**COURSE SYLLABUS**

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| **Course Title**：Electro-optical Semiconductor Materials | | | | |
| **Credits / Hours** | 3/3 | **Course Number** |  | **□Required ■Elective** |
| **Course Description**  This course outlines basic materials, fundamental physics, current applications, and developing technologies of elemental and compound semiconductors for optoelectronic and semiconductor fields. Based on the knowledge of quantum and solid state physics, the theories including energy band gap, wave function, and crystal structure are firstly mentioned. Different kinds of materials for optoelectronic and semiconductor devices are secondly introduced. The industrial products such as LED, photodiode, solar cell, laser and other optoelectronic devices are then explained in detail. The topics also include the material properties, preparation, and processing of these materials.  Textbook: (No textbooks required. Some for your reference.)  1. Optoelectronics and Photonics: Principles and Practices, 2/e (Hardcover), S. O. Kasap, ISBN:  0273774174, Prentice Hall, Pearson  2. Electronic and Optical Properties of Semiconductor Structures, Jasprit Singh, Cambridge University Press  3. Handout edited by Professors | | | | |
| **Course Topics** | | | | |
| **Topic** | | **Content** | | |
| Introduction | | What are those optoelectronic and semiconductor materials? | | |
| Review of basic semiconductor physics: Elemental and compound semiconductors | | Material properties, crystal structure, semiconductor band structures, density of states, Fermi levels and carrier statistics, doping, Shockley equations, band diagrams. | | |
| Semiconductor heterojunction structure | | Band offset, p-n heterojunction diodes, n-n and p-p heterojunctions, semiconductor quantum wells, electron and hole energy bands. | | |
| Light-matter interaction | | Optical transitions in bulk semiconductors, stimulated absorption and emission, loss, gain, spontaneous emission of photons, spontaneous emission into electromagnetic cavity mode. | | |
| Semiconductor photodetectors | | Shockley equations for photodetectors, PN junction photodetectors, PIN detectors, performance figures of merit, avalanche photodetectors, solar cells, fundamental limitations on solar energy conversion. | | |
| Semiconductor light emitting diodes (LEDs) | | Radiative and non-radiative recombination mechanisms in semiconductors, LED figures of merit, survey of visible LEDs, solid state lighting. | | |
| Integrated optical waveguides | | Dielectric slab waveguides, 2D dielectric waveguides, scalar solutions for propagating modes, perturbation theory, power and energy in dielectric waveguides. | | |
| Semiconductor lasers | | Integrated laser cavities, carrier and photon density rate equations, laser dynamics, relaxation oscillations, direct current modulation and modulation bandwidth, current-voltage characteristics of lasers. | | |
| Plasmonics | | Bulk and surface plasmons in metals, confined plasmon modes in metal particles, semiconductor plasmon lasers. | | |