UNIVERSITÀ DI PAVIA

Anno Accademico 2023/2024

MATERIALS AND PLATFORMS FOR ARTIFICIAL INTELLIGENCE

Enrollment year	2021/2022
Academic year	2023/2024
Regulations	DM270
Academic discipline	FIS/03 (MATERIAL PHYSICS)
Department	DEPARTMENT OF MATHEMATICS "FELICE CASORATI"
Course	ARTIFICIAL INTELLIGENCE
Curriculum	PERCORSO COMUNE
Year of study	3°
Period	2nd semester (04/03/2024 - 18/06/2024)
ECTS	6
Lesson hours	56 lesson hours
Language	English
Activity type	WRITTEN AND ORAL TEST
Teacher	PELLEGRINI GIOVANNI (titolare) - 6 ECTS
Prerequisites	Mathematical prerequisites include fundamental concepts of linear algebra and calculus. Familiarity with matrix-vector operations and the concept of eigenvalues and eigenvectors is required. The student must also be familiar with derivatives, integrals, univariate and multivariate functions, series expansions, Fourier transforms and simple linear differential equations. Physics prerequisites include the basic concepts of classical mechanics, quantum physics and statistical physics.
Learning outcomes	The present course has the objective to provide the students with the first basic concepts of solid state physics, and to give a first introduction to the fundamental building blocks of modern computing devices, such as p-n junctions and transistors. By the end of the course, the student should be able to: 1) Apply the quantum physics machinery to provide a qualitative explanation of the basic electronic properties of materials, with a

	particular focus on semiconductors. 2) Understand the basic properties of p-n junctions and transistors. 3) Use neural networks to solve the differential equations arising from the application of quantum mechanics to solid state physics problems.
Course contents	The focus of this course is the application of quantum mechanics for the explanation and description of the basic properties of solid state matter. Particular attention will be given to the electronic properties of semiconductors and semiconductor devices such as p-n junctions and transistors. Topics of the course include: 1) Schrodinger equation applied to atomic and solid state physics problems. 2) Application of Physics Informed Neural Networks to solid state physics problems. 3)Properties of free electrons. 4) Properties of electrons in crystals. Band theory and Bloch theorem: insulators, metals and semiconductors. 5) Basic properties of the p-n junctions 6) Basic properties of the transistors All the above topics are geared towards the comprehension of the basic building blocks of any modern computing device.
Teaching methods	Regular lectures will make use of a mix of live annotated interactive slides, traditional slides, and handwritten notes on a blackboard, depending on the classroom facilities. Interactive Q&A sessions, implemented through ad-hoc software solutions, will be included during the lecture whenever appropriate or possible. Hands-on exercise and training sessions will especially focus on the solution of practical problems, with special attention to the Physics Informed Neural Networks approach. The adopted toolbox includes widely available softwares and libraries, such as Python, Jupyter Notebook, Google Colab, Git, Github and widespread deep learning libraries (Tensorflow, Keras, Pytorch, .).
Reccomended or required readings	1) Kittel, Charles, and Paul McEuen. Introduction to solid state physics. John Wiley & Sons, 2018. [ISBN 1119456185] 2) Ashcroft, Neil W., and N. David Mermin. Solid state physics. Cengage Learning, 2022. [ISBN 0357886089] 3) Pierret, Robert F. Semiconductor device fundamentals. Pearson Education India, 1996. [ISBN 0201543931] 4) Streetman, Ben G., and Sanjay Banerjee. Solid state electronic devices. Pearson, 2014. [ISBN 0133356035] The textbooks are intended as a source of supplementary information for the students interested in more in depth information about specific arguments.
Assessment methods	The exam consists of a mix of tests with multiple choice questions and written exercises to establish the student's knowledge of the concepts presented in the course and the capability to solve simple problems. The duration of the test is 120 minutes. The written exam can be integrated with an oral exam at the discretion of the teacher.
Further information	

Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile