PHYS 7312: Electromagnetic theory

General information

Time and location:	Monday, Wednesday, Friday, 1:00-1:50pm, 152 Fondren Science
Instructor:	Pavel Nadolsky
E-mail:	nadolsky@smu.edu
Phones:	(214) 768-1756 (office)
Mailbox:	102 Fondren Science
Office:	203 Fondren Science
Office hours:	By appointment, request an appointment at doodle.com/pavelnadolsky
Course webpage	Posted on SMU Canvas courses.smu.edu To view, enter your 8-digit SMU ID and password.

Textbook, learning objectives, grading, policies

Text	*Classical Electromagnetism in a nutshell* , by Anupam Garg, 1st Edition
Recommended reading	1. *Classical Electrodynamics by John D. Jackson (3rd edition)* 2. *Introduction to Electrodynamics* by David J. Griffiths 3. Electromagnetic Fields and Energy by Herman A. Haus and James R. Melcher 4. *A student's guide to Maxwell's equations* by Daniel Fleisch 5. *Fundamentals of Electromagnetic Phenomena* by Lorrain and Corson
Grading	• Homework 50% • Three midterm tests 30% • Final test 20%
Homework assignments	In the Assignments folder on the website. Due dates are strictly enforced. 50% if late; 0% once the solutions are posted.
Final test	Thursday, 11 May 2017, 11:30am

Syllabus

Chapter 7. Electromagnetic waves
40. The wave equation for E and B
41. Plane electromagnetic waves
42. Monochromatic plane waves and polarization
43. Nonplane monochromatic waves; geometrical optics*
46. Oscillator representation of electromagnetic waves
47. Angular momentum of the free electromagnetic field*

Chapter 6 Symmetries and conservation laws
34. Discrete symmetries of the laws of electromagnetism
35. Energy flow and the Poynting vector
36. Momentum conservation
37. Angular momentum conservation*
38. Relativity at low speeds
39. Electromagnetic mass*

Chapter 9 The electromagnetic field of moving charges
54. Green's function for the wave equation
55. Fields of a uniformly moving charge
56. Potentials of an arbitrarily moving charge--the Lienard-Wiechert solutions
57. Electromagnetic fields of an arbitrarily moving charge
58. Radiation from accelerated charges: qualitative discussion

Chapter 10 Radiation from localized sources
59. General frequency-domain formulas for fields
60. Far-zone fields
61. Power radiated
62. The long-wavelength electric dipole approximation
63. Higher multipoles*
64. Antennas
65. Near-zone fields
66. Angular momentum radiated*
67. Radiation reaction

Chapter 13 Electromagnetic fields in material media
81. Macroscopic fields
82. The macroscopic charge density and the polarization
83. The macroscopic current density and the magnetization
84. Constitutive relations
85. Energy conservation

Chapter 16 Magnetostatics in matter
100. Magnetic permeability and susceptibility
101. Thermodynamic relations for magnetic materials

102. Diamagnetism
103. Paramagnetism
104. The exchange interaction; ferromagnetism
105. Free energy of ferromagnets
106. Ferromagnetic domain walls*
107. Hysteresis in ferromagnets
108. Demagnetization
109. Superconductors*

Chapter 18 Frequency-dependent response of materials
119. The frequency-dependent conductivity
120. The dielectric function and electric propensity
121. General properties of the ac conductivity*
122. Electromagnetic energy in material media*
123. Drude-Lorentz model of the dielectric response
124. Frequency dependence of the magnetic response*
19Q. uasistatic phenomena in conductors
125. Quasistatic fields
126. Variable magnetic field: eddy currents and the skin effect in a planar geometry
127. Variable magnetic field: eddy currents and the skin effect in finite bodies*
128. Variable electric field, electrostatic regime
129. Variable electric field, skin-effect regime
130. Eddy currents in thin sheets, Maxwell's receding image construction, and maglev*
131. Motion of extended conductors in magnetic fields*
132. The dynamo*

Chapter 20 Electromagnetic waves in insulators
133. General properties of EM waves in media
134. Wave propagation velocities
135. Reflection and refraction at a flat interface (general case)
136. More reflection and refraction (both media transparent and nonmagnetic)
137. Reflection from a nonmagnetic opaque medium*

Chapter 21 Electromagnetic waves in and near conductors
138. Plasma oscillations
139. Dispersion of plasma waves*
140. Transverse EM waves in conductors
141. Reflection of light from a metal
142. Surface plasmons*
143. Waveguides
144. Resonant cavities

Chapter 23 Formalism of special relativity
152. Review of basic concepts
153. Four-vectors
154. Velocity, momentum, and acceleration four-vectors

155. Four-tensors
156. Vector fields and their derivatives in space--time
157. Integration of vector fields*
158. Accelerated observers*

Chapter 24 Special relativity and electromagnetism
159. Four-current and charge conservation
160. The four-potential
161. The electromagnetic field tensor
162. Covariant form of the laws of electromagnetism
163. The stress--energy tensor
164. Energy--momentum conservation in special relativity
165. Angular momentum and spin*
166. Observer-dependent properties of light
167. Motion of charge in an electromagnetic plane wave*
168. Thomas precession*

Chapter 12 Action formulation of electromagnetism
77. Charged particle in given field
78. The free field
79. The interacting system of fields and charges
80. Gauge invariance and charge conservation