PHYSICS 450 – ELECTROMAGNETIC WAVES

Spring Semester 2017 TR 9:00–10:15 WAT 114
Instructor: Eric B. Szarmes (szarmes@hawaii.edu; WAT 212)
Office hours: to be announced

Course Description: Historically, the most important consequence of Maxwell's investigations into electrodynamics was the understanding that light is a purely electromagnetic phenomenon. Having developed Maxwell's equations and explored various applications of electrodynamics in Phys 350, we now focus our attention in Phys 450 on the nature and propagation of electromagnetic waves in vacuum and in media. We also explore general solutions to Maxwell's equations that reveal the rich physical content of these equations – that electromagnetic fields possess energy, linear momentum and angular momentum – and lastly, how electric and magnetic fields are not separate entities, but instead are fundamentally related through the four dimensional structure of spacetime. The course thus includes a thorough introduction to the theory of relativity.

Textbooks: David J. Griffiths, *Introduction to Electrodynamics, 4th ed.*, Pearson Higher Ed., Boston, 2013
(*optional*: T. A. Moore, *Six Ideas That Shaped Physics, UNIT R*, 2nd ed., McGraw Hill, 2003)

Course website: https://laulima.hawaii.edu → PHYS-450-001 [MAN.81636.SP17] → Resources

Recitation sessions: *day and time TBA*

Grade distribution:

Weekly homework:	30%
Recitation homework:	20%
Quizzes/Midterm exams:	10%/20%
Final examination:	20%

Grade assignment: *(approximate)*

A+	90 >	B+	75–80	C+	60–65	C–	40–50
A	80–90	B	65–75	C	50–60	D/F	< 40

COURSE OUTLINE

Dates	Topics	Chapter
Jan 10–Feb 7	the wave equation; properties of waves; electromagnetic plane waves in free space and dielectric media; reflection at surfaces; electromagnetic waves in conductors; guided waves	Griff 9
Feb 9–Feb 21	energy, momentum and angular momentum in electric and magnetic fields; Poynting's theorem; Maxwell's stress tensor	Griff 8
Feb 14	*Midterm Examination #1 due Friday, Feb 17*	
Feb 23–Mar 7	potential theory; scalar and vector potentials; Coulomb and Lorentz gauges; retarded potentials; Lienard-Wiechert potentials; field of a moving charge	Griff 10
Mar 9–Mar 14	nature and origin of electromagnetic radiation; power radiated by a moving charge; radiation reaction	Griff 11
Mar 21	*Midterm Examination #2 due Friday, Mar 24*	
Mar 16–Apr 13	principle of relativity; clock synchronization; the nature of time; the metric equation; proper time; the Lorentz transformation; Lorentz contraction; the causal structure of spacetime; four-vectors; energy and momentum	Griff 12 (notes)
Apr 18–Apr 27	electrodynamics and relativity; transformation of electric and magnetic fields; the field tensor and relativistic potentials	Griff 12
May 2	*Problem Session and Review*	
May 8–12	*Final Examination*	