ECE 5411 - Optical Communications
Laboratory Assignment #2

Introduction

The purpose of this lab is to measure properties of components used in WDM optical systems and measure the receiver senstiivity of a simple point to point link. These components are a fiber amplifier and a WDM demultiplexor. In the process, you will learn how to use a tunable laser source, broadband source, optical spectrum analyzer, wavemeter, variable attenuator, and bit-error rate tester. The equipment in this lab is very expensive. Your TA will instruct you on the proper use of this equipment. Mishandling and/or breaking this equipment is not an option.

Lab Procedure - Fiber Amplifier

1) The first step is to directly measure the gain profile of the amplifier. Hook the output of the amplifier to the spectrum analyzer. Explain what you see and how it relates to the amplifier gain spectrum.

2) Use the tunable laser source as the input to the amplifier. Attenuate the laser output to be at most -25 dBm so as not to damage the detector on the OSA or wavemeter. You might need to use a fixed attenuator so that the power does not damage the OSA. Can you estimate the signal to background ratio using the OSA?

3) Now, using the wavemeter, measure the amplifier small-signal gain as a function of wavelength. Use the entire tuning range of the laser, in 5nm increments. When you are within the gain region, use 2nm increments.

4) Measure the saturation of the amplifier at three different wavelengths within the gain region. You must attenuate the amplifier output so as not to damage the wavemeter. Use either the fixed 20 dB attenuator or a fixed length of fiber (50+ km). At each wavelength, measure the gain as a function of input power. What are the input and output saturation powers?

Lab Procedure - Bit-error rate

1) Make a simple point to point link by connecting the output and input channels of the 2.5 Gb/sec BERT to the variable attenuator. Adjust the attenuation so that the BER is 10^{-9} and calculate the receiver sensitivity.

2) Use a spool of fiber (> 25 km in length) and measure the atteunation of the spool using the OTDR. Now insert that spool into the mock link between the BERT and variable attenuator and adjust the attenuation to get BER of $10-9$. What is the receiver sensitivity now? Do you have a measurable power penalty due to dispersion?

3) Insert the amplifier into the link (between the fiber spool output and the variable attenuator input) and set the gain to be 20 dB. Again, calculate the receiver sensitivity, but subtract out the 20 dB gain of the amplifier. The difference between this answer and that from 2) will be due to noise of the amplifier. Calculate the SNR degradation due to the amplifier.

Lab Procedure - WDM Demux

1) Use the broadband light source and OSA to measure the wavelength and insertion loss of each of the 4 outputs. What is the spectral bandwidth of each channel? What is the channel spacing?

2) Use the tunable laser source as the input to the demux. Attenuate the laser output to be at most 0 dBm so as not to damage the detector on the wavemeter. Tune the laser to match channel 2. Measure the out of band crosstalk from the laser on the other channels.

3) Now, connect channel 2 to the wavemeter, and tune the laser to match each channel in sequence. Again, measure out of band crosstalk from the laser on channel 2.

4) In a fully populated 4 channel WDM system, what would be the signal to background ratio for channel 2? What about the extinction ratio? Can you say anything about the achievable bit error rate?