

## **Photonics Devices: Principals and Applications 0510.6610**

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1. **Guided waves in dielectric structures:** The modes of dielectric slab waveguide. Ray description and Maxwell equations analysis. Cutoff criterion, multiple layers dielectric waveguide, Inhomogeneous and leaky waves, frustrated total internal reflection.
2. **Coupling mechanisms:** Prism and diffraction grating couplers, directional couplers, coupled mode theory in coupled waveguides, super-modes.
3. **Interferometers.:** Mach-Zhender interferometer, Multi-mode interference devices, self-imaging and splitters.
4. **Microring resonators:** High index contrast waveguide, group vs. phase velocity, Frequency and time domain analysis or ring resonators, bending losses, Free spectral range Q-factor, Finesse, all-pass filter, add-drop filter, applications.
5. **Waves in periodic structures:** regular and reciprocal lattices, Bloch Theorem, distributed Bragg reflector.
6. **Coupled mode theory in periodic structures:** Perturbation theory, DBR band diagram, passband and bandgaps, phase and group velocity near the bandgap.
7. **Bloch waves in 1D and 2D structures:** Band diagrams, Brillouin zone, modes in different bands, Photonics crystals, defects in photonic crystals, defect modes.
8. **Waves in anisotropic media:** Tenzorial description of the dielectric susceptibility, dispersion relations in anisotropic crystals, the index ellipsoid, bi and uni-axial crystals, the electro-optic effect.
9. **Nonlinear devices:** Electro-optic modulators, high-frequency modulators, optical switches, optical activity and the Faraday effect, optical isolators and circulators.

### **Course format:**

The course will be given in an active learning (“inversed class”) format. Before each class the students should watch a set of short videos covering the topics to be discussed in class. The class (1 hour) would include a short quiz (15 minutes) and an in-depth discussion of specific topics from the short videos.

**Grading:** Final exam 50%; Home assignments 40%; In-class mandatory quizzes 10% (best 6 out of 12)

**Home assignments:** 2 “large” home exercises during the semester to be submitted individually

**In-Class quizzes:** An on-line based quiz (multiple choices) on the topics covered by th short videos.

**References:**

T. Tamir Ed., “Integrated optics”, Springer1975

A. Yariv & P. Yeh, “Photonics” 6th ed., Oxford University Press 2006  
Selected papers.