Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Applied Electronics and Information Engineering**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Masters
1.6 Programme of studies	Medical Electronics and Informatics

2. Date despre disciplină

2.1 Course name (ro) (en)				Prelucrarea informaţiei în interfeţe creier–maşină Information processing in brain machine interfaces			
2.2 Course Lecturer				Prof. Dr. Georgeta Mihaela NEAGU			
2.3 Instructor for practical activities				Prof. Dr. Georgeta Mihaela NEAGU			
2.4 Year of studies	2	2.5 Semester	I	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type		DA	2.9 Course code	UPB.04.M3.O.02-17		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	3	Out of which: 3.2 course	2.00	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42.00	Out of which: 3.5 course	28	3.6 seminary/laboratory	14

Distribution of time:	hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.	54
Tutoring	0
Examinations	4
Other activities (if any):	0

3.7 Total hours of individual study	58.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	
4.2 Results of learning	Acquire the knowledge specific to the following courses: mathematics, algorithms, object oriented programming, digital signal processing, estimation and decision, programming (Matlab), medical electronics, medical instrumentation, advanced signal processing methods

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	The lectures will be presented using the video projector.
5.2 Seminary/ Laboratory/Project	The lab will be run using the video projector and the computers having Matlab installed on. The labs are mandatory, as stipulated by the „Regulamentul studiilor universitare de licenţă” (Romanian version only) and „Regulamentul privind activitatea profesională a studenţilor” (Romanian version only).

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

The course provides the advanced knowledge regarding the coding, transmission, processing and storing of the neural information and offers the knowledge to use them to develop brain-machine interfaces, especially to support the intelligent prosthesis and brain-computer interfaces. After passing the course the students have the ability to address any problem regarding the neural information processing/propagation and the implementation of the brain-machine interface.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	Demonstrate the ability to operate with basics of fundamental sciences, engineering and medical sciences, general and specialized knowledge, to solve problems specific to the neural information propagation and processing within the brain-machine interfaces. Have the ability to develop the HW/SW for brain-machine equipment used in medical diagnose, therapy, rehabilitation and intelligent prostheses. Develop, implement, monitor and support the medical devices, equipment and technical systems that include BMIs. Provide technical support and specialized assistance for/within the organizations concerning the regulations, monitoring, use and control of the medical equipment and systems based on BMI. Coordinate and implement (research) projects for BMI based medical equipment/technologies. Apply IT solution specific for BMI based medical applications: data mining, advanced biosignal and medical image processing/analysis, medical data protection. Coherently and correctly argue and analyze the basic knowledge, based on the key concepts of the course and using the specific methodology. Communicate, verbally and in written, in Romanian, using the vocabulary specific to the course domain. Communicate, verbally and in written, in a foreign language (English), using the vocabulary specific to the course domain.

Transversal (General) Competences	Identify the lifelong learning needs and efficiently use the information sources and the communication and aided professional development resources (Internet, specialized SW, online courses, etc), both in Romanian and in a foreign language (English). Address and responsibly tack tasks in multidisciplinary teams, assuming different positions/attributions. Work within teams and efficiently communicate with the colleagues to solve problems of a medium complexity. Critical and independent evaluation: the students have the scientific ability to look for the necessary information and to present valuable conclusions/solutions. The ability to analyze and synthesize: the students have the ability to present efficiently the acquired knowledge, applying the systematization. Respect the academic ethics: proper citation. Apply emotional intelligence principles to emotionally and socially solve some situations regarding the real life/academic/professional tasks, showing self control and objectivity when deciding and under stress.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* **List** the most important information regarding the domain development. **Define**s domain specific concepts. **Descr**ibes/classify domain specific concepts/processes/phenomena/structures. **Reveals** domain specific consequences and relations.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* **Select** and group relevant information. **Apply** logically argued the domain specific principles. **Efficiently** work within teams. **Generate** scientific documents. **Experimentally** verify the identified solutions. **Solve** practical applications. **Correctly** identify the causal relations. **Anali**se and compare available domain solutions. **Identif**y solutions and propose solving plans/projects. **Formul**ate conclusions regarding the realized experiments. **Give** arguments when identifying solving solutions/steps.

Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* **Select** and analyze the appropriate literature. **Respect** the academic ethics, correctly citing the used literature. **Are open** to learn new concepts. **Collaborate** with the colleagues and the academic staff during the teaching activities. **Show** autonomy when organizing some applications, learning activities or when solving specific problems **Show social** responsibility by getting involved in the academic social life. **Promo**te and contribute to the domain, offering new solutions, to improve the quality of the social life. **Realistically** identify the contribution of the engineering domain to the social and economic life by offering reliable and sustainable solutions. **Apply** professional ethics/deontology when evaluating the technological impact of the domain specific proposed solutions, considering the environmental impact. **Analyze** and take business opportunities specific to the domain. **Demonstrate** management skills in real life situations (time administration, conflict elimination).

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

The teaching will include both knowledge presentation and interactive discussions, considering the learning preferences of the students and their learning needs; the direct and indirect exploration will be considered (experiments, demonstrations, modelling), and also active learning will be involved (exercises, problems solving, practical activities).
Power point presentations and specialized videos will be considered. Each course will summarize the information from the previous lectures, stressing especially the knowledge from the last course.
The lectures will contain images, plot and diagrams that facilitate information acquiring.
The course provides knowledge and practical activities that support students development by establishing optimal communication and collaboration steps and by discovery.
The active information listening and assertive communication skills will be considered, and the feedback will be implemented to include the needs of the students.
Team working activities will be also implemented.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Introduction: current points of interest, neural prosthetics and neural interfaces	2
2	Cerebral cortex (structure, layers, cells, intra/extra cellular recordings, connectivity, cerebral functional areas, neuro-motor system)	4
3	Monitoring the cerebral activity (recording methods, signals, sensors, neuronal decoding)	2
4	Statistical analysis applied in the analysis of the cerebral activity	2
5	Adaptive filtering and the adaptive recognition of the forms	2
6	ECoG paradigms in brain-machine interfaces	4
7	EEG paradigms in brain-machine interfaces	5
8	MRI/fMRI paradigms in brain-machine interfaces	5
9	Intelligent prosthesis	2
	Total:	28

Bibliography:

1. Neagu Georgeta-Mihaela, Prelucrarea informaţiei în interfeţe creier–maşină, Note de curs si prezentari Power Point, disponibile în Moodle.
2. Ungureanu Georgeta Mihaela (2013): Analiza şi prelucrarea semnalelor: aplicaţii în ingineria biomedicală (Digital Signal Processing and Analysis: biomedical engineering applications), MATRIX ROM, ISBN 978-973-755-946-3 (253 pages) (recognized by CNCSIS).
3. G. M. Ungureanu, Prelucrarea digitală a semnalelor, MATRIX ROM, 2008.
4. G. Buzsaki, Rhythms of the brain, Oxford University Press, 2006. https://neurophysics.ucsd.edu/courses/physics_171/Buzsaki%20G.%20Rhythms%20of%20the%20brain.pdf
5. Analysis and Classification of EEG Signals for Brain–Computer Interfaces, Szczepan Paszkiel, DOI https://doi.org/10.1007/978-3-030-30581-9, PublisherSpringer Cham, eBook Packages Intelligent Technologies and Robotics, Intelligent Technologies and Robotics (R0), Copyright InformationSpringer Nature Switzerland AG 2020
6. EEG-Based Brain-Computer Interface: Cognitive Analysis and Control Applications (2019). Dipali Bansal, Rashima Mahajan, Academic Press, DOI https://doi.org/10.1016/C2017-0-01267-3
7. H. C. Tuckwell, Stochastic Processes in the Neurosciences, Society for Industrial and Applied Mathematics, Philadelphia, 1989.
8. C. Koch, I. Segev, Methods in Neuronal Modeling – From Synapses to Networks, MIT Press, 1988.
9. Berlin BCI Competitions, https://www.bbci.de/competition/
10. 2020 International BCI Competition, https://osf.io/pq7vb/
11. EEGLAB, https://eeglab.org/
12. https://archive.physionet.org/physiobank/database/
13. http://bnci-horizon-2020.eu/database/data-sets

PROJECT		
Crt. no.	**Content**	**No. hours**
1	Implementation of a BMI application (Brain Machine Interface) in teams of 2 students	14
	Total:	14

Bibliography:

1. Neagu Georgeta-Mihaela, Prelucrarea informaţiei în interfeţe creier–maşină, Note de curs si prezentari Power Point, disponibile în Moodle.
2. Ungureanu Georgeta Mihaela (2013): Analiza şi prelucrarea semnalelor: aplicaţii în ingineria biomedicală (Digital Signal Processing and Analysis: biomedical engineering applications), MATRIX ROM, ISBN 978-973-755-946-3 (253 pages) (recognized by CNCSIS).
3. G. M. Ungureanu, Prelucrarea digitală a semnalelor, MATRIX ROM, 2008.
4. G. Buzsaki, Rhythms of the brain, Oxford University Press, 2006. https://neurophysics.ucsd.edu/courses/physics_171/Buzsaki%20G.%20Rhythms%20of%20the%20brain.pdf
5. Analysis and Classification of EEG Signals for Brain–Computer Interfaces, Szczepan Paszkiel, DOI https://doi.org/10.1007/978-3-030-30581-9, PublisherSpringer Cham, eBook Packages Intelligent Technologies and Robotics, Intelligent Technologies and Robotics (R0), Copyright InformationSpringer Nature Switzerland AG 2020
6. EEG-Based Brain-Computer Interface: Cognitive Analysis and Control Applications (2019). Dipali Bansal, Rashima Mahajan, Academic Press, DOI https://doi.org/10.1016/C2017-0-01267-3
7. H. C. Tuckwell, Stochastic Processes in the Neurosciences, Society for Industrial and Applied Mathematics, Philadelphia, 1989.
8. C. Koch, I. Segev, Methods in Neuronal Modeling – From Synapses to Networks, MIT Press, 1988.
9. Berlin BCI Competitions, https://www.bbci.de/competition/
10. 2020 International BCI Competition, https://osf.io/pq7vb/
11. EEGLAB, https://eeglab.org/
12. https://archive.physionet.org/physiobank/database/
13. http://bnci-horizon-2020.eu/database/data-sets

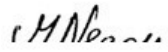
11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	Proving the ability to understand/apply the fundamental knowledge. Differential analysis of the theoretical methods/techniques.	written	50%
11.5 Seminary/laboratory/project	Showing the ability to address a BMI problem and having the ability to evaluate the results	written/project	50%
11.6 Passing conditions			

- Graduation rules valid for the students enrolled at ETTI/UPB.
- Obtaining 50% of the evaluation mark.
- The final grade is allocated only when the student attends the final exam, otherwise the student being declared Absent for the final with no final grade declared.

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

The involved activities will allow the students to gain skills in solving problems and improving the available solutions in the BMI domain.
The course considers the current knowledge/ aspects/ phenomena addressed by the domain literature and personal research/presentations.
The proposed activities that covers the neural transmission and processing in BMIs impact the students skills to deal with every day situations, improving the socioeconomic environment.

Date	Course lecturer	Instructor(s) for practical activities
	Prof. Dr. Georgeta Mihaela NEAGU	Prof. Dr. Georgeta Mihaela NEAGU
		

Date of department approval	Head of department
	Prof. Dr. Ing. Bogdan-Cristian FLOREA

Date of approval in the Faculty Council	Dean
	Prof. Dr. Ing. Mihnea UDREA, Abil.