UNIVERSITI TEKNOLOGI MARA

# MULTIWAVELENGTH SIGNAL GENERATION FROM MULTIPLE CAVITY BRILLOUIN ERBIUM FIBER LASER

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MSc

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**NUR SYAHIDA ABDUL RAHIM**

Thesis submitted in fulfilment
of the requirements for the degree of
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## AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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## ABSTRACT

This thesis focuses on the generation of multiwavelength Stoke signal from multiple cavity Brillouin erbium fiber laser (BEFL). BEFL system is one of the relatively new techniques proposed as a multiple wavelength sources to be used in various applications, especially for wavelength division multiplexing (WDM) system. However, the problems with the signals generated from BEFL are poor gain flatness, low signal-noise-ratio (SNR) and not producing enough number of channels from single laser source. The presence of nonlinear effect in single-mode fiber (SMF), mainly the stimulated Brillouin scattering (SBS) and linear effect in erbium-doped fiber (EDF) are studied since the multi-wavelength Stokes signal generated from BEFL is the result from the interaction of these two gain media. The performance of erbium-doped fiber laser (EDFL) and Brillouin fiber laser (BFL) was also investigated. The EDFL forward-pumping scheme is the most preferred choice because it gives higher conversion efficiency and lower noise performance. BFL with a recorded of 200-nm wide tuning range has been achieved across 1430 – 1630 nm wavelength range. Achieving stable operation of broad EDF gain profile in BEFL cavity (without external Brillouin-pump) has shown to be one of the fundamental requirement in achieving multiple signal generations in higher order Stokes lines over wide spectral range. Multiwavelength laser outputs were achieved using diverse cavity design of BEFL (single-, double- and triple-ring configuration). Twelve Stokes signals were obtained using the single-cavity BEFL while stable output laser comb of 50 lines was achieved by using double-cavity BEFL. A new BEFL cavity design was established from triple-cavity configuration and succeeded in generating a comb of 34 lines with channel spacing of 0.088 nm. The implement of triple cavity is expected to generate higher number of Stokes compared to double cavity BEFL. However, it only give 34 number of Stokes signal with SNR value of 20.80 dB. This result is due to the super-impose of EDFL free-running from Cavity 1 and 2 which did not significance to increase number of Stokes signal in BEFL system since the triple cavities are interdependent to one another in generating multiple Stokes. The output spectra of each cavity designs demonstrate more number of signals, large signal-noise-ratio (SNR) and flatter peak gain which has achieved the aim of this research project. Further work on the multiwavelength BEFL operation can be achieved by utilized the double-cavity BEFL from the implementation of internal self-seeded BP by feeding back the Brillouin Stokes into cavity via non-resonant direction thus integrating the nonlinear and linear gain for the development of multiwavelength BEFL.

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