

**Symposium on Undergraduate Nano-Education:  
"Addressing the Challenges of Nanoscale Science & Engineering Education"**

**Presentation:**

"Quantum Mechanics for Nanostructures: First Course in Nanoelectronics for Engineers"

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**Presenter Biography:**

Vladimir Mitin is SUNY Distinguished Professor of Electrical Engineering at University at Buffalo, The State University of New York. Currently his research is focused on nanostructures and nanodevices with emphasis on the structures with heterointerfaces between organic and inorganic materials, terahertz generators and detectors, and highly-sensitive nanodetectors. He has developed and taught new courses specifically designed for introduction of nanotechnology into the science and engineering undergraduate education. The following are some courses that Professor Mitin has developed and taught recently. During Spring 2005 semester a new course, EE 240 "Nanotechnology, Engineering and Science", for second-year undergraduate students has been developed and it has been offered each year since then. The course development was supported by the NSF NUE program. The text "Introduction to Nanoelectronics: Nanotechnology, Engineering, Science, and Applications" that has been prepared for the course was published by Cambridge University Press in 2008. During Fall 2007 a new Interdisciplinary Nanoelectronics Laboratory for the Engineering/Science Undergraduate Curriculum at the University at Buffalo has been developed and since then it is offered each Fall. Currently Professor Mitin with two co-authors is writing a textbook for undergraduate students "Quantum Mechanics for Nanostructures", which will be published by Cambridge University Press in 2010.

**Abstract:**

Nowadays, nanodevices and nanostructures penetrate all aspects of human life from medicine, electronics, photonics, and genetics to purification of water, agriculture, space exploration, and energy. The properties of new nanoscale materials, novel fabrication and characterization techniques, applications, as well as the operational principles of nanodevices and systems are solely determined by quantum-mechanical laws and principles. Therefore, the education in nanoscience has to begin with studying basics of quantum mechanics. Currently, most quantum mechanics courses for engineers in the USA are taught in a traditional way beginning with the history of the development of quantum mechanics, basic concepts, comparisons between classical and quantum mechanics, theory of operators, and only then the simplest applications of quantum-mechanical laws and principles are considered. We suggest a different way of teaching quantum mechanics for engineering majors. Students will acquire and learn deeper quantum-mechanical notions on the numerous examples where we will study nanostructures. Using this approach we have developed a new combined lecture and lab course on quantum mechanics for sophomore engineering students. Ten new lab experiments that will be developed for the lab part of the combined course will be supported by the corresponding lecture material. The advantage of the developed course is in the combination of teaching fundamentals of quantum mechanics with the hands-on experience of carrying out experiments, which reveal the quantum-mechanical behavior of particles, especially wave-particle duality. It was famously noted by Niels Bohr that anyone who does not feel dizzy, learning quantum mechanics for the first time, does not understand a word. Thus, it is important to help students to overcome this dizziness. For this purpose we will use a Clickers system for immediate students' response to control how the undergraduates understand conceptually new quantum-mechanical notions. The undertaken studies showed that interactive engagement helped students in a better conceptual understanding of physics and improve students' lecture attendance and alertness and, therefore, the way of learning especially during lecture presentations.