

## Lecture Outline 課程大綱

(Minor reasonable changes may apply without prior notice. 有可能出現不事先通知的小幅度且合理的變更。)

Last updated: Dec. 25 2023

### Optoelectronics 光電子學 (PME5443)

Cheng-Yao Lo 羅丞曜

Lectured in English 英語授課

#### Schedule 時間

T2T3T4 每週二 2, 3, 4

#### Place 地點

E1-216 工程一館 216

#### TA 助教

Mr. Pancham, #80128, pancham.eic06g@gapp.nthu.edu.tw

#### Description 課程目標

The goal of this course is to provide the background knowledge for understanding the working principles of various optoelectronic devices, as well as their applications. Starting from the fundamentals such as wave properties of light, solid state physics and polarization, followed by optoelectronics devices, including light emitting, detection, modulation and transmission devices, students may expect to gain sufficient concepts of optoelectronics for their own studies.

本課程目標為提供修課同學各種光電元件及應用的基礎知識及工作原理。課程將包含光的波動特性、固態物理、極化及光電元件(如發光二極體、光調變器及傳輸元件)等。學生經由學習本課程可以取得足夠的基礎光電知識以支援其研究。

#### Keyword 關鍵字

Modulation, optoelectronics, photonics, semiconductor, waveguide

半導體、光子學、光電子學、波導、調變

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##### I: Wave Nature of Light 光的波動特性

Electromagnetic wave, spectrum of light; refractive index, velocity, irradiance; refraction and Snell's law, total internal reflection, Fresnel's equation, and optical tunneling; temporal and spatial coherence; polarization; principle of superposition, interference, optical resonators; diffraction, gratings.

包含電磁波、光譜、折射率、波速、照度、折射與斯乃爾定律、全反射、弗奈爾公式、時間與空間同調、極化、干涉、共振、繞射及光柵。

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### 2: Fundamentals of Solid Physics 固態物理

Fundamentals of quantum mechanical concepts; energy band in solid, direct and indirect bandgap; semiconductors; work function; pn junction and band diagram.

包含量子力學、能階、半導體、功函數、pn界面等。

### 3: Modulation of Light 光的調變

Optical anisotropy, birefringent optical devices; optical activity; electro-optic effect, Pockels effect, Kerr effect, integrated optical modulators; magneto-optic devices; and acousto-optic effect.

包含雙折射、光學元件、光電效應、波克效應、克爾效應、積體光學、磁光元件、聲光效應等。

### 4: Light Emitting Devices 發光元件

Principles of light emitting diodes (LED), LED materials, heterojunction high intensity LEDs, LED characteristics; stimulated emission and photon amplification, laser oscillation condition; principles of laser diodes, heterostructure laser diodes, and vertical cavity surface emitting lasers.

包含原理、材料、異質界面、放大效應、雷射共振、光二極體、雷射二極體等。

### 5: Photodetectors and Photovoltaic Devices 光偵測器及太陽能元件

pn junction photodiode, photodiode materials, quantum efficiency and responsivity, pin photodiode, avalanche photodiode, heterojunction photodiodes; photovoltaic device principle, I-V characteristics, solar cells material, devices and efficiencies.

包含光二極體、材料、量子效率、累增崩潰、太陽能電池、電流電壓特性、轉換效率等。

### 6: Optical Fibers and Waveguide 光纖與波導

Waveguide condition, mode of propagation, modal and waveguide dispersion in planar waveguide, numerical aperture, single mode fiber; bit rate and bandwidth; graded index optical fiber; light absorption and scattering in optical fiber.

包含傳播模態、色散、數值孔徑、單模態光纖、頻寬、吸收及散射等。

### Schedule 課程進度

Week 1 – Wave and EM Optics (Chap. 1)

Week 2 – Wave and EM Optics (Chap. 1)

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Week 3 – Wave and EM Optics (Chap. 1)

Week 4 – **Project 1 (Simulation for color filter, 30%)**

Week 5 – Semiconductor Optics (Chap. 3A)

Week 6 – Semiconductor Optics (Chap. 3A)

Week 7 – Semiconductor Optics (Chap. 3A)

Week 8 – **Mid-term Examination (20%)**

(Week 9 – Discussion (Project 1 and examination))

Week 10 – Fiber Optics and Waveguide (Chap. 2)

Week 11 – Light Emitting Diode (Chap. 3B)

Week 12 – Laser (Chap. 4)

Week 13 – Polarization and Modulation of Light (Chap. 6)

Week 14 – **Project 2 (Simulation for polarizer, 20%)**

Week 15 – Polarization and Modulation of Light (Chap. 6)

Week 16 – Photodetector (Chap. 5)

Week 17 – **Final Examination or project 3 (30%)**

(Week 18 – Discussion (Project 2 and examination))

### Evaluation 評分標準

Project 1 (專案一): 30%

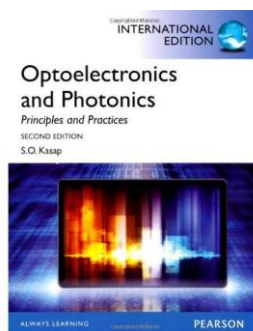
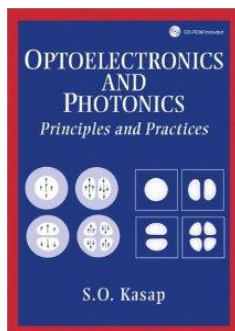
Mid-term exam. (期中考): 20%

Project 2 (專案二): 20%

Final exam., or final report, or project 3 (期末考或期末報告或專案三): 30%

### Reference 參考資料

1. Optoelectronics and Photonics (S. O. Kasap, 2001), ISBN: 978-0321190468
2. Optoelectronics and Photonics (S. O. Kasap, 2013), ISBN: 978-0273774174
3. Fundamentals of Semiconductor Devices (B. L. Anderson and R. L. Anderson, 2005), ISBN: 978-0071241526



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### Note      其他

In order to encourage the attendance, **DO NOT record/copy** any part of the lecture by electronic devices. However, welcome to write personal notes during lectures.

為鼓勵出席，課程內容**禁止以任何電子手法記錄**(錄影、錄音等，個人書面筆記不在此限)。