University of Gdańsk

Subject card

Subject name and code	Classical electrodynamics, PG_00182302		
Field of study	Physics		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2027/2028
Education level	Bachelor's studies	Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study
Mode of study	full-time studies	Mode of delivery	at the university
Year of study	2	Language of instruction	Polish
Semester of study	4	ECTS credits	7.0
Learning profile	academic	Assessment form	exam
Conducting unit			
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Tomasz Paterek	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	45.0	45.0	0.0	0.0	0.0	90

E-learning hours included: 0.0

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	90	0.0	85.0	175

Subject objectives

Introduction to theoretical foundations and mathematical formalism of classical electrodynamics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[FIZL3_U05] can apply the formalism of classical electrodynamics and Maxwell's equation to describe electric and magnetic fields in vacuum and in material media and in electrical circuits, and to classify material media according to the way they interact with an external electromagnetic field	- reasons using the laws of electrodynamics - solves problems in electromagnetism - distinguishes different types of electric and magnetic materials and understands their mechanisms	[SU1] oral statement/conversation/ discussion [SU2] presentation/project/paper/ report [SU4] test/exam - oral or written
[FIZL3_W07] knows and understands electromagnetic phenomena, laws of electrodynamics and the consequences of Maxwell's equations	- formulates in different ways the laws of electrodynamics (differential, integral, using potentials) - correctly describes static and dynamic electromagnetic phenomena	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion
[FIZL3_W01] has advanced knowledge of physical concepts, principles and theories, understands their historical development and significance not only for physics, but also for other exact and natural sciences and cognition of the world	- knows modern applications of electromagnetism - applies electrodynamics to understand phenomena around us	[SW4] test/exam - oral or written [SW1] oral statement/ conversation/discussion [SW2] presentation/project/paper/ report

Subject contents	1. Vectors. Orthonormal basis. 2. Gradient, divergence, curl, and basic differential properties of vectors. 3. Gauss and Stockes theorems. 4. Gradient and divergence in curvilinear coordinates. 5. Dirac delta. 6. Dirac delta in three dimensions. 7. Helmholtz theorem. 8. Coulomb's law. 9. Electric field. 10. Electrostatic potential. 11. Poisson's equation. Green's functions. 12. Discontinuity of electric field when crossing the boundary. 13. Electrostatic potential and charged surfaces. 14. Electrostatic energy of test charge in electric field. 15. Electrostatic energy of a set of charges. 16. Green's function and boundary conditions in electrostatics. 17. Conductors. 18. Induced charges in electrostatics. 19. Force acting on a conductor. 20. Capacitor: capacitance and energy. 21. Laplace's equation. 22. Dirichlet's boundary conditions. 23. Neumann's boundary conditions. 24. The method of images. 25. The method of separation of variables.

	26. Separation of variables in curvilinear coordinates. 27. Multipole expansion of electrostatic potential. 28. Dipole and its electric field. 29. Magnetistatics: basic equations. 30. Vector potential, gauge transformations. 31. Coulomb gauge. 32. Vector potential of magnetic dipole. 33. Discontinuity of magnetic field through surface current. 34. Maxwell's equations. 35. Potentials in full electrodynamics. 36. Coulomb and Lorentz gauge. 37. Electromagnetic waves in vacuum. 38. Electromagnetic energy density. 39. Poynting's vector. 40. Conservation of energy for electromagnetic fields. 41. Conservation of momentum and angular momentum of em fields. 42. Elektrodynamika makroskopowa (fenomenologiczna) równania Maxwella. 43. Polaryzacja i magnetyzacja ośrodka. 44. Prędkość fal elektromagnetycznych w dielektrykach. 45. Kryzys elektrodynamiki klasycznej nierozwiązane problemy. Wykaz literatury D. J. Griffiths, Podstawy elektrodynamiki, Wydawnictwo Naukowe PWN 2001 J. D. Jackson, Elektrodynamika klasyczna, PWN 1982
Prerequisites and co-requisites	Knowledge of mathematical analysis, algebra, mathematical methods of physics and classical mechanics on the level appropriate to 3 semesters of undergraduate courses in physics.

<table>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>oral exam</td><td>51.0%</td><td>40.0%</td></tr>
<tr><td>written exam</td><td>51.0%</td><td>40.0%</td></tr>
<tr><td>presentation / project</td><td>51.0%</td><td>20.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>D. J. Griffiths, Introduction to electridynamics

J. D. Jackson, Classical electrodynamics</td></tr>
<tr><td>Supplementary literature</td><td>http://www.plasma.uu.se/CED/Book/

http://www.tphys.uni-heidelberg.de/~wegner/e03.dyn/El03Gese.pdf</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2"></td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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