VE438: Advanced Lasers and Optics Laboratory

Laboratory manual
Lab 3: Fiber Optics[1]

Course instructor: Dr. Wan Wenjie

Teaching assistant: Yang Jianfan[2], Chen Yao

UM-SJTU Joint Institute
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[1]Edited based on the material and feedback from course instructor and previous TAs: Feng Yaming, Cao Jianjun and Shang Ce. Last Updated by Yang Jianfan(May 30, 2019)

[2]Email: 824403354@sjtu.edu.cn

1 Suggested Reading Assignment

Fundamentals of Photonics (Saleh & Teich) Ch 7, 8, 22

2 Pre-lab Questions

1. What's the numerical aperture (NA) of an objective lens and an optical fiber? Calculate the NA of a step-index fiber with core index 1.452 and cladding index 1.45.
2. For a step-index fiber, what is the largest core diameter if it is a single-mode fiber? Suppose core index 1.452, cladding index 1.45, and wavelength 1500nm.
3. Material dispersion arises from the difference of refractive index with respect to the wavelength of light. Find the dispersion relationship between refractive index and frequency, and explain the physical origin for the equation. (Hint: *Optics* by Hecht, Ch 3)
4. Explain the difference between phase velocity and group velocity. How does refractive index affect group velocity?

3 Procedure

NOTICE:

- Pay attention to all lab safety instructions. Lasers used in the lab might hurt your eyes if you look into the beam directly.
- Equipment used in optics experiments such as mirrors and prisms are very fragile thus special operating rules need to be followed. Your grade for in-lab operation will be deducted for improper operations.
- Make sure the checklist below is clear before leaving the lab:
  - ☐ The experimental setup has been shown to the TA;
  - ☐ The data sheet has been checked and signed by the TA;
  - ☐ The equipment has been restored;
- TA will give a question to one of the group members to check your understanding on lab content. Grade for in-lab operation and the question will be shared among the whole group.

PART A: Coupling of Multi-mode Fiber

1. Record the output power of the laser with the photon diode.
2. Mount the objective lens on the spatial filer;
3. Mount one of the FC ports of the multi-mode fiber on the spatial filter;
4. Connect the other FC port of the fiber to the photon diode;
5. Adjust the position of the spatial filter and the relative position of the objective lens until the transmitted power reaches its maximum;
6. Record the maximum of the transmitted power.

PART B: Coupling of Single-mode Fiber

Replace the multi-mode fiber in PART A with a single-mode fiber. Repeat the steps above.

4 Post-lab Questions

1. Describe the output at the end of the optical fiber (e.g. the shape of the light spot). How does the light spot vary with distance? Explain with NA.
2. What percentage of the power was transmitted through the optical fiber? Where did the rest power go?
3. How to transmit information based on the setup you built? What components should be added?
4. Can you increase the bandwidth for the transmission of information if an extra green laser is also given? What is the Wavelength Division Multiplexing(WDM) technology?