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Physics 180Q SPRING 2016

Quantum Optics Laboratory Syllabus

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Lecture: Mondays 2:00 - 3:50pm
Knudsen 6107
Lab: Tuesday thru Friday
Knudsen A-142 180888

This guide is the syllabus for Physics 180Q in the Spring quarter of 2016 and may be updated and changed slightly from time to time. Version information for this document can be found at the top of this page.

Materials

There are no books that you are required to purchase for this course. That said, Laser Electronics by Verdeyen is typically recommended, and will make a good reference for your library if you purchase it.

Overview

The purpose of this class is to provide you with direct experimental evidence of the most difficult concepts of quantum mechanics. To do this, however, requires you to learn a substantial amount of modern optics skills. Therefore, the beginning of the class will focus on developing these skills. Once these are developed we will test quantum mechanics. The enforced pre/co-requisite for this course is Physics 115C.

Modern Optics topics: ray tracing, ABCD matrices, Gaussian beams, fiber optics, polarization manipulation, Jones vectors, lasers, laser feedback, optical cavities. Quantum mechanics topics: information contained in wavefunction, quantum superposition, quantum measurement, decoherence, two-photon interference, Bell's inequalities.

There will be around 9 weekly laboratory experiments. Each experiment will require the completion of a prelab assignment *before* the experiment is performed. Each laboratory experiment will also require the completion of a laboratory report. These will form the basis for most of the grading. There is one lab report due per week. The report is basically what you did and answering the specific questions. You do not need to write up a standard lab report with

"goals, hypothesis, equipment" etc, except as described below. You should prepare your report as if it were a solution set for another student who was not able to do the lab or answer the questions.

Instead of a final exam, students will be required to submit a journal style article describing their data collection for either the Bell's inequality or Hong-Ou-Mandel experiment. This article must provide a brief introduction, describe the experiment and data collection procedure, and interpret the collected data.

Grading

Pre-labs are due at the beginning of the Monday lecture before you perform each experiment (with the exception of week 1, which will be due to your TA before you show up in the lab). You must turn in your pre-lab before you will be allowed to begin your experiment. Pre-labs will typically be worth 25 points and regular lab reports will be worth 50 points. Regular lab reports are due at 9 am exactly 1 week after your assigned day in lab (e.g. if your day is Wednesday, your report is due at 9am the following Wednesday). The combination of your pre-labs and your lab reports make up 70% of your grade. Late submissions (anything pre-lab turned in after the lecture begins on Monday or lab report turned in after 9 am) will have 10 points deducted right away, and an additional 5 points deducted for each calendar day they are late.

The remainder (30%) of your grade will be determined by your formal "journal-article-style" lab report you turn in for one of the last two experiments.

Working together on the prelab is encouraged. However, all work that you hand in must be your own. That means that you must do the problems on your own in the end. Also, though you will work with a partner during the lab, you must each submit your own lab report, which must be written in your own words and should not be based on the work of any other person in any way.

Schedule

Week number and start date	Topic of Monday Lecture	Tues-Friday Experiment
1. Mar. 28	Introduction, Jones Calculus	Basic Skills
2. Apr. 4	Gaussian Beams, ABCD matrices	Polarization
3. Apr. 11	Fiber Optics	ABCD/Gaussian Beams
4. Apr. 18	Optical Cavities	Fibers
5. Apr. 25	External Cavity Diode Lasers (ECDLs)	Cavities
6. May. 2	Bell's Inequality	ECDL
7. May. 9	Bell's Inequality II	Entanglement Apparatus
8. May. 16	Hong-Ou-Mandel (HOM)	Bell's Inequality
9. May. 23	(no lecture, but prelab is due)	HOM
10. June 1	**Final journal-article-style report due**	**Due by 5 pm.**