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Q-SWITCHING AND MODE-LOCKING PULSE GENERATION BASED ON PASSIVE TECHNIQUES

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Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Computer Science and Mathematics

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CONFIRMATION BY PANEL OF EXAMINERS

I certify that a panel of examiners has met on 10th February 2015 to conduct the final examination of Amri Ab. Rahman on his Doctor of Philosophy thesis entitled "Q-Switching and Mode-locking Pulse Generation Based On Passive Techniques" with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examniners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

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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 institution or non-academic institution for any degree or qualification.

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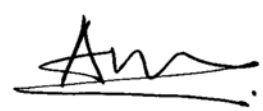
Signature	;	 .....
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ABSTRACT

The field of fiber lasers and fiber optic devices has experienced a sustained rapid growth despite witnessing the infamous 'telecom bubble burst'. All-fiber optic devices have inherent advantages of relatively low cost, compact design, light weight, low maintenance, and increased vibration tolerances. In this research, various new fiber lasers operating in Q-switching and mode-locking modes are proposed and demonstrated. At first, Q-switched Erbium-doped fiber lasers are demonstrated using a homemade passive saturable absorber (SA) based on single-walled carbon nanotubes (SWCNTs) and graphene oxide films. For instance, with the use of a SWCNTs-Polyvinyl alcohol (PVA) SA, the laser has a multi-wavelength output at 1533.5 nm region with a repetition rate of 13.1 kHz, pulse width of 7.2 μs and pulse energy of 21 nJ at the pump power of 64 mW. Two mode-locked EDFLs are also demonstrated using a homemade SA based on SWCNTs. For instance, a stable mode-locked EDFL is demonstrated using SWCNTs-PVA SA to generate a dissipative soliton pulse train operating in 1533.6 nm region. At pump power above the threshold value of 35.2 mW, the EDFL generates a self-starting pulse train with duration of 1.8 ps and repetition rate of 15.3 MHz. Besides showing good Q-switching and mode-locking performances, the proposed new saturable absorbers are easy to fabricate and cheap. Finally, we explore a new technique based on nonlinear polarization rotation (NPR) to demonstrate both Q-switched and mode-locked fiber lasers.For instance, a stable passive Q-switched EDFL operating at 1534.5 nm region is demonstrated by employing a polarization dependent isolator and a highly nonlinear Erbium-doped fiber (EDF) to induce intensity dependent loss in a sufficiently-high lossy ring cavity. A simple NPR based EDFL with three switchable operation states have also been successfully demonstrated by employing a 6.9 km long dispersion shifted fiber (DSF) in the ring cavity. It firstly generates a square dissipative soliton pulse with a repetition rate of 87 kHz.Then, the laser produces a fundamental repetition rate of 29 kHz with a fixed pulse width of 8.5 μs with the maximum pulse energy of 131.5 nJ is achieved at the pump power of 116.7 mW. Finally, the EDFL produces a fixed pulse width of 2.8 μs and harmonic pulse repetition rate of 58 kHz. Q-switched and mode-locked EDFLs have wide and important applications in many fields such as optical communications, laser micro-machining, optical sensors and laser ablation.

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