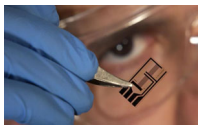
The University of Iowa

optical science OSTC technology center

**The University of Iowa Microfabrication Facility**

# Hands-on Course in Nanotechnology (Spring 2015)

**(includes Field-trip to Argonne National Laboratory)**



## Course Title:
## Fundamentals of Micro and Nanofabrication
## Course code: 029:135 (PHYS: 3750), 3 s. h.

**(Lecture Tue. &Thu., 12:30-1:20 pm, Labs every two weeks, starting Jan. 26)**

- **Learn how to make devices or structures that are about 1000 times smaller than the size of human hair.**
- **Learn how devices such as Iphones, computers processors, various electronic gadgets, sensors, bio-medical devices, DNA chips are fabricated using state-of-the-art tools and techniques.**
- **Go on a field trip to the Argonne National Lab to see some real-world nanotechnology applications and nano-scale manufacturing.**

***Enrollment in this course only requires that you have taken an undergraduate lab course in Chemistry or Biology or Physics or Engineering. Limited enrollment.***

**What is the course about?**

This undergraduate/graduate multidisciplinary course offered by the Department of Physics and Astronomy and the Optical Science and Technology Center is available in the Spring of 2015. Students from various disciplines were previously enrolled in this course. The topics of the course deal with the fundamentals of micro- and nano-fabrication techniques involved in the manufacture of a wide range miniature devices with applications in areas as diverse as computing, communications, energy, medicine, genomics and bio-medical. The course involves a series of laboratory experiments where students acquire hands-on experience on state-of-the-art tools in the new cleanroom in the University of Iowa Microfabrication Facility (UIMF), in the Optical Science and Technology Center (OSTC).

**Course description:**

*An introduction to the fundamentals of micro- and nano-fabrication processes. The physical principles of photo and electron beam lithography, alternative nano-lithography techniques, thin film deposition, molecular beam epitaxy, atomic layer deposition, self-assembly. Metrology methods. Physical and chemical processes of wet and plasma etching. Cleanroom science, operations and safety protocols. Sequential micro- and nano-fabrication processes involved in the manufacture of semiconductor, photonic and nano-scale devices. Imaging and characterization of micro- and nano-structures. Scientific and technological applications of emerging micro- and nano-devices and systems*.

**Key Course Modules and hands-on Labs:** Lithography, NanoImprint, Atomic Layer Deposition**,** Electron Beam metal deposition and dielectric sputterer, Reactive Ion Etching, Scanning Electron Microscope, 3D Optical Profiler and Ellipsometry.

## Field trip to the Argonne National Laboratory

A **free** field trip to the Center for Nanoscale Materials, Argonne National Laboratory has been arranged for the students enrolled in this course.

## Why is this course important?

The field of Micro- and Nano-fabrication is the meeting ground of engineering, biology, physics, medicine and chemistry. Most of these disciplines converge at the nano-scale towards the same building blocks, principles, tools of investigation and fabrication. This emerging field is already impacting many areas of nanotechnology by generating new products and enabling technologies that will enhance our lives on many levels. It is estimated that about 2 million workers in this field will be required by the year 2020 [1, 2], with over half of the workers required in North America alone. Some experts have characterized the field of Nanotechnology to be in the process of giving birth to the second industrial revolution [3]. The overarching benefit of this course is to address the potential shortage of these skills by equipping students with the key fundamentals and hands-on skills in the area of micro- and nano-fabrication. The course also encourages interdisciplinary learning since disciplines such as chemistry, physics, biology, materials science and engineering are central to the study, experimentation and further development of nanotechnologies [4]. It is a fact that students work with computers and high-tech devices but probably, most of them have remote ideas about the micro- and nano-technologies used to fabricate them. They are comfortable with the concept of moving information around electronically but the idea of literally creating and moving 'nano-size' features to build devices is still remote to them. This course offers a general approach to nanotechnology, micro- and nano-fabrication with the objectives of (a) providing a solid theoretical, hands-on and broad information base on which students can build upon, and (2) creating a versatile nanotechnology workforce that can move from industry to industry [5].

## References


[1] "UI facility studies small structures, supports big projects" http://now.uiowa.edu/2014/01/ui-facility-studies-small-structures-supports-big-projects.

[2] S. J. Fonash, "Nanotechnology and economic resiliency", Nano Today, 4, 290-291 2009.

[3] M. Rocco, "The long view of nanotechnology development: The national nanotechnology initiative at 10 years", Journal of Nanoparticle Research, 13, 427-445 2011.

[4] R. Cingolani, "The road ahead", Nature Nanotechnology, Vol. 8, No.11, pp 792-793 2013

[5] A. S. Jugessur, "Canada's 'Nano' Technologists", IEEE Gold Rush Newsletter, 16, Issue June 2011.


## Contacts:


**Aju Jugessur Ph.D**.
Director, University of Iowa Microfabrication Facility (UIMF)
Professor (Adj.), Department of Physics and Astronomy
OSTC, Iowa Advanced Technology Labs, University of Iowa, 205 N. Madison,
Iowa City, Iowa 52242 US, Office: 202 IATL
Tel: 319-353-2342, E-mail: aju-jugessur@uiowa.edu
www.ostc.uiowa.edu/uimf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