



Radial diversification of pump and signal intensities in EDFA comprising LP₀₁ mode dispersion compensation fibers in third order nonlinear condition

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Abstract The article gives simple and reliable analytical expressions for estimating signal and pump intensity (SPI) variations with normalized radial distance (R) of an erbium-doped fiber amplifier (EDFA). We predict the aforementioned variations corresponding to both signal and pump with and without third-order nonlinearity (TON) using some dispersion compensation fibers (DCFs) in our study. The suggested formulation employs the implementation of iteration-based Chebyshev formulation for the LP₀₁ modal field of DCFs. In the absence and presence of TON, our observations align remarkably well with numerical results. The exact results were obtained using finite element method (FEM). It is worth noting that our suggested method involves very little calculation and the simplicity and correctness of our formalism will help designers in constructing an effective low-dispersion fiber optic link.

Keywords Third-order nonlinearity · EDFA · Dispersion compensation fibers · Signal and pump intensity · Chebyshev formalism

Introduction

It is important to evaluate the propagation characteristics of optical fiber under nonlinear conditions. The fiber's refractive index profile (RIP) depends on the strength of light, resulting in nonlinearity. The propagation parameters differ noticeably from those in the linear area as the brightness of input light increases and the nonlinearity impact is especially prominent as high-powered lasers are utilized as a provider of optical energy [1–3]. Lengthy optical fiber transmission with low attenuation loss and negligible dispersion can be accomplished concurrently by modifying the RIP so that waveguide dispersion cancels out material dispersion at 1.55 μm . Dispersion-shifted fibers (DSFs) are the name for these types of fibers. Another popular fiber in communication systems is called a dispersion-flattened fiber (DFF), wherein material dispersion is balanced by waveguide dispersion across a wide range of wavelengths. Because of the tremendous data-carrying capacity resulting from wavelength division multiplexing, the fibers are of major interest [4]. So, research on DCFs in the presence of TON should be given considerable attention. The performance of optical communication is influenced significantly by the factors namely attenuation and dispersion. The signal degrades significantly as a result of attenuation, necessitating strong signal amplification. The EDFA is particularly important in this context since it fully avoids the process of converting an optical signal from its optical form into an electrical signal, and back again. The EDFA has a substantially greater gain (about 40 dB to 45 dB) and significantly less noise (between 3 and 4 dB) [5, 6]. It is recommended to use signal wavelengths between 1530 and 1570 nm with a pump wavelength of 980 nm or 1480 nm since excited state absorption becomes a limiting factor in EDFA [5–8]. The strength of light beam and the

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