INTEGRATED PHOTONICS DEVICES AND CIRCUITS

PROF. BIJOY KRISHNA DAS
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IIT Madras

TYPE OF COURSE : New | Elective | UG/PG
COURSE DURATION : 12 Weeks (26-Jul' 21 - 15-Oct' 21)
EXAM DATE : 24 Oct 2021

PRE-REQUISITES : EM Fields/Engineering Electromagnetics, Fundamentals of Semiconductor Devices

INTENDED AUDIENCE : Engineering UG/PG Students and Research Scholars

INDUSTRIES APPLICABLE TO : Semiconductor Industries

COURSE OUTLINE :

Lightwave technology and photonics played an important role in the progress of long-haul fiber optic communication systems. Recent advances in CMOS compatible silicon photonics technology has made it feasible for on-chip high-speed optical interconnects, biomedical lab-on-chip sensors, microwave photonics system-on-chip, linear optical quantum computing (LOQC) and highest degree of secured quantum key distribution (QKD) photonics chips with large-scale integrated components. In this course, students will learn theory of integrated optical waveguides and working principles of various integrated photonics devices (passive and active). The design rules and technology for large-scale photonic integrated circuits will be also addressed in this course.

ABOUT INSTRUCTOR :

Bijoy Krishna Das received his Master Degree in Solid State Physics from Vidyasagar University, West Bengal, India, in 1996, and Ph.D. Degree (Dr.rer.nat) in Applied Physics from the University of Paderborn, Germany in April 2003. His first postdoctoral assignment was offered as an FRC Fellow with the Graduate School of Engineering, Osaka University, Osaka, Japan, from 2004 to 2005. He also worked for a while with the Laboratoire Aime Cotton, CNRS, Orsay, France. Since August 2006, he has been with the Department of Electrical Engineering, IIT Madras, Chennai, India, where he is currently a full Professor. His current research interest is in the area of CMOS compatible silicon photonics integrated circuit design, fabrication and testing. He has published more than one hundred research articles in various International Journals and Proceedings of International Conferences.

COURSE PLAN :

Week 1**:** Introduction to Photonic Integrated Circuits – Functional Building Blocks; Theory of Optical Waveguide – The Basic Building Block; Orthogonality Condition of Guided Modes.

Week 2**:** Introduction to Photonic Integrated Circuits – Functional Building Blocks; Theory of Optical Waveguide – The Basic Building Block; Orthogonality Condition of Guided Modes.(Contd)

Week 3**:** Design Principle of Single-Mode and Multimode Waveguides: Channel and Ridge/Rib waveguides, Waveguide Bends; Slot and Photonic Crystal Waveguides.

Week 4**:** Design Principle of Single-Mode and Multimode Waveguides: Channel and Ridge/Rib waveguides, Waveguide Bends; Slot and Photonic Crystal Waveguides.(Contd)

Week-5: Coupled Mode Theory; Waveguide Distributed Bragg Reflector (DBR) and Sub-Wavelength Grating (SWG) waveguide; Adiabatic Mode-Size Converter (MSC), Fiber-to-Waveguide Vertical Grating Coupler (VGC),

Week-6: Coupled Mode Theory; Waveguide Distributed Bragg Reflector (DBR) and Sub-Wavelength Grating (SWG) waveguide; Adiabatic Mode-Size Converter (MSC), Fiber-to-Waveguide Vertical Grating Coupler (VGC),

Week-7: Directional Coupler (DC), Multi-Mode Interferometric Coupler (MMIC). Mach-Zehnder Interferometer (MZI) and Microring Resonator (MRR): Filters and Delay Lines.

Week-8: Directional Coupler (DC), Multi-Mode Interferometric Coupler (MMIC). Mach-Zehnder Interferometer (MZI) and Microring Resonator (MRR): Filters and Delay Lines.

Week-9: Practical Planar Lightwave Circuits and CMOS Compatible Silicon Photonics Technology Platforms; Thermo-Optic and Electro-Optic Switches; Reconfigurable Filters and Tunable Delay Lines, Concept of Field Programmable Photonic Gate Array (FPPGA).

Week-10: Practical Planar Lightwave Circuits and CMOS Compatible Silicon Photonics Technology Platforms; Thermo-Optic and Electro-Optic Switches; Reconfigurable Filters and Tunable Delay Lines, Concept of Field Programmable Photonic Gate Array (FPPGA).

Week-11: Integrated Optical High-Speed Modulators: Design and Working Principle

Week-12: Integrated Optical High-Speed Modulators: Design and Working Principle