

Final Exam
December 12, 2005

1. 40 points

Imagine you are asked to build an optical setup to experimentally demonstrate light interference.

- a) Draw a schematic of one (of many) possible optical setups;
- b) Identify which are the critical dimensions and why they are critical;
- c) Explain whether (or not) the following parameters that describe the light source are important and *why* they are important (or unimportant): 1) intensity, 2) color, 3) coherence.
- d) Your supplier only has two lamps:
 - 1) a white-light lamp that comes with a filter that absorbs 100% of the light with wavelengths below 495 nm and above 505 nm (and absorbs none in the 495-505 nm range), and
 - 2) a light source that emits light only between 495 and 505 nm (with the same intensity throughout this range).

Which of the two lamps would you choose, and why?

2. 60 points

Using monochromatic light from a distant source, we project light through a small square hole onto a circular lens and we are interested in the image formed at the image plane. By “small” we mean about 10 times larger than what the lens can resolve.

- 1) Compose a drawing that illustrates why the lens acts as a “low-pass optical filter”
- 2) Invoking Fourier analysis concepts, describe the following patterns as quantitatively as possible and draw a 1-D plot for each of them:
 - a) the diffraction pattern of light projected onto the plane of the lens;
 - b) the light pattern right after the lens;
 - c) the light pattern at the image plane – including an explanation of **how** and **why** the image of the hole differs from the original hole;
 - d) the diffraction pattern in the plane of the lens if the square hole is replaced by a rectangular hole (longer side 5 times longer than the width of the square);
 - e) the diffraction pattern in the plane of the lens if the square hole is replaced by two square holes (you may define the distance between them and use this distance in your answer).