

## **EC770: Guided-Wave Optoelectronics**

with Advanced Engineering Electromagnetics

Instructor: Prof. Abdoulaye Ndao

Spring 2021 - Course Syllabus

### **1. Fundamentals**

- 1.1. Maxwell's equations and time-harmonic fields, boundary conditions, power and energy flow, conservation principles in electrodynamics
- 1.2. Electromagnetic response of materials: polarization models in engineering
- 1.3. Wave equations and their solutions in different reference systems
- 1.4. Radiation and potentials, electric and magnetic radiation
- 1.5. Electromagnetic theorems and principles
- 1.6. Green's functions

### **2. Guided-wave structures**

- 2.1. Rigorous vector formulation of the problem
- 2.2. Rectangular and cylindrical waveguides
- 2.3. Multi-layered waveguides
- 2.4. Active waveguides: gain and absorption
- 2.5. Plasmonic waveguides
- 2.6. Dielectric slot waveguides
- 2.7. Numerical methods: Lumerical
- 2.8. Matlab programming examples

### **3. Coupled-mode theory**

- 3.1. General formulation of photonic coupling
- 3.2. Theory of waveguide coupling
- 3.3. Photonic tight-binding and waveguide coupling
- 3.4. Resonant cavities and coupling
- 3.5. Micro-disks and micro-rings coupled arrays
- 3.6. Waveguide couplers and modulators

3.7. Diffraction gratings and Grating couplers

#### **4. Nano fabrications of optical waveguides**

4.1 Ridge waveguide, Strip loaded waveguide, Rib waveguide

4.2 Titanium diffused waveguide

4.3 Annealed proton-exchanged waveguide

#### **5. Novel concepts in photonics**

5.1. Exceptional Point and PT symmetry

5.2. Stimulated Raman adiabatic passage (STIRAP)

5.3. Emerging device applications

#### **Textbook**

Theory and computation of electromagnetic fields, by Jian-Ming Jin, (J. Wiley-EEE Press, 2nd Ed., 2015) and Electromagnetic waves and antennas, by S.J. Orfanidis (freely available for download in pdf). Notes from the instructor will be distributed.

#### **Other references**

Advanced Engineering Electromagnetics, by Constantine A. Balanis (John Wiley, 2nd Ed. 2012)  
Quick Finite Elements for Electromagnetic Waves, by G. Pelosi et al. (Artech House, 2nd Ed. 2009)  
The Finite Element Method: Theory, Implementation, and Applications, by Mats G. Larson and Fredrik Bengzon (Springer-Verlag 2013)  
The essence of dielectric waveguides, by C. Yeh, F. I. Shimabukuro, (Springer, 2008)  
Photonic Devices, by Jia-Ming Liu (Cambridge University Press, 2005)