes and transistors. Optoelectronic elements. High Frequency Elements. Sensors 1.5 Advanced Electronic Technologies. Plates. SMD technology. Integrated Circuits. VLSI electronic devices. Epitaxial technologies. Nanotechnologies and	**6**

	nanoelectronic elements. Spinronics 1.6 Basic electronic measuring instruments - ammeters, voltmeters, wattmeters, etc. Combined (multi-functional) devices. Oscilloscopes. Modern measuring systems – spectrum analyzers, circuit analyzers, signal analyzers.	
	I Part (signals, passive elements and circuits) - finishes with control work № 1	
II	2.1 Classification of signals. Simple-periodic signals. Presentation of the complex periodical signals through Fourier transforms. Resolved examples. Spectrum of signals and effective spectrum. Non-periodic signals and their representation through integral Fourier. Resolved examples. Random signals (noise). Baseband signals: analogue, discrete and digital. Main parameters. Examples. 2.2 Modulated signals. Need for modulated signals. Spectral representation of amplitude-, frequency- and phase-modulated analogue signals. Examples. Pulse-code modulation (PCM). Digital modulation (manipulation). Examples: bi-PSK, QPSK-modulation; GMSK modulation in GSM communications. Modulations with many carriers. The concept of orthogonal modulation - an example of a WiMAX and LTE network 2.3 Electronic circuits. Concept of electronic circuit analysis and basic analytical methods. Schematic simulator. Direct method with Kirchhoff's laws. Circular current method. Nodal Potential Method. Equivalent Theory Methods - the Thévenin's and Norton theorems. The principle of superposition. Complex and operational methods for analysis of ac-current circuits. Resolved examples. Analysis of circuits with non-linear elements. 2.4 Four-pole devices. Representation of the electric circuits as multipole devices. Primary four-pole parameters - matrix description. Secondary parameters. Relationship between the primary and secondary parameters. Type of connections for four-pole devices. Concept of high-frequency S-parameters of devices. CAD, CAM-oriented software simulators. 2.5 Passive RC, RL and RLC circuits. RC circuit. RC circuits in an established (harmonic) mode. RC circuits in a transient mode in under pulse signals. RC circuits like four-pole devices. Differentiating and integrating RC circuits. Examples. The RL chain as an analog of the RC-chain: examples. 2.6 The LC (resonant) circuits and resonators. Free and forced oscillations in the resonant circuits. Scheme, properties, resonance curves, and parameters of series and parallel resonant LC circuits. Definitions of quality (Q-) factor of the resonance circuits; loading the resonance LC circuits. Applications of resonant circuits. Concept for high-frequency resonators. Connected resonance circuits - analysis and specific features of the resonance curve. Transformers - transformation of current, voltage and impedances. 2.7 Electrical filters. Classification and examples. Characteristics and parameters of LC and RC filters. Low-frequency and high-frequency filters (LPF, HPF). Example of LPF and HPF analysis using aggregated g-parameters. Band-pass (BPF) and band-stop (BSF) filters. Quartz (acoustic) filters. Delay lines. Examples of high-frequency filters. 2.8 Circuits with distributed parameters. Characteristics of the wave process in a low-loss transmission line. Example of a classical two-wire line. Concept of running and standing wave - parameters. Influence of the load impedance; concept for matching. Two-wire line and coaxial cable applications. Concept for the waveguide. High-frequency microstrip line.	**12**
	Part II (Electronic devices and technology) - finishes with control work № 2	
III	3.1 Physical bases of the active electronic elements. Zone theory of dielectrics, metals and semiconductors. Doped semiconductors. Basic parameters describing semiconductors. Structure, characteristics and parameters of pn-junctions. Diode - features, equivalent circuit, action, circuit connections. Schottky diode. Other types of diodes as intended: rectifying, Zener, pin,	**12**

	tunneling, Gun, IMPATT, etc. LED's and photo diodes. Solar cells. 3.2 Bipolar transistors (BJT) - action, connection schemes, modes of operation. Field transistors (FET) - action, connection schemes, modes of operation. Modern high frequency transistors - HBT, p-HEMT, nanotransistors, spin-transistors. 3.3 Basic analogue electronic devices: classification by purpose and basic properties: amplifiers, oscillators, synthesizers, impulse devices, modulators, demodulators, detectors, mixers, multipliers, etc. Basic parameters and applications. 3.4 Example - block diagram of GSM mobile terminal and base station - basic modules, purpose and main features. Energy balance – link budget. An example of system analysis. Antenna concept. Wireless communications. 3.5 Introduction to digital electronics. Binary numbers. Basic logical devices. Basic logic operations. Digital devices and systems. ADC, DAC. Digital Signal Processing (DSP). 3.6 Fast response of modern electronic devices - physical fundamentals. Examples: Computer hardware - basic elements and purpose. High-speed microprocessors. Moor's law and physical limitations to the technology. Advanced solutions for fast memory. Future of electronics.	

Bibliography

[1] P. Dankov, Lectures of Basic Electronics, on-line available: http://phys.uni-sofia.bg/~dankov

[2] Curtis A. Meyer, "Basic Electronics – An Introduction to Electronics for Science Students", Carnegie Mellon University, 2007 (pdf files)

[3] Tony R. Kuphaldt, "Lessons in Electric Circuits" (PDF-files), on-line available: http://www.ibiblio.org/obp

Author: / /

(Assoc. Prof. Plamen Dankov)