PHYSICS 450 – ELECTROMAGNETIC WAVES

Spring Semester 2020 TR 9:00–10:15 WAT 114
Instructor: Eric B. Szarmes (szarmes@hawaii.edu)
Office: Watanabe Hall, Room 212

Course Description: Historically, one of the most important consequences 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 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 space-time. The course thus concludes with a thorough introduction to the theory of relativity.

Textbooks: David J. Griffiths, *Introduction to Electrodynamics, 4th ed.,* Cambridge University Press, 2017
(*recommended*: T. A. Moore, *Six Ideas That Shaped Physics, UNIT R*, 3rd ed., McGraw Hill, 2017)

Course website: https://laulima.hawaii.edu/portal/site/MAN.81154.202030 → see Resources

Grade distribution:

Weekly Homework:	50%
Midterms/Quizzes:	M1(10%) / M2(10%) / Q(10%)
iClicker Questions:	included in Quiz total
Final Examination:	20%

HW Corrections: Up until one week after any weekly problem set is returned to you, you may resubmit any corrected problem on that problem set for up to an additional 3 points per problem. Corrections must be done on the original problem set, either written directly on the original writeup in *distinguishable ink* (for small corrections) or on a separate page attached to the original problem set (for longer corrections) as needed. If you are not sure where you made your original error, or have trouble understanding anything about a problem for which you lost points, you may meet with me for a brief tutoring session to go over any questions you may have.

Grade assignment:

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 14–Feb 11	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 13–Feb 25	energy, momentum and angular momentum in electric and magnetic fields; Poynting's theorem; Maxwell's stress tensor	Griff 8
Feb 18	*Midterm Examination #1 due Friday, Feb 21*	
Feb 27–Mar 10	potential theory; scalar and vector potentials; Coulomb and Lorentz gauges; retarded potentials; Lienard-Wiechert potentials; field of a moving charge	Griff 10
Mar 12–Mar 24	nature and origin of electromagnetic radiation; power radiated by a moving charge; charges in arbitrary motion	Griff 11
Mar 24	*Midterm Examination #2 due Friday, Mar 27*	
Mar 31–Apr 21	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 23–May 5	electrodynamics and relativity; transformation of electric and magnetic fields; the field tensor and relativistic potentials	Griff 12
May 7	*Problem Session and Review*	
May 11–15	*Final Examination*	