Important Dates

<table>
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<tr>
<th>Event</th>
<th>Date</th>
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<tbody>
<tr>
<td>First day of Fall 2018 classes</td>
<td>August 27</td>
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<tr>
<td>Labor Day, observed, no classes</td>
<td>September 3</td>
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<tr>
<td>Last day to add/drop a course</td>
<td>September 4</td>
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Welcome Back!

Registration Reminders

**Force Registration**

Make sure to review the [Advising and Registration](#) page on the website for questions regarding Force Registration.

Registration Deadline

The last day you can make changes to your Fall ‘18 schedule is September 4. After that, you will need to Resign from a course in order to drop it (Resign deadline: November 9).

Events & Campus Opportunities

**September 15 | 1:00PM—5:00PM | Knox Hall, Room 14**

**LEED Green Associate (GA) Training**

LEED (Leadership in Energy and Environmental Design) is simply a sustainability scorecard for green buildings. Buildings can become LEED Certified as can people! The LEED Green Associate is the only professional designation to show employers and clients you have certified knowledge in the field.

For more information or to register, click [here](#).

Review Course Opportunity

**Starting Tuesday, September 11 | 7:00PM—10:00PM | Fronczak 454**

**Fundamentals of Engineering (F.E.) Review Course**

This 12-week course is designed to cover material on civil, environmental, and mechanical engineering F.E. exams. Applications are due September 6, 2018. The course is organized and coordinated by the Engineering Society of Buffalo and the Erie-Niagara Chapter New York State Society of Professional Engineers, in conjunction with SEAS.

See attachments for pricing and more details!

To post to the weekly bulletin, contact Andrew Fogelsonger at afogelso@buffalo.edu
**What is Nanotechnology?**

Nanotechnology is the ability to manipulate and modify material properties at the molecular or nanoscale. The ability to modify material properties at the molecular level allows for the creation of customized materials that can be used in a very wide range of applications, from medicine to basic materials, aerospace, electronics, energy, just to mention a few.

**Why Study Nanotechnology?**

Nanotechnology is already here and being used by many manufacturers (for example, Intel’s processor was based on 32 nm technology in 2011, now it is 6th generation based on 14nm technology and device sizes continue to go down. Nanotechnology is an ever expanding field with improved growth every year.
Nanotechnology in the Industry

Timeline of mainstream Nanotechnology launch by Markets.

- Healthcare and Biotech
- Electronics and Computers
- Tools and Equipment
- Materials and Chemicals, Defense and Security

2005
- Next 2-5 years
- Next 5-10 years
- 2015 and beyond

Investment Spending on Nano – Drivers
- Favorable risk-reward profile
- Initial products have entered the market
- Focus on product-oriented research
- Continued governmental support

Industry Segmentation – Estimated composition of market by 2015

- Electronics & Computing 28%
- Medicine & Healthcare 19%
- Aerospace & Defence 6%
- Others 6%
- Chemicals & Materials 41%

Source: U.S. National Science Foundation.
Note: Others include consumer products and basic research which encompasses more than one market.
Summary of EE 418/518 (Lectures)

- Introduction: Nanoworld and quantum physics
- Short review of classical motion of particles and electromagnetic fields and waves
- Wave-particle duality and its manifestation in radiation and particle's behavior
- Layered nanostructures as the simplest systems to study electron behavior in one-dimensional potential
- Quantum states in atoms and molecules
- Quantization in nanostructures
- Short introduction to nanostructures fabrication
- Short introduction to devices with new functionalities based on nanostructures

Summary of EE 418/518 (Lab)

During the semester the students will perform a total of nine experiments for this lab course. The experiments are listed below:
- **Experiment 1**: Propagation of Errors
- **Experiment 2**: Quantum yard stick – measurement of Planck's constant
- **Experiment 3**: Diffraction of light by a double slit - one photon at a time
- **Experiment 4**: Photoelectric effect: waves behaving as particles
- **Experiment 5**: Atomic spectra; hydrogen Balmer lines; sodium D-doublet
- **Experiment 6**: Photoluminescence from InP quantum dots
- **Experiment 7**: Introduction to atomic force microscopy (AFM)
- **Experiment 8-9**: Study of InAs quantum dots and Si nanowires using AFM
University at Buffalo:
Undergraduate Nanoelectronics Laboratory: Highlights of the AFM/STM experiments

The Principles of the Scanning Tunneling Microscopy (STM)

The STM is a non-optical microscope technique which employs principles of quantum mechanics. A sharp probe (tip close-up fig. B), whose end is as sharp as a single atom, moves over the surface of the material under study, and a voltage is applied between the probe and the sample surface. Depending on the voltage applied, electrons will tunnel through the potential barrier between the surface and probe, resulting in a weak electric current. The direction of the tunneling depends on the polarity of the electric field. The magnitude of this current is exponentially dependent on the distance between probe and the surface. For tunneling to occur, the substance being scanned must be conductive (or semiconductive). Insulators cannot be scanned by STM, as the electron has no available energy state to tunnel into or out of, due to the large bandgap in insulators.

The Atomic Force Microscope (AFM) or scanning force microscope (SFM) is a very high-resolution type of scanning probe microscope, with demonstrated resolution of features of a nanometer, more than 1000 times better than the optical diffraction limit.

The AFM was invented by Binnig, Quate, and Gerber in 1986, and is one of the foremost tools for imaging, measuring, and manipulating matter at the nanoscale.

Forces of the order of a few pico-Newton can now be routinely measured with a vertical distance resolution of better than 0.1 nanometer.

Gold as seen to the left has a face centered cubic (FCC) lattice structure. This structure really cannot be seen in the scanned sample clearly so an atomic structure is provided to the left as well.

Graphite is shown to the right. In this picture you can see the upper layer of the graphite structure and you can almost see the actual atomic structure. In the bottom left of the picture there is a close-up view of the sample with the atomic structure indicated in red.

STM-ART

STM

Gold and Graphite STM Sample Images from student involved experiments

STM

The Principles of the Atomic Force Microscopy (AFM)

The AFM consists of a micro-scale cantilever with a sharp tip (probe) at its end that is used to scan the specimen surface. The cantilever is typically silicon or silicon nitride with a tip radius of curvature on the order of nanometers.

When the tip is brought into proximity of a sample surface, forces between the tip and the sample lead to a deflection of the cantilever according to Hooke’s law. Depending on the situation, forces that are measured in AFM include mechanical contact force, Van der Waals forces, capillary forces, chemical bonding, electrostatic forces, magnetic forces, Coulomb forces, solvent forces etc.

Typically, the deflection is measured using a laser beam reflected from the top of the cantilever into an array of photodiodes. Other methods that are used include optical interferometry, capacitive sensing or piezoresistive AFM cantilevers.

The AFM is used to scan both conductive and non-conductive materials and provides a three-dimensional mapping of the image surface.

STM

AFM-ART

STM

The image on the left (figure A) represents the wing microstructure of the Morpho butterfly. It is mainly this structure that produces the amazingly bright blue color you see on the butterfly’s wing.

How the structure does that is better explained in figure B. You can see from the cross-section of this structure the Christmas-tree like figures. The structure is transparent in visible light and it absorbs all the colors in white light except blue, which it reflects back. Thus, it gives you the bright blue color that you see.

Figure C represents a close-up of a burned CD-R with the grooves and flat surfaces indicating the stored data. The grooves indicate a zero because as laser is shined into it, it reflects away from the sensor which is closely adjacent. But when the laser hits a flat surface it reflects back and indicates a one. With these two you get binary 0 and 1.

STM

AFM ART

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Prepare for the Fundamentals of Engineering (FE) Exam

Take a Review Course (RC)*:

FE Exam review course

- Classes begin Tuesday September 11, 2018, UB North Campus, Fronczak 454.
- Classes meet Tuesday evenings, 7 P.M. to 10 P.M. for 12 review sessions covering the following topics included on the civil, environmental and mechanical engineering exams: ethics, mathematics, probability, statics, mechanics, economics and fluid mechanics.
- Registration fee is $500.00 ($250.00 for UB students), which includes 12 lectures and lecturers’ notes.
- For questions about the schedule or course content, please contact Prof. James Jensen, jjensen@buffalo.edu
- If general questions, please contact the FE course coordinator Richard J. Fickelscherer, Ph.D., P.E., at (716) 680-2369 (cell) or email richfick@verizon.net
- NOTE: ADVANCE REGISTRATION ONLY, APPLICATIONS MUST BE RECEIVED BY SEPTEMBER 6, 2018. Please make check payable to: PE Examination Course
- Mail check and application form to:
  
  PE Examination Course  
  c/o: Mr. James R. Bates, P.E.  
  2216 Long Road  
  Grand Island, NY 14072

Organized and Coordinated by the Engineering Society of Buffalo and the Erie-Niagara Chapter New York State Society of Professional Engineers, in conjunction with the University at Buffalo School of Engineering and Applied Sciences.
**FE REVIEW COURSE 2018 – Tentative Schedule**

**Date and Time:** Tuesdays from 7-10pm, 9/11/18 to 12/4/18

**Locations:** Meet Fronczak 454

**Supervising Instructor:** J.N. Jensen, jjensen@buffalo.edu

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<td>Mechanics,</td>
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<td>Dynamics,</td>
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<td>November 27</td>
<td>Structural analysis and</td>
<td>Thermodynamics II,</td>
<td>Risk + Other Topics,</td>
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<td>Dec 4</td>
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APPLICATION

FUNDAMENTALS OF ENGINEERING

F.E. REVIEW COURSE LECTURES

Name: ____________________________________ Date: __________________

Home Address:        Street: ______________________________________________________
City/State: ____________________________________ Zip: __________________
Home Phone: ______________________ Work Phone: ______________________________
Email Address: ____________________________________________________________
Business Address:   Employer: __________________________________________________
Street: _____________________________________________________________
City/State: ____________________________________ Zip: __________________
College Attended: ______________________________ Year Graduated: __________
College Major  _____________________________

Signature: ____________________________________________________________

FUNDAMENTALS OF ENGINEERING COURSE / 12 SESSIONS
Includes: lectures on ethics, mathematics, probability, mechanics, fluid mechanics, economics

(Check Appropriate Box)

□  $500   General Tuition
□  $250   Full Time Student

Please make check payable to:    PE EXAMINATION COURSE
NOTE: ADVANCE REGISTRATION ONLY, APPLICATIONS MUST BE RECEIVED
BY SEPTEMBER 6, 2018
CLASSES BEGIN TUESDAY, SEPTEMBER 11, 2018

Mail Check & Application to:    PE Examination Course
c/o:  Mr. James R. Bates, P.E.
2216 Long Road
Grand Island, NY  14072