PHY 649A: Photonic Green Nanotechnology

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Credits: 9 ; Prequisite: PHY103

Note: The course is offered primarily as a PG elective, and as an elective to senior undergraduates

Course Description:
The term "*green*", in our context, is used to denote those processes and applications that are environmentally benign and sustainable. Our present energy intensive manners of building and powering our lives have damaged eco-systems and is even threatening the future of life on earth due to climate change and global warming. The solutions to energy problems lie in both technology and human behaviour. This course addresses the immense possibilities that arise from nanoscience and nanotechnology to counter the "*green*" challenge. Indeed, it turns out any solutions will involve manufacture and implementation on immensely large areas or volumes, which in turn, present their own challenges for nano-manufacturing technologies.

This course will focus on optical and photonic nanotechnologies: from nanomaterial solar collectors and photovoltaic devices, daylight illumination systems, thin films and coatings for smart windows, nano-paints and materials for thermal insulation and sky-cooling or passive roof-cooling systems. Other issues like challenges of managing terawatt photovoltaic systems and nanomaterials for scrubbing pollutants from air by photocatalysis etc. will also be discussed. Issues of nano-manufacturing created by the demands for these applications will be kept in focus through out.

Topics to be covered [*Tentative no. of lectures*]
- Introduction to photonics, nanotechnology and "Green" processes [4]
- Issues of natural energy flows, energy management and carbon emissions [4]
- Interaction of radiation with materials [5]
- Basic properties of photonic nanomaterials materials [5]
- Photo-voltaic systems, solar cells and solar collectors [8]
- Nanotechnology for indoor lighting, electric lighting, daylight lighting and smart windows [5]
- Photonic Cooling technologies: high reflectivity surfaces, sky-cooling and rooftop cooling [5]
- Photonic Nanomaterials for Air quality sensing and cleaning scrubbers [4]

Submission of one term paper by each student on the review of some modern literature on green nanotechnologies will be required. Plagiarism in the term-paper will be punishable with a **F** grade in the course.

Books and references:

1. G.B. Smith and C.G. Granqvist, "*Green nanotechnology" Solutions for sustainability and energy in the built environment*", (CRC Press, Boca Raton, 2011)
2. Shien-Kuei Liaw and Gong-Ru Lin, "Green Photonics and Smart Photonics" (River Publishers Series in Optics and Photonics, Taiwan, 2016)
3. Frederic Quan, "Green Photonics: A Review article", Journal of Optics (IoP, UK), **14** (2), 024001 (2012) and reference therein.

Other resources will be review papers and commentaries in journals

Evaluation:
Mid-semester exam: 30%
End semester exam: 40%
Term paper: 30%