Course unit English denomination	**Dealing with cognitive neuroscience data with R: an introduction (Macro Topic 1: Statistics)**
SS	**PSIC-01/A**
Teacher in charge (if defined)	Andrea Zangrossi
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The course aims to provide an introduction to the R software (with practical coding sessions) focusing on the following points: • Introduction to the R environment; • Reading and importing data; • Working with data of different types; • Automating repetitive processes; • Creating functions; • Visualizing data; • Exporting data from R to other software.
Learning goals	Learn how to flexibly deal with different types of data and automatize data processing.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No

	The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Practical coding session
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Statistics for neuroscience – Level A (Macro Topic 1: Statistics)**
SS	**STAT-01/A**
Teacher in charge (if defined)	Giovanni Saraceno
Teaching Hours	15
Number of ECTS credits allocated	3
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	Introduction to R. Multiple Linear models (i.e. t-test, Anova and Ancova)
Learning goals	Basics of R programming. Fitting, interpreting and evaluating multiple linear models.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods	Brief homework assigned after each class

(if applicable)	
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Statistic for neuroscience – Level B (Macro Topic 1: Statistics)**
SS	**STAT-01/A**
Teacher in charge (if defined)	Livio Finos
Teaching Hours	15
Number of ECTS credits allocated	3
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	Mixed models and selective inference
Learning goals	Defining and fitting generalized linear models with fixed and random coefficients. Understanding and performing post hoc corrections and multiple testing
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	

Examination methods (if applicable)	Final test
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Graph theory and null models: theory and applications for the study of the brain networks** **(Macro Topic 1: Statistics)**
SS	**PHYS-04/A, PSIC-01/B**
Teacher in charge (if defined)	Samir Simon Suweis (Module 1), Arianna Menardi (Module 2)
Teaching Hours	15
Number of ECTS credits allocated	3
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	This course will be divided into two modules. In the first module (4 hours, Prof. Suweis), we will cover some basic concepts of graph theory including connectivity, centralities, assortativity and clustering. Applications on some real networks are also shown. The second part of the first module introduces some more advanced topics, such as the use of random graphs (Erdos-Reny, Small-World and Barabasi) as null models, to actually infer biological information from data on brain networks. In the second module (11 hours, Dr. Menardi), we will apply the use of graph theory analysis on real neuroimaging data. Practical hands-on sessions will be carried out to familiarize with the data, the extrapolation of measures, as well as getting acquainted with several different tools to plot and visually represent brain graphs. In particular, we will make use of a start-to-finish analysis pipeline, from the raw functional magnetic resonance imaging data to the building of the brain graph.
Learning goals	Upon completion of the course, students will be able to: (1) Calculate the main structural properties of graphs; (2) understand the fundamental properties of some families of random graphs; (3) Use random graphs as null models to test different properties of real networks; (4) gain understanding on the strengths and limitations of this technique applied to neuroimaging data.

Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Wooclap quiz and small data analysis project
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Basic Course on Programming in Python (Macro Topic 2: Neuroimaging techniques)**
SS	**IINF-05/A**
Teacher in charge (if defined)	Emanuele Di Buccio
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	• What is Python? • Python Basics • Functions • Control statements and loops • Lists, Tuples, Sets, and Dictionaries • Python Libraries (for data science and data visualization)
Learning goals	• Learn Python data types and data structures. • Write a Python program able to read data from a file, process the data through a function or a set of functions, and write the result in a file. • Create (data) visualizations in Python
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No

	The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Homework and final programming assignment
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Analysis of EEG signal (theory and hands-on) (Macro Topic 2: Neuroimaging techniques)**
SS	**IBIO-01/A**
Teacher in charge (if defined)	Camillo Porcaro
Teaching Hours	15
Number of ECTS credits allocated	3
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The course will provide the basic skills to collect and analyze electroencephalographic (EEG) signals. Practical sessions will allow students to gain experience with EEG recording. If access to the laboratory is limited, the EEG recording will be addressed by showing ad hoc video tutorials. The course will also underline step-by-step EEG pre-processing for data at rest and during event-related potential (ERP) analysis. The analysis will be conducted using EEGLAB software or other open-access software based on the student's specific needs. All lessons will include theoretical and practical sessions to allow the students to familiarize themselves with the software. Direct interactions will be encouraged during the lessons.
Learning goals	The skills acquired in the course will allow the students to critically choose the most appropriate way to analyse EEG data with basic and advanced methods such as Independent Component Analysis.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD	☒ Yes

students from other courses	☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Use the Toolbox EEGLAB on real data of the topics covered.
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Analysis of fMRI and PET signals (theory and hands-on) (Macro Topic 2: Neuroimaging techniques)**
SS	**IBIO-01/A, PSIC-01/B**
Teacher in charge (if defined)	Alessandra Bertoldo, Lorenzo Pini
Teaching Hours	15
Number of ECTS credits allocated	3
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	• Introduction (structural/functional sequences) • Atlases • Pre-processing of resting state fMRI data: coregistration, segmentation, regression, filtering • Despiking and censoring • Functional connectivity (FC) • Graph measures (principals) • Dynamic FC: sliding windows, coactivation patterns • Introduction to effective connectivity • Static PET: PET tracer, partial volume, reference region, early phase, late phase • Dynamic PET: experimental setup • Multimodal integration: PET versus resting state fMRI
Learning goals	During the course, students will acquire fundamental skills in analyzing imaging signals derived from fMRI and PET techniques. Furthermore, the course aims to provide an overview of the critical steps in data preprocessing, including: slice timing, distortion and motion correction, non-neural signal regression, filtering, co-registration, and normalization to a standard template.
Teaching methods	
Course on transversal, interdisciplinary,	☐ Yes ☒ No

transdisciplinary skills	
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	TBD
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Neuroanatomy** **(Macro Topic 3: Neuroanatomy, neurophysiology & neuropsychology)**
SS	**MEDS-22/B**
Teacher in charge (if defined)	Renzo Manara
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	Brain anatomy as investigated by MRI and CT Fissures, scissures and primary sulci, main giri of the frontal, parietal, insular, temporal and occipital lobes, basal ganglia, brainstem and cerebellum.
Learning goals	Recognition of above mentioned anatomical structure on MRI and CT
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	

Examination methods (if applicable)	Practical exam
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Neurophysiology (theory and laboratory)** **(Macro Topic 3: Neuroanatomy, neurophysiology & neuropsychology)**
SS	**BIOS-06/A**
Teacher in charge (if defined)	Aram Megighian
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	Movement and its central control: Visuomotor responses; Locomotion or navigation in the local environment; Motor Control
Learning goals	1. Behaviour is the internally coordinated responses (actions or inactions) of whole living organisms (individuals or groups) to internal and/or external stimuli. 2. Motor responses are produced by spatial and temporal patterns of muscular contractions orchestrated by neural circuits in the brain and spinal cord. 3. Circuits in the forebrain and cerebellum that organize the intricate patterns of neural activity responsible for more complex motor acts.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students

	enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Homework and interactive assessment during the course
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Psychophysiology** **(Macro Topic 3: Neuroanatomy, neurophysiology & neuropsychology)**
SS	**PSIC-01/B, PSIC-04/B**
Teacher in charge (if defined)	Chiara Spironelli (Module 1), Elisabetta Patron (Module 2)
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The Psychophysiology course provides a brief review of the main psychophysiological models along with the basic techniques and methods used in this field during a psychophysiological assessment. The association between body and mind is scientifically analyzed not only by introducing the characteristics of every approach, but also with a practical/supervised training session. 1. First module (5 hours) – Prof. Spironelli: (1) The key concepts of the psychophysiological approach; dependent and independent variables. (2) Electroencephalography (EEG), electromyography (EMG) and eye movement/blinks: basic information and practical/supervised training on EEG; (3) functional Transcranial Doppler sonography (fTCD): basic information and practical/supervised training on fTCD. 2. Second module (5 hours) – Prof. Elisabetta Patron: (1) The key concepts of psychophysiology of emotion and its clinical applications; (2) Emotion, attention and the startle reflex; (3) Autonomic psychophysiology: models and basic techniques, including examples of clinical applications and practical activities.
Learning goals	• Comprehension of the subjects covered, and acquisition of the methods and topics discussed throughout the course. • Gaining knowledge of the main models and methods in clinical

	psychophysiology.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Active participation to the classroom exercises will be considered to pass.
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Cognitive Science and Neuropsychology (Macro Topic 3: Neuroanatomy, neurophysiology & neuropsychology)**
SS	**PSIC-01/A**
Teacher in charge (if defined)	Andrea Zangrossi
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The Cognitive Science and Neuropsychology course will give a theoretical and practical introduction to the study of the brain-behavior link. The course will focus on a set of cognitive functions (e.g., memory, attention and visuospatial functions, executive functions) to discuss their cognitive models, related deficits, quantitative assessment (i.e., tests) and neural correlates.
Learning goals	During this course the students will learn to: 1. use cognitive models to study behavior; 2. relate cognitive and brain models of a cognitive function; 3. identify cognitive deficits in clinical populations; 4. assess cognitive functions by means of tests.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students

	enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	NA
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Soft Skills**
SS	**PSIC-01/B, PSIC-02/A, PSIC-01/B**
Teacher in charge (if defined)	Giorgia Cona (Module 1), Judit Gervain (Module 2), Antonino Vallesi (Module 3)
Teaching Hours	15 Module 1 – Presentation skills and public outreach (Giorgia Cona): 4 hours Module 2 – Academic writing: How to write a scientific paper (Judit Gervain): 5 hours Module 3 – Grantsmanship: The art of securing funding for research (Antonino Vallesi): 6 hours
Number of ECTS credits allocated	3
Course period	1st semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	Module 1 – Presentation skills and public outreach (4 hours, 1st year) This course illustrates the basic guidelines to make an effective talk and includes practical exercises. In the first part of the course, theoretical lessons will deal with: (a) how to prepare slides; (b) communicative aspects; (c) emotional aspects; (d) content of the talk. In the second part of the course PhD students will be challenged with theatrical and public speaking exercises. Module 2 – Academic writing: How to write a scientific paper (5 hours, 2nd year) This course is a hands-on, practical course introducing students to the basic principles of writing academic texts in English. Students will be familiarized with basic guidelines and best practices, will carry out exercises and small assignments and will then be working on an individual writing project for which they will get personalized feedback.

	• 1h: How to write an efficient sentence • 1h: How to write an efficient paragraph • 2h: How to write an efficient text • 1h: Project discussion and individual feedback <u>Module 3 – Grantsmanship: The art of securing funding for research (6 hours, 2nd and 3rd year)</u> Writing a successful grant application is an ability that needs being trained to fully flourish. While the primary focus of the evaluation process is on the scientific content, feasibility, impact and methodological soundness, the way you present your proposal and your adherence to the specific requirements of the funding agency are also critical factors that can help determining the fate of your application. In this 6-hour interactive course, I will provide some guidelines and practical examples on how to manage grant applications from the generation of the idea to the submission of the final proposal and even further.
Learning goals	<u>Module 1 – Presentation skills and public outreach</u> • Presentation skills and public outreach • Understanding what are the key points for a good presentation • Learning how to deal with a successful presentation <u>Module 2 – Academic writing: How to write a scientific paper</u> • Writing an efficient sentence • Writing an efficient paragraph • Writing an efficient scientific/argumentative text <u>Module 3 – Grantsmanship: The art of securing funding for research</u> • Distinguishing the different grant types and their purposes • Aligning a grant proposal with the requirements and goals of your selected funding agency • Enhancing a grant proposal to be more informative, convincing, and captivating
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.

Prerequisites (not mandatory)	
Examination methods (if applicable)	Module 1 – Presentation skills and public outreach Individual performance on the assigned work will be considered as criterium to pass the course. Module 2 – Academic writing: How to write a scientific paper Written assignment Module 3 – Grantsmanship: The art of securing funding for research Active participation to the classroom exercises (e.g., presentations, group work, flipped classroom) and individual performance on the assigned work will be considered as criteria to pass the course.
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Basic introduction to Bayesian reasoning (Area 1: Programming and Computational Neuroscience)**
SS	**MATH-04/A**
Teacher in charge (if defined)	Giovanni Zanzotto
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The probability that a woman of age 40-60 has breast cancer is about 1%. If she has breast cancer, the probability that she tests positive on a screening mammogram is 90%. If she does not have breast cancer, the probability that she nevertheless tests positive is 9%. What are the chances that a woman who tests positive actually has breast cancer? This class briefly presents some basic notions of Bayesian probability to help in the analysis of uncertainty inherent in statistical information. Techniques based on the use of natural-frequency trees will be emphasized, which give an intuitive and direct insight into risk estimation, providing tools for a more transparent risk representation and a reduction of misleading risk information. Real-world examples will be considered throughout, connected for instance with the medical, psychological, and legal practice. One focus will be the correct judgment of the predictive value of medical diagnostic tests, also in relation to the recent COVID-19 public-health emergency.
Learning goals	Formal and intuitive understanding of Bayes' Theorem, and its use in real world scenarios. Use of Natural-frequency Trees to develop the intuition, and facilitate the handling, of probabilistic information when a Bayesian approach is helpful
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.

Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Brief homework assigned during or after each class.
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Dimensionality reduction and controllability of neural systems (Area 1: Programming and Computational Neuroscience)**
SS	**PHYS-06/A, PHYS-04/A**
Teacher in charge (if defined)	Michele Allegra, Samir Simon Suweis
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	An outstanding problem in contemporary neuroscience is understanding how to intervene on the brain to control its global activity – chiefly, with the aim of restoring a normal activity balance in subject affected by brain pathologies. From the microscopic scale of a few neurons to the macroscopic one of large brain areas, control requires understanding how to collectively modulate the behavior of several neural units at the same time. As these units are not independent, it is convenient to apply suitable dimensionality reduction schemes to achieve a low-dimensional representation of the system in terms of a few collective variables effectively controlling the global behavior of the system. In this course, we shall introduce the traditional paradigm for “brain controllability”, highlighting its limitations when many units are simultaneously considered. We will then provide a few dimensionality reduction techniques that can be applied to achieve a ‘collective’ view of neural activity ad different scales. Contents: • The Kalman approach to dynamical controllability • Kalman control for brain activity and its limitations • Dimensionality reduction: linear approaches (PCA, ICA) • Dimensionality reduction: non-linear approaches (Isomap, Autoencoders)

Learning goals	The students will learn how to perform a dimensionality reduction starting from high-dimensional neural data, and to perform a linear controllability analysis of a (linear) model of brain dynamics
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Data analysis exercise
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Deep Learning for Biomedical Images** **(Area 1: Programming and Computational Neuroscience)** **[Course unit taken from the Department of Information Engineering]**
SS	**IBIO-01/A**
Teacher in charge (if defined)	Marco Castellaro
Teaching Hours	18
Number of ECTS credits allocated	4
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The rapid evolution of deep learning in the field of computer vision provided state-of-the-art solutions for classical tasks such as object detection, classification, segmentation, and activity recognition. Besides, medical imaging is the ideal candidate model for the application of complex deep neural network (DNN) or Convolutional neural network (CNN) and more recent introduced Transformers architectures. In this course the teacher will provide students the knowledge and the practical skills to understand the most recent networks and to use them in the field of biomedical imaging. Topics: • Introduction to biomedical images (DICOM/Nifti standards) • Introduction to Pytorch and Monai (Medical Open Network for Artificial Intelligence) • Pre-processing, transform and data augmentation • Case studies: DNN and CNN architectures for image classification, segmentation, and image reconstruction • Training procedures, algorithms, and strategies • Transfer learning and fine tuning • Transformers, attention principle and its application to biomedical images analysis tasks
Learning goals	The learning goal of the deep learning for biomedical images course is to

	equip students with the knowledge and practical skills necessary to comprehend and utilize the latest deep neural network. Through topics such as data pre-processing, deep neural network and convolutional neural networks architectures, training, transfer learning and fine-tuning procedures, the course aims to empower students to address complex challenges in medical image analysis using cutting-edge deep learning methodologies.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☒ Yes ☐ No
Available for PhD students from other courses	☒ Yes ☐ No
Prerequisites (not mandatory)	Python programming and basic machine learning theoretical background.
Examination methods (if applicable)	The examination will be based on a team-work to implement a deep learning based task to be applied to a real dataset of biomedical images.
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**A primer on machine and deep learning (Area 1: Programming and Computational Neuroscience)**
SS	**PSIC-01/A**
Teacher in charge (if defined)	Marco Zorzi
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The course will provide a non-technical overview of machine learning and deep learning, with a focus on conceptual understanding of the main methods, their pros and cons, and the methodological issues for their application to neuroscience data analysis.
Learning goals	The students will learn basic conceptual and methodological knowledge of machine and deep learning, as well as the ability to evaluate its applicability to neuroscientific data.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.

Prerequisites (not mandatory)	
Examination methods (if applicable)	Discussion of possible use cases in the student's own research work
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Theoretical models of classification learning in neural systems and of the primary visual cortex (Area 1: Programming and Computational Neuroscience)**
SS	**PHYS-06/A**
Teacher in charge (if defined)	Davide Bernardi
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	This class aims to offer an intuitive understanding of two fundamental topics in Computational Neuroscience. The first part focuses on a core computational task faced by living systems: learning categories and associations. We will show how idealized models of neurons and synaptic plasticity can create and store associations. Notably, this kind of task is one that artificial intelligence algorithms inspired by biological networks excel at. In the second part, we will explore the primary visual system, illustrating how phenomenological models can effectively describe and predict neuronal responses to stimuli. The course includes a hands-on component in which simple tasks related to the course topics will be solved using basic analytical calculations and computer programming in Python.
Learning goals	• Developing an understanding of how computational models can interpret and mimic functions in biological systems. • Learning the application of analytical and programming skills to model and analyze neurobiological systems.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary,	☐ Yes ☒ No

transdisciplinary skills	
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	Only a basic math and programming knowledge is assumed as a prerequisite.
Examination methods (if applicable)	Two brief assignments discussed in class
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Analysis of EEG signal (theory and hands-on) – Advanced (Area 2: Cognitive and Behavioral Neuroscience and Psychophysiology)**
SS	**IBIO-01/A**
Teacher in charge (if defined)	Camillo Porcaro
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The course will provide advanced skills to analyze electroencephalographic (EEG) signals. Practical sessions will allow the students to gain experience with EEG recording. If access to the laboratory is limited, the EEG recording will be addressed by showing ad hoc video tutorials. The course will also underline step-by-step advance EEG data analysis such as: • Independent Components (ICs) dimensionality reduction through Principal Component Analysis (PCA) in the high-density EEG (hdEEG); • Application of methods of automatic identification of artifacts and management of the effects of down-cleaning and over-cleaning of the data; • EEGLAB Study Design implementation, pre-calculation and statistics; • TMS-EEG by TESA.
Learning goals	The skills acquired in the course will allow the students to critically choose the most appropriate way to analyse EEG data and TMS-EEG data.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal,	☐ Yes

interdisciplinary, transdisciplinary skills	☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	The use of the EEGLAB Toolbox on real data of the topics covered.
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Practical course for noninvasive brain stimulation (Area 2: Cognitive and Behavioral Neuroscience and Psychophysiology)**
SS	**PSIC-01/B**
Teacher in charge (if defined)	Giorgia Cona
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The course will address theoretical, methodological and practical issues of transcranial magnetic (TMS) and electric stimulation (TES) including: 1) Basic TMS and TES principles; 2) TMS/TES parameters; 3) safety issues; 4) possible applications. The course includes also a practical part in which students will familiarize with TMS procedure: coil position, selection of motor threshold, change of frequency and paradigm (single-pulse vs. repetitive TMS).
Learning goals	• Learning how to design a TMS and TES experiment • Learning how to administer the TMS stimulation
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the

	Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Active participation of the working-class exercises will be used as a criterium to pass the course
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Systematic review meta-analysis and study quality in neuroimaging (Area 2: Cognitive and Behavioral Neuroscience and Psychophysiology)**
SS	**PSIC-04/B**
Teacher in charge (if defined)	Claudio Gentili
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	Knowledge to be acquired: • how to perform a systematic search • how to write a systematic review • how to assess quality of a neuroimaging paper • how to perform a basic ALE meta-analysis. Possibly the students will be guided toward the different steps of systematic review and meta-analysis in order to perform their own meta-analysis.
Learning goals	Understand the differences among narrative review, systematic review, meta-analysis, coordinate based meta-analysis. Understand which information are relevant for each of the above (narrative narrative review, systematic review, meta-analysis, coordinate based meta-analysis) and where to find them.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No

Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	Basic knowledge for the course: • Principles of neuroimaging techniques (principal techniques, main differences among techniques) • Basic knowledge in literature search • Basic knowledge in neuroanatomy
Examination methods (if applicable)	Design a coordinate based meta-analysis and perform a systematic research
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Practical course for Functional Near-Infrared Spectroscopy (fNIRS) and infant brain imaging (Area 2: Cognitive and Behavioral Neuroscience and Psychophysiology)**
SS	**PSIC-02/A**
Teacher in charge (if defined)	Judit Gervain
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	NIRS is an increasingly popular brain-imaging technique, which, apart from its classical use in developmental cognitive neuroscience, has wide range of applications in freely behaving participants and in situations where MRI/EEG are not applicable, such as real-time brain-computer interfaces, cochlear implant users, pilots flying planes or athletes performing physical activities. The course overviews the basic principles, different uses and analysis methods of this technique, with hands-on applications. The course has two parts. Part 1 provides a theoretical overview of the basic physical (optical) and physiological principles behind NIRS. Part 2 is a hands-on, lab-based demo where students are invited to test the technique themselves and familiarize themselves with analysis methods.
Learning goals	• Understanding the physiological and physical principles underlying NIRS • Developing basic practical skills for designing and conducting NIRS studies • Developing basic skills to analyze NIRS data
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.

Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Practical/Written assignment (e.g. designing a NIRS experiment)
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Light-based methods for reconstructing brain activity at cellular resolution** **(Area 3: Cellular and Molecular Neuroscience)**
SS	**PHYS-06/A, BIOS-06/A**
Teacher in charge (if defined)	Mario Bortolozzi (Parts 1-5: 5 hours), Marco Dal Maschio (Parts 6-8: 5 hours)
Teaching Hours	10
Number of ECTS credits allocated	2
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No

Course unit contents	Workload: about 10 h in classes and 5 h for the exam preparation (group activity with teachers and tutors)
	
	The course combines a set of lessons on basic concepts of light microscopy and fluorescence imaging with practical sessions dealing with optics and microscopy along with the acquisition and the analysis of a functional dataset from a living model organism.
	
	• Part 1 (Mario Bortolozzi)
	  ◦ Lesson on optics theory: light propagation, reflection, refraction, lenses, image formation, transverse and longitudinal magnification, magnifier, angular magnification.
	  ◦ Hands-on session: playing with a lens.
	• Part 2 (Mario Bortolozzi)
	  ◦ Lesson on fluorescence: irradiance, absorption and transmission, fluorescence emission, Jablonsky diagram, saturation irradiance, quenching, bleaching, fluorescence spectra.
	• Part 3 (Mario Bortolozzi)
	  ◦ Lesson on microscopy: upright and inverted microscopes, filters and beam splitters, point spread function, diffraction limit, numerical aperture.
	  ◦ Hands-on session: working with a microscope.

	• Part 4 (Mario Bortolozzi)
	  ◦ Lesson on Multiphoton microscopy: the basic principles, pulsed lasers, 2P-microscope configuration, 2P resolution, typical 2P dye spectra, examples of typical experiments.
	• Part 5 (Mario Bortolozzi)
	  ◦ Lesson on Calcium Imaging: fluorescent dyes, deriving Ca2+ concentration from fluorescence, practical limitations and formula, examples, ratiometric dyes, non-equilibrium conditions, genetically encoded fluorescent activity reporters.
	• Part 6 (Marco Dal Maschio)
	  ◦ Lesson on light-based methods to modulate circuit activity.
	• Part 7 (2h) (Marco Dal Maschio)
	  ◦ Hands-on session on the acquisition of a functionally activity dataset using a multiphoton microscope: sample preparation, visual stimulus presentation, multiphoton microscope configuration and acquisition of the dataset.
	• Part 8 (2h) (Marco Dal Maschio)
	  ◦ Hands-on session on the data analysis using Suite2P and Python: segmenting the dataset and retrieving the neuronal time series, plotting of the time series, regression analysis to highlight visual stimulus tuning.

Learning goals	Acquiring (i) theoretical knowledge about optics and microscopy observation of biological samples; (ii) practical experience in the use a multiphoton microscope and data analysis of neuronal activity.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	30 minutes, preparation of short report on the activity (max 3 pages)
Suggested readings	Learning material will be made available during the course

Additional information

Course unit English denomination	**Visuomotor responses in a simple nervous system: the invertebrate nervous system (*Drosophila melanogaster*)** **(Area 3: Cellular and Molecular Neuroscience)**
SS	**BIOS-06/A**
Teacher in charge (if defined)	Aram Megighian
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No

Course unit contents	• Visuomotor mechanisms in invertebrates and vertebrates
	  ◦ Optic flow and optomotor responses
	  ◦ Selective visual responses
	  ◦ Pursuit?
	• Navigation in invertebrates and vertebrates
	  ◦ Navigation as a goal directed response
	  ◦ Internal and external sensory information
	  ◦ Cognitive maps in navigation

Learning goals	1. Navigation is a behavioral response involving the integration of multiple sensory information together with previous memories and individual decision-making processes. 2. Visuomotor responses permit to analyse the neurobiological processes orchestrating navigation.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No

Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Homework and interactive assessment during the course
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Electrophysiological recordings in animals (Area 3: Cellular and Molecular Neuroscience)**
SS	**BIOS-06/A**
Teacher in charge (if defined)	Stefano Vassanelli
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	Methods to measure and characterize brain activity based on electrophysiological tools, both 'in vitro and 'in vivo'.
Learning goals	• Knowledge of fundamental single neurons recording methods • Knowledge of fundamental neural populations and brain circuits recording methods • Knowledge of main neural stimulation methods and underlying neurophysiological mechanisms
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.

Prerequisites (not mandatory)	
Examination methods (if applicable)	Discussion with the teacher
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Translating neuroscience into clinical practice (Area 4: Translational and Clinical Neuroscience)**
SS	**MEDS-12/A**
Teacher in charge (if defined)	Angelo Antonini
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	The course aims to offer a holistic and integrated vision of the molecular, genetic and clinical alterations underlying neurodegenerative diseases including dementia, Parkinson's disease and rare neurological diseases
Learning goals	• Understand the pathological aggregation processes of brain proteins such as amyloid, tau and synuclein. • Explain how pathological protein aggregates alter brain functioning and connectivity. • Define the contribution to cognitive and behavioral alterations and explore consequences for the patient's functioning.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the

	Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	TBD
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Motor recovery and neuroplasticity after central nervous system injury (Area 4: Translational and Clinical Neuroscience)**
SS	**MEDS-19/B**
Teacher in charge (if defined)	Alessandra Del Felice
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	Neurobiological and neurophysiological signatures of recovery after CNS injury; basic principles of neurorehabilitation.
Learning goals	The course will provide students the conceptual understanding of the micro- and meso-scale events underpinning neuroplasticity after CNS injury, exploring clinical and experimental interventions to boost recovery. Learning objectives include the knowledge of timing of neurobiological events occurring after lesions and the rationale for intervention in different time windows, the experimental approaches trialed and the reasons for the lack of translatability, and a brief review of current clinical approaches according to international guidelines.
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No
Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students

	enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Critical review of a recent top-journal paper on the topic
Suggested readings	Learning material will be made available during the course
Additional information	

Course unit English denomination	**Brain-body interactions in psychopathology and the bio-neurofeedback (Area 4: Translational and Clinical Neuroscience)** **The course will not be available for the Academic Year 2025-26**
SS	**PSIC-04/B**
Teacher in charge (if defined)	Elisabetta Patron
Teaching Hours	5
Number of ECTS credits allocated	1
Course period	2nd semester Timetable available at https://pnc.unipd.it/phd-neuroscience/teaching-activities/
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (70% minimum of presence) ☐ No
Course unit contents	This course intends to provide an introduction to the psychophysiological basis of brain-body interaction, with a particular focus on brain-heart interplay in emotion and psychopathology. Bio- and neurofeedback are interventions based on brain body interaction. The course will provide theoretical framework and clinical protocols. • First module (2 hours): The psychophysiological basis of brain body interaction with a particular focus on the role of brain heart interplay. • Second module (3 hours): The scientific basis of biofeedback and neurofeedback and their main clinical applications.
Learning goals	• Theoretical knowledge of the physiological basis of brain-body interaction • Basic ability to design bio- neurofeedback experimental protocols
Teaching methods	Lectures, project work, use of technological tools (e.g. software, wooclap quiz), active participation of students in class, oral presentations, written papers.
Course on transversal, interdisciplinary, transdisciplinary skills	☐ Yes ☒ No

Available for PhD students from other courses	☒ Yes ☐ No The course is open to all PhD students, with priority given to PhD students enrolled in the Neuroscience Program. External PhD students will email the Administrative Office (administration.pnc@unipd.it) and they will be contacted in case of vacancies.
Prerequisites (not mandatory)	
Examination methods (if applicable)	Brief homework assignment: design a bio-neurofeedback experimental protocol.
Suggested readings	Learning material will be made available during the course
Additional information	