PHYS5320 Photonics: Materials and Devices

Lecturer: Wang, Jianfang (王建方)
jfwang@phy.cuhk.edu.hk
Room G9, Science Center North Block

Tutor: Li, Nannan (李楠楠)
nnli@phy.cuhk.edu.hk
Tel: 5448 3704
Consultation time: Tu 11:30 am – 1:15 pm
Room LG220, Run Run Shaw Science Building
(Please enter Room LG220 and reach the hallway close to the windows on the other side, where Mr. Nannan Li sits.)
PHYS5320 Photonics: Materials and Devices

**Time & Location:**
- Mon, 4:30 pm – 6:15 pm, SC_L2
- Wed, 4:30 pm – 6:15 pm, SC_L5

**Score weight**
- Homeworks: 10×, 15%
- Exams: 3×, equally weighted, 85%

Course information (contents, homework, and lecture slides) is available at:
http://www.phy.cuhk.edu.hk/~jfwang/
Why do we want to study OPTICS and PHOTONICS?

We rely on OPTICS and PHOTONICS every day.
Some key advanced technologies based on OPTICS and PHOTONICS
lasers

light-emitting diodes

laser surgery

laser surgery
Photonic chip – *Photonic integrated circuit*
https://www.submarinecablemap.com/
How do the optical fibers look like?

How are signals transmitted through optical fibers?
Light sources (**LEDs** and **LDs**) are needed!
Electronic signals have to be somehow converted into optical signals (modulators).

Photodetectors are needed to convert optical signals back into electronic signals.
WLAN (Wireless Local Area Network): does not require costly wiring. Easier, cheaper, and faster to set up.

WLAN operates using radio frequency (RF) technology (2.4, 3.6, 4.9, 5.0 (~60 mm) and 5.9 GHz). A key device is known as an access point (AP). It is usually connected to a wired network. It sends out wireless signals. Computers and cellular phones are equipped with wireless network adapters, which receive wireless signals.
Course Contents

Nature of light
Waves
Photons

Dielectric waveguides and optical fibers
Refractive index
Snell’s law and total internal reflection
Slab waveguides
Step index fibers
Dispersion in single mode fibers
Bit-rate, dispersion, electrical, and optical bandwidth
Graded index optical fibers
Attenuation in optical fibers

Semiconductor physics
Crystal structures of solids
Semiconductor concepts
Charge carriers in semiconductors
Carrier transport

Light emitting diodes
PN junction principles
Forward and reverse applied bias
Light emitting diodes

Lasers
Stimulated emission and photon amplification
Laser gain
Population inversion
Threshold gain coefficient
Laser resonators
Beam irradiation and divergence
Examples of important laser systems
Examples of applications

Photodetectors
Photoconductor
PN Photodiode
PIN photodiode
Avalanche photodiode
Phototransistors
Course Contents – Continued

### Photovoltaic cells
- Solar energy spectrum
- Photovoltaic cell principles
- PN junction photovoltaic I-V characteristics
- Heterojunction photovoltaic cells
- Materials for photovoltaic cells and efficiencies

### Polarization and modulation of light
- Polarization
- Birefringence
- Birefringent optical devices
- Electro-optic effects
- Acousto-optic effects
- Magneto-optic effects

Some groups (Daniel H. C. Ong, Dajun Wang, Sen Yang and my group) are carrying out research on or using optics and photonics. You can try to visit their groups to have a look at various optical components.
References


Highly Recommended Preliminary Knowledge

1. Electromagnetism
2. Introduction to solid state physics
Some Notes

1. **Tutoring** classes will be used for lecturing.

2. **State-of-the-art related research works** will be selectively introduced briefly.

3. Welcome to **ask questions** about the course in the classes, by email, or stopping at my office.

4. **Homeworks**: Answers will be provided. The questions will be incorporated in the exams.

5. The **final grades** are based on the overall scores.

6. Please try to **attend the exams**. If someone misses one exam, no points will be given for that exam.

7. Why are there **3 exams** and homeworks?
2018 – 2019 second term

Teaching period: 07 Jan 2019 (Mon) – 18 Apr 2019 (Thu)

Class make-up: 23 Apr 2019 (Tue) & 24 Apr 2019 (Wed)

Exam period: 25 Apr 2019 (Thu) – 11 May 2019 (Sat)

Holidays: 04 Feb 2019 (Mon) – 09 Feb 2019 (Sun), Lunar New Year
05 Apr 2019 (Fri), Ching Ming Festival
19 Apr 2019 (Fri) – 22 Apr 2019 (Mon), Easter

Approximate exam dates: First, 11 Feb 2019 (Mon)
Second, 25 Mar 2019 (Mon)
Third, 29 Apr 2019 (Mon)