

**AN OPTICAL WAVELENGTH MEASUREMENT TECHNIQUE
USING ERBIUM-DOPED FIBER ATTENUATION**

By

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Chairman : Associate Professor Mohamad Khazani Abdullah, Ph.D.

Faculty : Engineering

The widespread deployment of optical fiber with its attractive technologies such as dense wavelength division multiplexing (DWDM) is helping to satisfy the apparently insatiable demand for bandwidth in the telecommunication systems. However, the adoption of the technology in the optical communications systems, requires the establishment of traceable measurement facilities, which are capable of providing the information about the performance of the system. Information of particular parameter of interest, such as channel wavelength, can be obtained by either using an external or in-line or built-in wavelength determination system. Currently, there are a number of techniques including bandpass filter technique, and interferometric fringe-counting techniques have been used in the system to measure the wavelength accurately.

In this thesis, a new approach for measuring optical signal wavelength using optical fiber power loss phenomenon is introduced. In this technique a relationship between input signal at one particular wavelength and attenuated signal in optical fiber is used. A wavelength dependent attenuator made of erbium-doped fiber has been used as the main component or element to develop and be applied for the wavelength determining system. The variation of the optical power loss of erbium-doped fiber with the wavelength of an input signal is utilized for wavelength discrimination. This research demonstrates some of the methods that can be used to exploit the erbium-doped fiber for measuring optical signal wavelength accurately.

Results of the study showed that by changing parameter such as value of attenuation element, erbium-doped fiber length, ion concentration, or the erbium-doped fiber material type, or changing the attenuation element setup, the signal measurement could be as accurate as ± 2 nm and produce a wavelength range as wide as 45 nm.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**TEKNIK PENGUKURAN PANJANG GELOMBANG ISYARAT OPTIK
MENGUNAKAN PELEMAHAN GENTIAN TERDOP-ERBIUM**

Oleh

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Penggunaan fiber optik yang menawarkan teknologi menarik seperti Pemultipleksan Pembahagian Panjang Gelombang Terpadat (DWDM) secara meluas dapat membantu menyediakan keperluan lebarjalur dalam sistem telekomunikasi. Bagaimanapun, penggunaan teknologi ini di dalam sistem komunikasi optik, memerlukan penyediaan kemudahan pengukuran boleh pantau, yang berupaya untuk menyediakan maklumat mengenai prestasi sistem. Maklumat parameter yang dikaji iaitu panjang gelombang saluran, boleh diperolehi samada melalui sistem pengukuran luaran atau diukur pada laluan sistem atau sistem pengukuran di dalam sistem itu sendiri. Pada masa ini, terdapat berbagai teknik mengukur panjang gelombang yang tepat termasuklah teknik penapis lulus rendah, dan teknik pengiraan-pinggir interferometrik.

Di dalam tesis ini, satu pendekatan baru untuk mengukur panjang gelombang menggunakan fenomena kehilangan kuasa gentian optik telah diperkenalkan. Di dalam teknik ini perkaitan di antara isyarat masukan pada satu panjang gelombang tertentu dan isyarat terlemah di dalam fiber optic digunakan. Satu pelemah yang bergantung kepada panjang gelombang yang dibuat daripada gentian erbium-doped digunakan sebagai komponen atau elemen utama bagi membentuk sistem menentukan panjang gelombang ini. Perubahan kehilangan kuasa isyarat optik gentian erbium-doped terhadap panjang gelombang isyarat masukan digunakan untuk penentuan panjang gelombang. Penyelidikan yang dibuat menunjukkan beberapa kaedah bagaimana gentian erbium-doped boleh digunakan untuk pengukuran panjang gelombang isyarat optik dengan tepat.

Keputusan penyelidikan menunjukkan bahawa perubahan beberapa nilai pembolehubah elemen pelemah seperti panjang gentian erbium-doped, ketumpatan ion, atau jenis bahan erbium-doped, atau mengubahsuai litar elemen pelemah, pengukuran isyarat boleh mencapai ketepatan ± 2 nm dan menghasilkan julat panjang gelombang selebar 45 nm.

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I certify that an Examination Committee met on 29 October 2003 to conduct the final examination of Norhayati binti Affandi on her Master of Science thesis entitled “An Optical Wavelength Measurement Tehcniqe Using Erbium-Doped Fiber Attenuation” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Univerisiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that if it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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