ECE 632
PHOTOVOLTAIC ENERGY CONVERSION
Spring 2018

INSTRUCTOR: Prof. Siva Sivoththaman

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LECTURE: [redacted]

LOCATION: [redacted]

COURSE DESCRIPTION: This course is intended for engineering graduates and educates them on the fundamental concepts semiconductor and device technologies for photovoltaics (PV), device design and fabrication processes, PV modules and system electronics, engineering applications, and future directions in PV.

COURSE OUTLINE:

Introduction

Photons and Solar Radiation
Review of properties of light and photons; physical source of solar radiation; direct and diffuse radiations; radiation standards for photovoltaic performance evaluation.

Review of Semiconductor Properties for PV
Review of electronic materials; dynamics of electrons and holes; photon absorption; photo-generated carriers; generation and recombination processes; fabrication technologies of bulk semiconductors; thin-film semiconductor deposition for PV; techniques for material evaluation.

Review of Semiconductor Device Basics
PN junctions, band-diagrams, light interaction, carrier-transport mechanisms in homo- and hetero- junctions, current-voltage characteristics.

Photovoltaic Device Operation
Operating principles of photovoltaic devices; energy conversion efficiency; spectral response; equivalent circuits; illuminated and dark I-V characteristics; device simulation and performance evaluation.

Efficiency Limits and Losses in Photovoltaic Devices

Short circuit current-, open circuit voltage-, and fill factor- losses; temperature effects; theoretical efficiency limits; advanced concepts to overcome efficiency limits.

Photovoltaic Device Fabrication Technologies
Baseline technologies for PV device fabrication; silicon-based, thin-film, and compound semiconductor devices; surface passivation; optical confinement; high-low junctions; industrial processes; spectrally-engineered devices; emerging technologies for advanced PV devices.

Photovoltaic Modules
Fabrication of PV modules, design, interconnection, I-V characteristics, temperature effects, mis-match effects.

Power Conditioning for Photovoltaics
System components, maximum power-point tracking, blocking diodes, inverters circuits, storage, battery types.

Applications and Economics of Photovoltaics
Stand-alone and grid-interactive PV systems; Building-integrated PV, cost-analysis, time-value.

Text: There is no official textbook for this course since it touches upon a variety of topics. A comprehensive set of Lecture Notes will be provided.

Recently published review papers in relevant topics provide a good reading. There are also textbooks that may be used as reference; e.g., S.R.Wenham, M.A.Green, M.E.Watt, and R. Corkish, "Applied Photovoltaics 2nd Edition, UNSW, ISBN(073342175X).

Expected Background: Familiarity with semiconductor materials and/or electronic devices. Discuss your background with the instructor.
(send email to instructor for permission number to register for the course)

Marking Scheme: Final Exam: 60%, Projects, design exercises: 40%