Fiber Optic Communications
Lecture 10: Modulation Formats

- CDM, TDM
- ASK, PSK, and FSK
Code Division Multiplexing

- Each channel is encoded differently using different keys.
- Decoding requires a key which selects only a particular channel.
Code Division Multiplexing

• Mathematically, create a multidimensional vector space with orthogonal vectors
Time Division Multiplexing

- Each signal has particular time windows within a periodic array
- Arguably a special case of CDM with ‘Cartesian’ codes
Bitrate for Various Techniques: 2-user Gaussian channel
Recap: ON-OFF Keying (OOK)

Frequency shift keying (FSK) and Phase Shift keying (PSK) are variants of OOK. Amplitude shift keying (ASK) is considered more difficult to implement optically.
Amplitude Shift Keying

Can only be implemented coherently with an external modulator
Most common configurations: lithium niobate in a MZ interferometer
Phase shift will obey \[ \delta \phi = \left( \frac{2\pi}{\lambda} \right) (\delta n) l_m \]

Can thus be tuned through voltage variation
Frequency Shift Keying

Two types: narrow and wide-band frequency variation, characterized by the ratio of frequency shift to bit rate. Can use lithium niobate or acousto-optic modulators.
Laser Response

![Graph showing laser response vs. modulation frequency (Hz). The graph compares two types of DFB lasers: Phase-tunable DFB and Standard DFB. The y-axis represents modulation efficiency in GHz/mA, ranging from 0.1 to 10, and the x-axis represents modulation frequency from $10^3$ to $10^9$ Hz. The Phase-tunable DFB maintains a relatively flat line, while the Standard DFB shows a peak around $10^5$ Hz and a dip around $10^7$ Hz.]