**Dissertation Defense Announcement**

**Candidate**: Md Borhan Mia

**Chair of Committee**: Dr. Sangsik Kim

**Committee Members**: Dr. Ayrton Bernussi, Dr. Jingyu Lin

**Title of Dissertation**

Silicon Photonic Subwavelength Gratings for Dense Photonic Integration and Polarization Control

**Abstract**

Silicon photonics is a promising optical chip platform based on a silicon-on-insulator

(SOI) compatible with a well-established complementary-metal-oxide-semiconductor

(CMOS) fabrication process. Taking advantage of CMOS foundry, silicon photonics

provides a low-cost solution with large-scale photonic integrated circuits (PICs), which is critical for commercialization. Similar to electronics, a higher chip integration is desired as it provides more functionality, lower cost, and lower modular power. However, increasing the chip integration density of PIC is extremely challenging due to the wave nature of photons. In recent years, subwavelength gratings (SWG) structures, which can form anisotropic metamaterials, have been proposed to shrink the chip footprint and enhance the performance of some photonic components. SWGs effectively form anisotropic metamaterials, allowing us to engineer the anisotropic properties in PICs. In this thesis, I explore the fundamentals of the SWG effect in coupled waveguides and utilize those fundamentals to enhance photonic devices’ performance. First, exceptional coupling that completely suppresses the crosstalk between closely spaced waveguides will be presented. Anisotropic dielectric perturbation, which can be tuned via SWGs, is the key to achieving such phenomena, drastically increasing the chip integration density. Second, SWGs are used for designing mode-evolution-based polarization beam splitter (PBS). Due to the reduced skin-depth via SWGs, ultra-broadband PBS is achieved with a high fabrication tolerance. Third, by engineering coupling coefficient between modes with SWG metamaterial, a broadband polarization beam splitter-rotator (PSR) via mode-evolution is presented. Large coupling coefficient of SWG reduces the mode conversion length of the proposed PSR. Additionally, a heterogeneous photonic waveguide structure is designed and analyzed to achieve extremely high group velocity dispersion (GVD). The induced GVDs are analytically represented, and engineering the coupling wavelength and dispersion peaks are also examined. For the following years, I propose to develop an SWG-based polarization rotator and splitter and analytically solve the exceptional coupling phenomenon.

**Date and Time**

**Date:** March 31, 2022

**Time:** 10 AM Central Time

**Face to Face**

**Location:** ECE 226