In the first part of this lab you will investigate some of the issues related to alignment and coupling of fibers. In particular you will examine the sensitivity of lateral, longitudinal, and angular misalignment between both multi-mode and single mode fibers. Chapter 6 in the Newport Lab Book has a pretty good description of these issues. I have attached copies of Sections 6.1 and 6.2 that give some background. Please read this material prior to commencing the lab.

In the second part of the lab you will investigate some of the operating and emission properties of semiconductor laser diodes. These devices are used extensively in fiber applications due to their operating characteristics and physical compatibility with fiber components.

A. Fiber Optic Connectors:

TASKS:

* Calculate the theoretical loss in dB as a function of:
  * lateral misalignment,
  * axial separation, and
  * angular misalignment for both MLD and FSV fiber with 632.8 nm light.

Show the relations that you are using, and use the cladding and core values for these fibers as given in the Newport catalog (i.e. MLD fiber 100/140 µm for the core/cladding, and 4/125 µm for the FSV fiber core/cladding).

Determine the optimum beam diameter for the FSV fiber from the V# relation provided in the last lab.

1. Measurements:
   a) Following the procedure outlined in the Newport lab book (Section 6.5.1), measure the butt coupled dry connection loss, lateral misalignment loss, axial misalignment loss, and the angular misalignment loss for two sections of MLD fiber. In order to ensure that the fiber modes are properly filled, use a spool of fiber for the launch fiber (this should work better than the mode scrambler outlined in the Newport lab book).
   b) Plot your results.
   c) **Analysis:** Compare your measured results to your theoretical calculations, and explain the differences that you observe. Remember that the MLD fiber is a graded index fiber.
   d) After completing these measurements, bring the fibers to a maximum butt coupling efficiency condition. Measure the coupling efficiency and then add a drop of index matching oil at the joint and re-measure the coupling efficiency. Compare your results to what you would expect with Fresnel losses. Assume the oil index is 1.51.
2. Based on your measurements and calculations, what is the most critical alignment consideration for connector design?

**A. Laser Diode Operation**

Laser diodes are very sensitive to variations and spikes in drive current. An improper connection can lead to diode failure. In addition, the emission wavelength can be in the infrared, therefore eye safety is important. Please be careful!

With the laser disconnected, take a few moments to examine the LD mounting and packaging with a magnifying glass. Take note of the electrical connections and the heat sink. Compare to the specification sheet in the lab. Note the locations of the anode and cathodes on the specification sheet.

**Tasks and Questions**

1) *Measure the divergence angles of the beam emitted in both orthogonal directions.* A reasonably accurate measurement can be obtained by translating a detector through the beam. The active area of the detector should be reduced with a pinhole to restrict the illuminated area. Locate the minimum and maximum divergence directions with the IR viewing card or IR viewer and align one of them with the plane of the table. *After scanning the horizontal, rotate the laser in the mount by 90° and secure it in place then repeat the scan of the beam profile with the detector.* This is one way to measure the beam divergence in the two orthogonal directions of the laser emission profile.

*Plot the two profiles. From this data, calculate the size of the emission region.* This can be done using Gaussian beam diffraction relations.

2) *Calibrate a detector for the sensitivity at 780 nm and measure the laser output power versus drive current.* Determine the threshold current level and the differential efficiency of the laser.

3) *Determine the polarization axis of the laser.* How does this compare to the emission surface of the laser? Why should the dimension of the emission area affect the polarization?