Introduction:
In this experiment a system for generating an ‘eye diagram’ to analyze the properties of a digital communications channel will be evaluated. This diagnostic tool is frequently used to assess the performance of digital systems. Since many kilometers of fiber can be wrapped on a small diameter spool it is possible to have both the transmitter and receiver can be used in a localized area. The receiver can be triggered by the transmitter and used to evaluate changes introduced by the optical system. This is the basis for the ‘eye’ diagram experiment.

Experimental System:
The general arrangement of the equipment for viewing the ‘eye’ diagram is shown in Figure 1. The wave-generator provides a modulation frequency to clock a device called a pseudo-random bit generator. The pseudo-random bit generator forms a random pattern of N 1’s and 0’s where N is a number on the order of 32 or 64. Within each displayed bit period there will be Highs, Lows, and Up and Down transitions (see Figure 13-21 from Keiser). When properly triggered a pattern results which looks a bit like an ‘eye’ (see Section 13-6 from Keiser). As the signal deteriorates the eye will close.

Tasks:
1. Draw a sketch of the system showing components used for the measurements. Indicate the operating range for each instrument. What is the maximum modulation bandwidth that can be accurately analyzed with this setup? What component limits the maximum modulation bandwidth?
2. Record the power from the source and the operating wavelength. Measure the power prior and after the modulator. What variation in signal amplitude through the modulator results from varying the polarization?
3. Observe the bit pattern and then activate the ‘eye’ diagram mode of operation with the modulator output directly connected to the receiver. Measure the noise levels for the 1 and 0 states, signal level, p-p and RMS jitter, the rise and fall time, and the period. (Assume that the standard deviation of the noise function is 1/2 the width of the high and low signal levels.)
4. Connect a 20 km spool of fiber to the system after the modulator and measure the power after the spool of fiber. Calculate the fiber loss/km in dB/km. Repeat step 3 with the 20 km spool of fiber observing the eye diagram and taking measurements.
5. Using your estimate for the fiber attenuation and its affect on the eye diagram determine the length of fiber that can be used and still maintain a SNR of 2.
6. Make an estimate of the BER for your signal and justify your answer.
7. Make a fusion splice of two pieces of SMF and record the splice loss.
Figure 1. System for generating an `eye' diagram for analyzing the performance of a fiber optic link.

Figure 2. 'Eye' patterns for evaluating signal performance.