PART III
CODING OPTICAL INFORMATION

An optical source is a requirement for generating optical data to be transported over a fiber. The source is modulated by the data signal (see Chapter 6, Section 6.14, Modulators) so that when the modulated light impinges onto the receiver's photodetector, the original data is recreated. The modulation method in optical communications is very important because it plays a key role in the signal power that is coupled into the fiber, in the reduction of nonlinearity contributions (e.g., four-wave mixing, etc.), in the reduction of the overall signal-to-noise ratio, and in increasing the reliability of signal detection.

The *heterodyne* and *homodyne* detection techniques that were developed for radio transmission, where they are known as *coherent*, are also used in optical transmission. However, in optical transmission, the term "coherent" indicates that another light source is used as the local oscillator at the receiver.

In the case of digital communications systems, the phase, the frequency, or the amplitude of a carrier signal may be modulated. When the phase is modulated, the method is called *phase-shift keying* (PSK); when the frequency is modulated, it is called *frequency-shift keying* (FSK); when the amplitude is modulated, it is called *amplitude-shift keying* (ASK). Each modulation method has its own advantages and disadvantages. Another method by which the intensity of a light source is modulated and also detected by a photodetector is known as *intensity modulation with direct detection* (IM/DD).

The modulation technique plays an important role in the performance of fiber transmission. For example, coherent techniques improve receiver sensitivity by ~20 dB, and thus longer fibers may be used (an additional 100 km at 1.55 μm). In dense wavelength division multiplexing (DWDM) systems, where many channels are used in the same fiber, the channel spacing with IM/DD is in the order of 100 GHz whereas with coherent techniques it can be as small as 1–10 GHz.

An example of coherent detection of an incoming modulated signal using a local oscillator (i.e., a light source of a frequency in the vicinity of the transmitted source) is shown in Figure III.1. In the absence of a local oscillator with a narrow

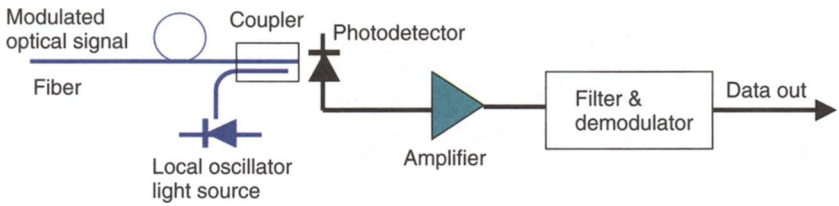

Figure III.1 Coherent detection requires a local oscillator with a narrow spectral width comparable to the source in the incoming signal.

spectral (or line) width comparable to the source in the incoming signal, however, the coherent detection method is impractical. Local oscillators emit light spontaneously and thus become sources of noise. Therefore, the selection of the local oscillator and its amplitude are important in receiver design. In the case of IM/DD, the incoming signal is directly coupled into the detector, thus eliminating the coupler and the local oscillator.

Part III consists of two chapters. Chapter 12 describes several coding techniques that are used in digital transmission and in digital optical transmission, and Chapter 13 describes the decoding techniques.