1. Annotation

Course Description

This course is aimed for the first year master students, and provides an overview of the main physical principles of photonics and photonic devices. The emphasis is made on the demonstration that the light matter interaction in photonic devices can be modified by means of the modern technology. The course give the illustration how the basic physical laws help to get qualitative understanding of different branches of photonics such as light emission, transmission and detection. This introductory course is designed for both theoreticians and experimentalists.

Course Prerequisites / Recommendations

The students should pass the basic physics, solid state physics and electrodynamics courses.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Summary of Topic</th>
<th>Lectures (# of hours)</th>
<th>Seminars (# of hours)</th>
<th>Labs (# of hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optics of Dielectric Layered Media, Photonic Crystals.</td>
<td>Waveguides, Planar Dielectric Waveguides, Two-Dimensional Waveguides, Photonic-Crystal Waveguides, Optical Coupling in Waveguides, Optical Fibers, Guided Rays, Guided Waves, Attenuation and Dispersion.</td>
<td>12</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Optical Resonators</td>
<td>Optics of resonators, Planar-Mirror Resonators, Spherical-Mirror resonators, Two- and Three-Dimensional Resonators, Microresonators.</td>
<td>6</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Light and semiconductors</td>
<td>Optics of semiconductors, Light matter coupling in semiconductors, Light-Emitting Diodes, Semiconductor Optical Amplifiers, Laser Diodes, Quantum-Confined and Microcavity Lasers, Semiconductor photon detectors, Vacuum Photodetectors, Photoconductors, Photodiodes, Avalanche Photodiodes, Noise in Photodetectors.</td>
<td>12</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Final Project</td>
<td>Presentation of the projects</td>
<td>0</td>
<td>9</td>
<td>0</td>
</tr>
</tbody>
</table>

### 3. Assignments

<table>
<thead>
<tr>
<th>Assignment Type</th>
<th>Assignment Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>Problems to be solved can be found on Canvas</td>
</tr>
<tr>
<td>Team Project</td>
<td>Selection of the project topics during the course.</td>
</tr>
</tbody>
</table>

### 4. Grading

| Type of Assessment | Graded       |
## Grade Structure

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Activity weight, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework Assignments</td>
<td>30</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>30</td>
</tr>
<tr>
<td>Final Project</td>
<td>40</td>
</tr>
</tbody>
</table>

## Grading Scale

- A: 86
- B: 75
- C: 60
- D: 56
- E: 46
- F: 0

## Attendance Requirements

Mandatory with Exceptions

## 5. Basic Information

### Course Stream

Science, Technology and Engineering (STE)

### Course Term (in context of Academic Year)

Term 2

### Course Delivery Frequency

Every year

### Students of Which Programs do You Recommend to Consider this Course as an Elective?

<table>
<thead>
<tr>
<th>Masters Programs</th>
<th>PhD Programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Systems</td>
<td></td>
</tr>
<tr>
<td>Materials Science</td>
<td></td>
</tr>
<tr>
<td>Photonics and Quantum Materials</td>
<td></td>
</tr>
</tbody>
</table>

### Course Tags

Physics

## 6. Textbooks and Internet Resources
### Required Textbooks

<table>
<thead>
<tr>
<th>Required Textbooks</th>
<th>ISBN-13 (or ISBN-10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahaa E. A. Saleh, Malvin Carl Teich</td>
<td></td>
</tr>
<tr>
<td>1200 pages April 2007</td>
<td></td>
</tr>
</tbody>
</table>

### 7. Facilities

### Software

- Matlab

### 8. Learning Outcomes

#### Knowledge

Basic understanding of the main physical concepts of photonics. Light emission, transmission and absorption devices. (see course description for details)

#### Skill

Modelling of the light propagation in layered structure based on the transfer matrix formalism.

#### Experience

Working with scientific literature; problem solving; programming; presentation of results; scientific discussions;

### 9. Assessment Criteria

**Input or Upload Example(s) of Assignment 1:**

- **Select Assignment 1 Type**
  - Problem Set

- **Input Example(s) of Assignment 1 (preferable)**
A 1-mW He–Ne laser produces a Gaussian beam at a wavelength of 633 nm with a beam waist diameter 0.1 mm.

(a) Determine the angular divergence of the beam, its depth of focus ($z_0$), and its diameter at 350 000 km (approximately the distance to the moon).

(b) What is the radius of curvature of the wavefront at $z = 0$, $z = z_0$, and $z = 2z_0$?

(c) What is the optical intensity (in W/cm²) at the beam center ($z = 0$) and at the axial point $z_0$?

Compare this with the intensity at $z = z_0$ of a 100 W spherical wave produced by a small isotropically emitting light source located at $z = 0$. 

Assessment Criteria for Assignment 1

It is important to try to solve all the problems and in case of difficulties contact the Instructor.

Presentations and discussions during the seminars are also counted.

Input or Upload Example(s) of Assignment 2:

Select Assignment 2 Type

Other

Input Example(s) of Assignment 2 (preferable)

Mid Term Exam: Set of 3 problems will be given for 3 hours written exam.

Example:

When thin transparent dielectric layer is surrounded by two media with smaller refractive indexes the waveguide mode can be formed for frequencies above so-called cut-off frequency. Find the cut-off frequency of plain slab waveguide (200 nm thickness, refractive index $n_w$) on the substrate with refractive index $n_s$ ($1 < n_s < n_w$). How does it depend on light polarisation?

Assessment Criteria for Assignment 2

Correct solution of all problems gives 30 points

Input or Upload Example(s) of Assignment 3:

Select Assignment 3 Type

Other

Input Example(s) of Assignment 3 (preferable)

Final Project.

Presentation on the selected topic.

Assessment Criteria for Assignment 3

up to 40 points depending on scientific quality of the material and demonstrated presentation skills

Input or Upload Example(s) of Assignment 4:

Input or Upload Example(s) of Assignment 5:
10. Additional Notes