Introduction to Nanomaterials science and engineering, in support of PSU's initiative to create a Center for Nanometrology and Nanoelectronics

2 hours lectures, two times per week, Tue/Thurs. 17:00 to 18:50 with one 5 minutes break

to be listed preliminary as Phys 410/510, Chem 410/510, ECE 410/510,

This is a regular 4 credit hours, 10 weeks course, which is planned to be regularly offered each year in the Spring from either one of the involved departments and will be for both undergraduates and graduates with majors or minors in one of the sciences or engineering disciplines at PSU with the objectives to:
- enhance the prospects of PSU graduates finding employment in Oregon's emerging high tech and nanotechnology companies
- complement the ECE 410/510 course on nanoelectronics, complement all other ongoing nanoscience and nanoengineering courses
- **prepare theoretically** for the 4 credit hours 10 weeks summer course Phys 410/510, Chem 410/510 entitled currently as "Fabrication and Characterization of Nanomaterials"
- prepare for a lecture series "Topics in Crystallography" that Geology plans to develop
- possibly serve as foundation for dedicated courses on nanoscience and nanoengineering in interested departments
- possibly help in the further interdepartmental development of a prospective minor in nanoscience and nanoengineering

Prerequisites: for majors or minors according to their respective specializations

At least one advanced science or engineering course, consent of the instructor, recommendation from other PSU faculty members of either one of the involved departments

for physics students: PH 312
for chemistry students: one chemistry or physics course at the 300 level
for ECE students: PH 311, or PH 312, or PH 317, or PH 318
for Geology students: G 312 (Mineralogy)
for Computer Science students: any of the courses above
for MSE students: any of the courses above, or ME 372

Consent of the instructor, recommendation from other PSU faculty members of either one of the involved departments.

Pass/no pass option, individual course work

Section	Lectures	Comments
Introduction to Nanomaterials science and engineering	1-5	What nanoscience and -engineering is, how it came into being, what its foundations and applications are
(nano)materials science -the foundations	6-30	scientific foundations of mesoscopic systems, **(nano)metrology** as a sub-discipline of physics (sources of experimental errors and error propagation analyses - a skill any scientist or engineer needs), scientific foundations of self-assembly on all length scales *(complementary to CH 510/410: Introduction to Nanomaterials which focuses on devices and bio-nano-applications taught by Shankar B. Rananavare typically in the Fall term)*

(nano)materials engineering and nanoelectronics materials – the applications	31-40	from **materials science** and engineering concepts to materials physics and materials chemistry aspects of **nanoelectronics materials** *(Complementary to the respective nanoelectronics course in ECE that focuses on devices taught by Prof. James Morris in the spring quarter; (Complementary to CH 510/410: Introduction to Nanomaterials and ECE 580-IN: Introduction to Nanomaterials which focuses on devices and bio-nano-applications taught by Prof. Shankar B. Rananavare typically in the Fall term; Complementary to PH 510/610: Microelectronic Device Fabrication Course Series by Prof. Raj Solanki, which focuses on the "science and practice of modern microelectronic device fabrication", and runs for the whole academic year*

The annual guest lecture series by Prof. Michael Hietschold, Department of Physics, Technical University Chemnitz, on scanning probe microcopies (AFM, STM, NSOM with and without apertures) and nanophysics is included within the course.

Lectures will draw heavily on the following recourses; there will not be required course textbooks, just recommendations for accompanying reading.

Section	**Texts**	**Comments**
Introduction to Nanomaterials science and engineering	R.W. Chan, FRS, The Coming of Materials Science, Pergamon 2001, only for the "Introductory part of this Introduction" Richard P. Feynman's "There's Plenty of Room at the Bottom" seminal talk on December 29th 1959 at the annual meeting of the American Physical Society: http://www.zyvex.com/nanotech/feynman.html	"Materials science and engineering" as the oldest human endeavors, its relation to all of the sciences and engineering disciplines, converging energy scales for many kinds of activities at the nanometer scale, Prof. **Sherry Cady** (Geology) volunteers one hour on Nanoparticles and the environment
Nanoscience – the foundations	E. Roduner, Nanoscopic Materials: Size-dependent Phenomena, RSC Publishing, Cambridge, 2006, **main resource for the course** G.A. Ozin and A.C. Arsenault, Nanochemistry: A Chemical Approach to Nanomaterials, **main resource for the course** C. Dupas, P. Houdy, M. Lahmani (Eds.) Nanoscience: Nanotechnologies and Nanophysics, Springer 2007 Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Imperial College Press, 2004 General review papers that are accessible at a dedicated nanoscience website of the Minerals, Metals $ Materials Society http://members.tms.org/TAQs/nanomaterials.asp	**Self-assembly** on all length scales, Prof. **Scott Reed** (Chemistry) volunteers a one hour guest lecture on "Introduction to synthetic nanochemistry: self-assembled monolayers and nanoparticles"

nanomaterials engineering and nanoelectronics – the applications	S.M. Allen and E.L. Thomas The Structure of Materials; **main resource for the course** M. O'Keeffe and B.G. Hyde Crystal Structures I: Patterns and Symmetry, freely accessible as *.pdf files at http://www.public.asu.edu/~rosebudx/okeeffe.htm, **main Internet based resource for the course** Y. Gogotsi, Nanomaterials Handbook, Taylor & Francis CRC Press, 2006 United Kingdom's Royal Society and Royal Academy of Engineering joint report on 'Nanoscience and nanotechnologies: opportunities and uncertainties' - 29 July 2004. http://www.nanotec.org.uk/finalReport.htm M.J. Hibbard, Mineralogy, A Geologist's Point of View, McGraw Hill, 2002 Review Articles from the Alivisatos, Dresselhouse, Lieber, and Samuelson groups Nanoparticles and the environment, J. F. Banfield and A. Navrotsky, eds., Reviews in Mineralogy and Geochemistry, Vol. 44 (2001) Mineralogical Society of America Review Articles from the Whitesides group, Articles in nanotoday and materials today Review papers and specialized articles that are accessible at a dedicated nanoscience website of the Minerals, Metals $ Materials Society http://members.tms.org/TAQs/nanomaterials.asp Review articles and opinion pieces from both nanotoday and materials today	Prof. **Bryant York** (Computer Science) volunteers a two hours guest lecture on "Parallel/high performance computing for crystallography and database support" Focused-ion-beam techniques, thin film deposition, epitaxy, **nanoscale modeling,** single molecule spectroscopy, free internet resources, Prof. **Sherry Cady** (geology) volunteers one lecture on bio-minerals / biomaterials