Physics/ECE 411/611 **LABORATORY 7** **Oct. 20-22, 2003**

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EXPERIENCE WITH USE OF A SINGLE-MODE FIBER

and

OBSERVATION OF THE FOUR LOWEST ORDER LP MODES

PLEASE DO YOUR EXPERIMENT AND REPORT IN GROUPS OF TWO (2)

Introduction

In Newport's *Projects in Fiber Optics*, read Sections 0.3.1, 3.1, 3.6.1, and Project #4, except for Sections 4.2 and 4.4.2, as background for this experiment. You will do only Section 4.4.1. For Section 4.4.1 you will probably find that projecting the image from the end of the fiber on a small screen several inches from the fiber is just as useful as employing the 40X objective as stated in Section 4.4.1 (part 3).

The Newport kit has two single-mode fibers, each of numerical aperture 0.11. The core diameters of each are 4 ìm and 8 ìm, respectively.

Calculate the V-number of each fiber for our 633-nm laser. Using Fig. 4.1, decide which mode(s) could exist for each of the two fibers. For this experiment we will use the F-SS fiber which has a diameter of 8 ìm. Consult the Newport catalog to determine the basic specifications for the F-SS fiber you are using and list these in your report.

Beginning Your Lab Work

Following sections 4.1 and 4.4.1 in Newport's *Projects in Fiber Optics*, set up the experiment. However, you should include two mirrors between the laser and the fiber coupler to improve your ability to insert light into a fiber with a very small core diameter. Make a sketch of the setup and include it in your report.

Follow the same precautions you have used in the past in using the laser. Be sure that your detector has its OD 3 neutral density filter attached.

Main Portion of the Lab

Very carefully experiment with the x- and y-adjustments and the two angle or tilt adjustments for the fiber coupler available at the laser-end of the fiber. What is the purpose of each adjustment and which is/are the most critical?

Without making any adjustment, explain what the purpose of the z-adjustment is.

What is the optical power available from the laser at your lab position?

What is the maximum output optical power at the end of your fiber?

Allow the light from the output-end of the fiber to shine on a white sheet or board several centimeters from the fiber end. By varying the four transverse coupler adjustments (not the z-adjustment!), adjust the input to show each of the four LP modes shown in Fig. 4.2 of the Newport manual. Follow the procedures indicated in Section 4.4.1 (parts 5 and 6). Each mode might be in combination with another, but try to adjust to emphasize the particular mode you are studying. Sketch the four cases you study. What mode or modes seem to be present in each picture? Label the modes on your sketch. Measure the NA aperture of the LP_{01} mode and compare its value to the manufacturer's specification.

(This space is for additional mode sketches.)

Look at the mode pictures obtained by other lab groups. You can include what you observe in you own report, but be sure to list the names of the students that obtained these results.

Each group can borrow a laboratory manual to refer to as needed to finish your laboratory report. This must be returned in time for the laboratory next week.

Laboratory 7 Names_____

Date _____

REPORT

For your report you should include the items listed below.

Calculate the V-number of each single-mode fiber available in the Newport kit when used with the 633-nm laser. Consult the Newport catalog to determine the basic specifications for the F-SS fiber you are using and list these in your report. Is the F-SS single-mode fiber a step-index or graded-index fiber?

Show a sketch of your lab setup, including approximate positions and distances.

Were the mirrors useful? Explain.

What is the purpose of each transverse coupler adjustment and which is/are the most critical?

Explain the purpose of the z-adjustment.

What is the optical power available from the laser at your lab position?

What is the maximum output optical power at the end of the fiber in your setup?

What percentage of available power arrived at the detector?

How does your NA value compare with the published value?

Show your four carefully labeled sketches of the four LP modes or mode combinations.

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Mathematically explain the azimuthal variation of the light output observed in the experiment. Start with g(ö) = A cos (mö) + B sin (mö) and use the identity for cos (x - y). Consider m = 0, 1, and 2. The function g(ö) is one of the factors that describes the field observed in the experiment.

Discuss any problems you had in doing the experiment.