

**INVESTIGATION OF MICROWAVE PHOTONIC (RF-OPTICAL) OPTICAL  
AMPLIFIER**

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OPTICAL) OPTICAL AMPLIFIER  
Sesi Pengajian : 

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For my lovely father and mother

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## ABSTRACT

In the world of telecommunication, video and data transmission are purpose for the need of higher capacity and speed optical fiber communication systems are being extensively used. Nowadays, almost all the trunk lines of existing networks are using the optical fiber. Optical fiber extensively used because the usable transmission bandwidth on an optical fiber is larger (as much as 50 THz) as a result of which, it is capable of allowing the transmission of many signals over long distances. However, attenuation is the major limitation that imposed by the transmission medium for long distance with high speed optical systems and networks. In the optical communication, transmission rates now growing and highly demands in the field of communication, so it will make the electronic regeneration become more and more expensive. The optical amplifiers came into existence, which is to eliminate the costly of conversions from optical to electrical signal and vice versa. Furthermore, optical amplifier has wide gain spectrum ease of integration with other devices and low cost. This thesis is mainly concerned about the optical amplifier by using Raman amplifier (Distributed Raman Amplifier and Discrete Raman Amplifier) and Erbium doped fiber Amplifier (EDFA). The aim of investigation is to produce a working conversion from RF to optical. The performance of Raman Amplifier and EDFA were used and the performances have been compared based on the various types of configurations of optical amplifiers. Besides that, furthering investigate of the optical amplifier was done by using different parameter of RAMAN and EDFA such as fiber length, pump wavelength, pump power, signal wavelength and also signal power. Based on this investigate, the objective of this project was achieved where to find out, the best optical amplifier according to requirement.

## ABSTRAK

Dalam dunia telekomunikasi, video dan penghantaran data adalah bertujuan untuk keperluan kapasiti yang lebih tinggi dan sistem komunikasi optik gentian sedang digunakan secara meluas. Pada masa kini, hampir semua batang baris rangkaian yang sedia ada menggunakan gentian optik. Fiber optik banyak digunakan kerana penghantaran jalur lebar yang menggunakan gentian optik adalah lebih besar (sebanyak 50 THz) yang mana, ia boleh membenarkan penghantaran isyarat pada jarak yang jauh. Walau bagaimanapun, pengecilan adalah syarat utama yang dikenakan oleh medium penghantaran untuk jarak jauh dengan sistem dan rangkaian optik berkelajuan tinggi. Dalam komunikasi optik, kadar penghantaran kini berkembang dan permintaan tinggi dalam bidang komunikasi, jadi harga untuk komponen barangan elektronik menjadi lebih mahal. Penguat optik wujud untuk menghapuskan penukaran dari optik ke isyarat elektrik dan sebaliknya. Selain itu, penguat optik mempunyai keuntungan yang mudah pelbagai integrasi dengan peranti lain dan kos yang rendah. Perkara utama di dalam tesis ini ialah berkenaan dengan penguat optik yang menggunakan penguat Raman dan EDFA. Tujuan penyiasatan adalah untuk menghasilkan penukaran kerja dari RF kepada optik. Prestasi Penguat EDFA dan Raman telah digunakan dan analisis dibandingkan berdasarkan pelbagai jenis konfigurasi penguat optik. Selain itu, penyiasatan dikukuhkan dengan melakukan perubahan pada Raman dan EDFA seperti panjang gentian, panjang gelombang pam, kuasa pam, panjang gelombang isyarat dan juga isyarat kuasa. Berdasarkan penyiasatan ini, objektif projek telah tercapai di mana untuk mencari, penguat optik yang terbaik mengikut keperluan.



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## LIST OF ABBREVIATIONS

EDFA	- Erbium-Doped Fiber Amplifier
NF	- Noise Figure
OSNR	- Output Signal Noise Ratio
RFA	- Raman Fiber Amplifier
SRS	- Stimulated Raman Scattering
DRBS	- Double Rayleigh Backscattering
SM	- Single Mode
CW	- Continuous Wave
ASE	- Amplified Spontaneous Emission
OSA	- Optical Spectrum Analyzer
MUX	- Multiplexer
RA	- Raman Amplifier

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# CHAPTER I

## INTRODUCTION

### 1.1 Project Background

Optical communication has been used for long time ago and greatly used nowadays. Since then, it offers the flexibility to perform well for long-distance communication. There have several types of optical amplifier medium; such as Raman Amplifier and Erbium doped fiber amplifier (EDFA). There are two types of Raman Amplifier: Distributed Raman Amplifier and Discrete Raman Amplifier. For the Raman Amplifier, fiber length was varies from 0km to 100km, for the pump wavelength fixed to 950nm. For the EDFA, fiber length that was varies from 2m to 10m, because the optimum fiber length for EDFA is between 4 to 6m. The value of pump power was fixed at 100mW. The statistic analysis is to compare between Raman amplifier and EDFA are: gain, Noise Figure (NF), Quality, and also OSNR. Distributed Raman Amplifier is one of the best components in the design of the transmission signal to the optical (RF-optical) based on the requirement. The transmission signal that was used in this optical amplifier is microwave signal with frequency of 3G Hz.