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OPTICAL FREQUENCY COMB GENERATION IN SEMICONDUCTOR LASERS USING Q-SWITCHING AND MODE LOCKING TECHNIQUES

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ABSTRACT

This work introduced a numerical simulation of Optical Frequency Comb (OFC) in semiconductor lasers, were OFC is generated and investigated for a laser with 1.55 μm wavelength using Q-switching and mode locking techniques. The study shows that OFC generated depends on the frequency of the open- close frequency of the shutter used to produce Q-switching. OFC generated depends on mode locking technique shows that the OFC properties depend on the laser cavity length.

KEYWORDS: Frequency comb, semiconductor lasers, Q-switching, mode-locking.

INTRODUCTION

Optical frequency combs have attracted more attention in the last decade. Because it became a useful tool for many applications viz., optical atomic clocks [1], comb spectroscopy [2–5], a new microwave generation [6, 7], communication such as 5G and 6G, synchronization of many optical systems [8, 9], etc., Optical frequency combs (OFCs) are coherent light of evenly spaced pulses in the spectral domain. It can be described to be a mirror reflects the field shape inside the gain curve of multi-longitudinal mode lasers. There are several way to produce OFCs in semiconductor lasers viz., modulated signal as injection current, Q-switching, mode-locking technique, external optical injection [10] and phase turbulence [11].

In this work we studied the generation of OFCs in semiconductor lasers by using Q-Switching and Mode locking techniques and investigated their dependence on the injection current, shutter open- close cycle and the laser cavity length respectively.

Theory:

The rate equation that describes semiconductor lasers dynamics can be written as [12]: