Analysis and designing of EDFA with optimum parameter`s

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Abstract: This paper is centered on the EDFA amplifier and explain the basics of EDFA amplifier and also explain the different parameters of the optical amplifier. This also explain why EDFA amplifier is much better as comparison to the other optical amplifier. The basics of the optical network with the optimum utilization of the EDFA amplifier. Optical amplifier directly converts the optical energy without converting electrical energy. In this paper tells the optimum parameters utilization for the conversion of amplify the optical signal without any distortion. In this paper try to implement the cascaded stages of the optical amplifier without any loss of the different parameters used into the paper. It's also explain the future prospective of the EDFA amplifier.

Index Term. EDFA, OPTICAL AMPLIFIER, OPTICAL NETWORK ETC.

INTRODUCTION:

Optical amplifier can amplify the incoming optical signals in the optical domain itself without any conversions to the electrical domain. It do not need high speed electronics circuitry and they are transparent to bit rate, can amplify multiple optical signals at different wavelength simultaneously. The development of EDFA provide tremendous growth in communication system capacity using WDM, in which multiple wavelengths carrying independent signals are propagated through same single mode fiber. Optical amplifiers can be used at many points in communication link. A booster amplifier is used to boost the power of the transmit signal before it launching into the fiber link. The pre amplifier placed just before the receiver is used to increase the receiver sensitivity. In line amplifiers are used at intermediate points in the fiber link to overcome losses. Today, most of the optical fiber communication system use EDFAs, due to their advantages in terms of bandwidth, high power output, and noise characteristics. Erbium doped fiber amplifier is an optical amplifier, it amplifies weak input optical signals directly without any conversions pumped with a laser diode. The main application of EDFA is to amplify signals in optical domain. The EDFA became a key enabling technology for optical communication networks, and have since comprised the vast majority of all optical amplifiers deployed in the field.

Optical Network: An optical network connects computers (or any other device which can generate or store data in electronic form) using optical fibers. Optical fibers are essentially very thin glass cylinders or filaments which carry signals in the form of light (optical signals). Optical networks offer the promise to solve many of the problems we have discussed. In addition to providing enormous capacities in the network, an optical network provides a common infrastructure over which a variety of services can be delivered. These networks are also increasingly becoming capable of delivering bandwidth in a flexible manner where and when needed. Optical fiber offers much higher bandwidth than copper cables and is less susceptible to various kinds of electromagnetic interferences and other undesirable effects. As a result, it is the preferred medium for transmission of data at anything more than a few tens of megabits per second over any distance more than a kilometer. It is also the preferred means of realizing short-distance (a few meters to hundreds of meters), high-speed (gigabits per second and above) interconnections inside large systems. Optical fibers are widely deployed today in all kinds of telecommunications networks. The amount of deployment of fiber is often measured in sheath miles. Sheath miles is the total length of fiber cables, where each route in a network comprises many fiber cables. For example, a 10-mile-long route using three fiber cables is said to have 10 route miles and 30 sheath (cable) miles. Each cable contains many fibers. If each cable has 20 fibers, the same route is said to have 600 fiber miles. A city or telecommunications company may present its fiber deployment in sheath miles; for example, a metropolitan region may have 10,000 fiber sheath miles. This is one way to promote a location as suitable for businesses that develop or use information technology. When we talk about optical networks, we are really talking about two generations of optical networks. In the first generation, optics was essentially used for transmission and simply to provide capacity. Optical fiber provided lower bit error rates and higher capacities than copper cables. All the switching and other intelligent network functions were handled by electronics. Examples of first-generation optical networks are SONET (synchronous optical network) and the essentially similar SDH (synchronous digital hierarchy) networks, which form the core of the telecommunications infrastructure in North America and in Europe and Asia, respectively, as well as a variety of enterprise networks such as Fibre Channel. Second-generation optical networks have routing, switching, and intelligence in the optical layer. Before we discuss this generation of networks, we will first look at the multiplexing techniques that provide the capacity needed to realize these networks.

EDFA Design: The key feature of EDFA technology is the Erbium Doped Fiber (EDF), which is a conventional silica fiber doped with erbium. Basically, EDFA consists of a length of EDF, a pump laser, and a WDM combiner. The WDM combiner is for combining the signal and pump wavelength, so that they can propagate simultaneously through the EDF. EDFA can be designed that pump energy propagates in the same direction as the signal (forward pumping), the opposite direction to the signal (backward pumping), or both direction together. The pump energy may either by 980nm pump energy or 1480nm pump energy, or a combination of both. The most common configuration is the forward pumping configuration using 980nm pump energy. Because this configuration takes advantage of the 980nm semiconductor pump laser diodes, which feature effective cost, reliability and low power consumption. Thus providing the best overall design in regard to performance and cost trade-offs.

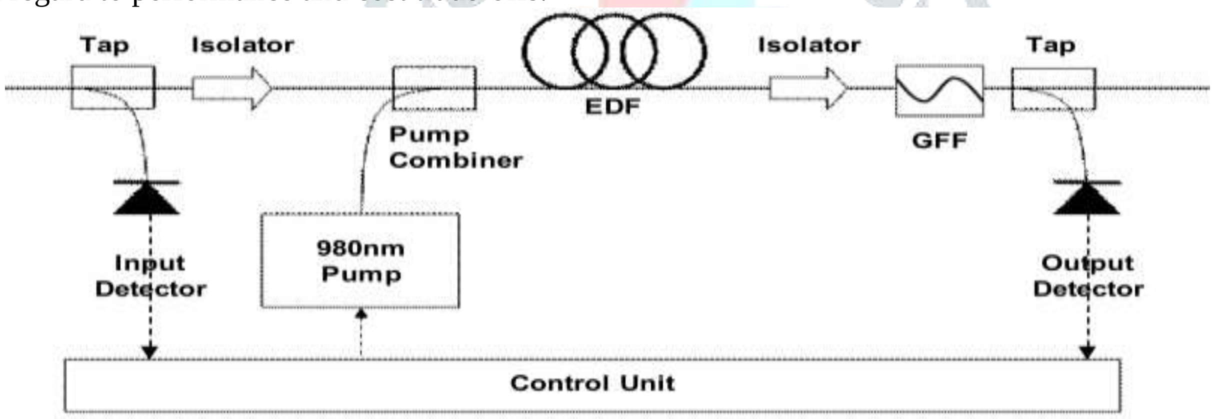

FIGURE 1.1 BASICS OF EDFA

Optical Network Design:

We design the optical network with help of WDM using the fiber optical simulation program and the Gain Master.

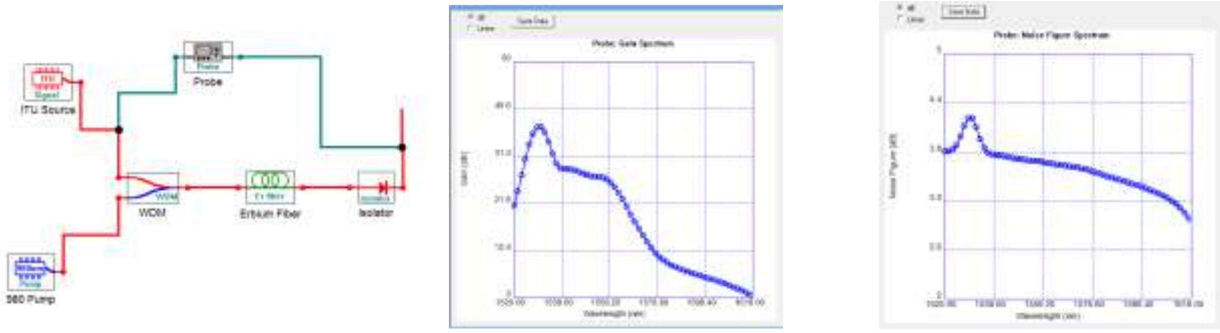

Figure:1 First Stage of optical network design. Fig:1(a) Gain Versus Wavelength Fig:1(b) Noise Versus Wavelength

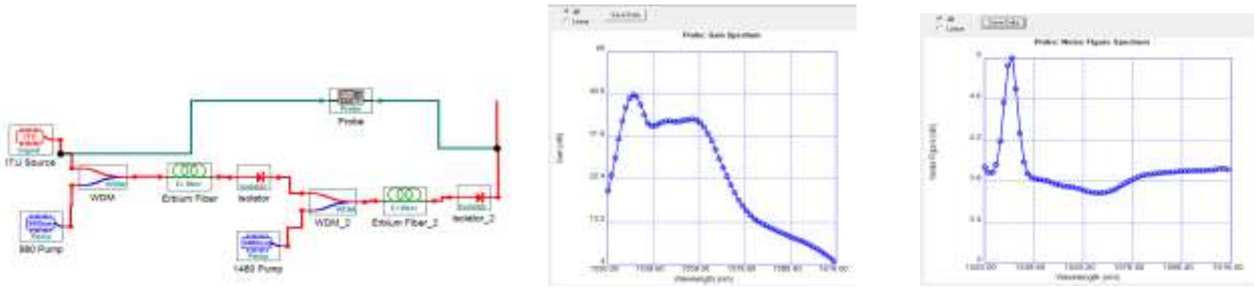

Fig:2 Second Stage of Optical Network Design Fig:2(a) Gain Versus Wavelength Fig:2(b) Noise Versus Wavelength

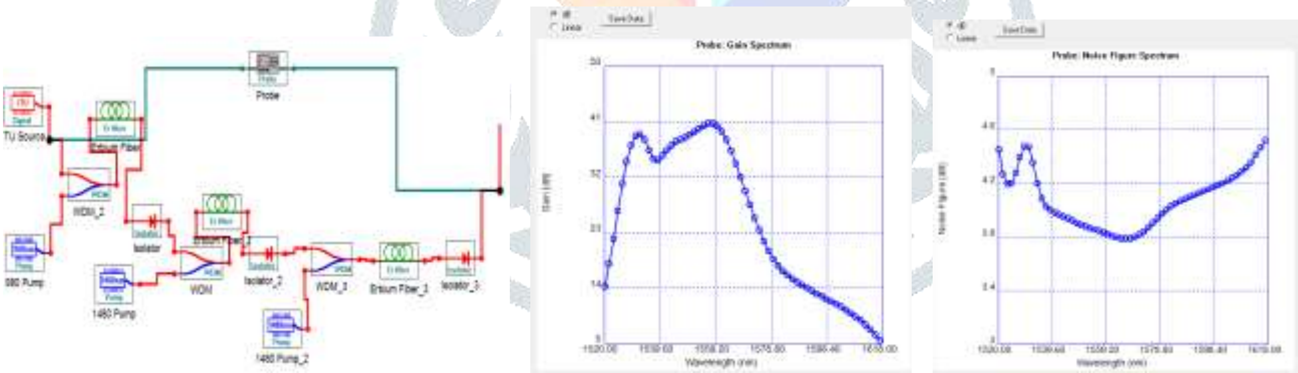

Fig:3 Third Stage of Optical Network Design Fig:3(a) Gain Versus Wavelength Fig:3(b) Noise Versus Wavelength

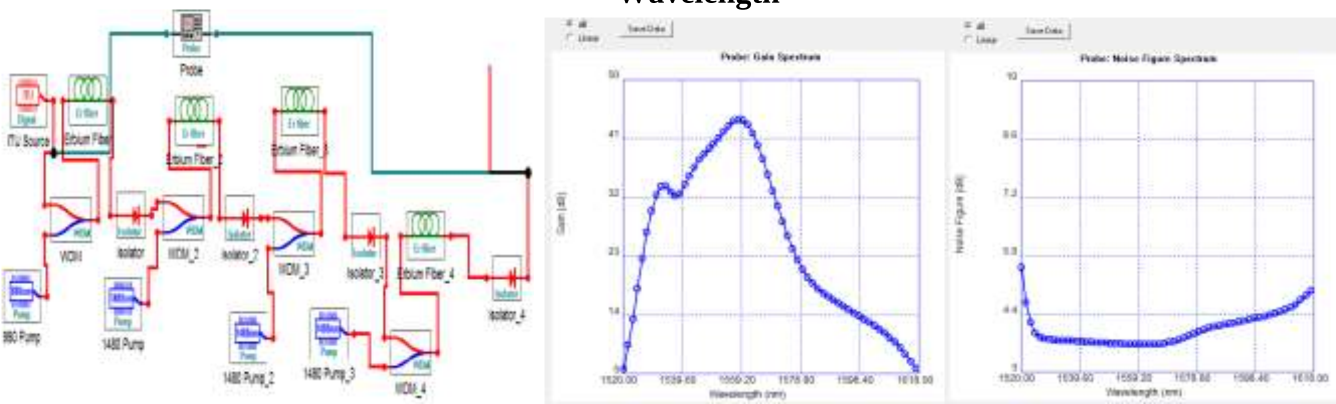

Fig:4 Forth Stage of Optical Network Design Fig:4(a) Gain Versus Wavelength Fig:4(b) Noise Versus Wavelength

The software allows for schematic representation of an optical network to be input via a graphical user interface which mimics the symbolic language often used by engineer to outline a design on paper. The program tracks the optical power through the design, integrating the differential equations to solve the propagation of signal, pump and amplified spontaneous emission (ASE) bands through all erbium fiber sections. Also, by use of the probe component, the user may make common two point measurements of interest, such as gain, noise figure, conversion efficiencies, etc. Optical parameters of any component may be changed and the simulation re-run to observe the effects on amplifier performance.

Sl. No.	Parameter	Range in dB (First Stage)	Range in dB (Second Stage)	Range in dB (Third Stage)	Range in dB (Forth Stage)
1	Average gain	27.801	32.485	34.531	35.929
2	Maximum gain	36.967	40.368	40.670	43.891
3	Minimum gain	3.487	4.670	5.389	5.710
4	Gain flatness (p-p)	33.480	35.991	35.281	38.181
5	Gain Flatness (rms)	10.586	11.750	11.973	12.092
6	Gain tilt	17.816	15.066	8.814	0.125

In the paper we have shown the variation of gain and noise with respect to the wave length for the first stage, second stage, third stage and forth stage of optical network. The range consider the 1550 nm -1620 nm. The software use is gain master of erbium doped fiber amplifier optical network upto the threshold value the gain increases after that the gain decreases with wavelength and becomes zero at the peak value of wavelength on the similar pattern the noise also 1st increases and then decreases and finally becomes zero at the peak wavelength.

The Optimum Parameter Found The Analysis Are:

Performance of the optical network

Sl. No.	Parameter	Range in (First Stage)%	Range in (Second Stage)%	Range in (Third Stage)%	Range in (Forth Stage)%
1	Power conversion efficiency	29.944	39.361	40.541	41.213
2	Quantum conversion efficiency	47.113	48.295	47.014	46.656

Conclusion:

This paper shown that the optical network is to be used for amplify the signal and basically designed an optical network to increase the level of the input signal and found that the optimum parameters for the transmission of the data. The input wavelength is taken in between 1520-1617nm. Moreover it also shown the noise spectrum of the erbium doped optical network. Wavelength division multiplexing (WDM) technique is used. It shown the results to the all stages of the optical network and the different optimum parameters of the optical networks.

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