Welcome to Electrical and Computer Engineering at the University of Dayton
The application of engineering skills to solving problems, designing, prototyping, and doing R&D in:

- Computer hardware and software
- Telecommunications
- Control systems
- Embedded systems
- Signal and image processing
- Antennas and radar
- Electro-optics
- Electronic circuits, devices
- Nanotechnology
- Biomedical/bioengineering

What is Electrical and Computer Engineering?

The most diverse engineering field. UD ECE prepares you for all these areas.
What is Electrical and Computer Engineering?

- Computer hardware and software

- Hardware design
What is Electrical and Computer Engineering?

Control systems

Humanoid Robots (Asimo)

New $1,000,000 Robotics Lab in ECE
Control systems

Automotive Systems
(Tesla Motors Electric Car)

Aerospace and Military

IDCAST:
Center for UAV Remote Sensing
Wide-Area Surveillance
What is Electrical and Computer Engineering?

⇒ Embedded systems

Portable Devices
What is Electrical and Computer Engineering?

⇒ Signal and image processing

Hubble Space Telescope

Digital Audio and Video Processing
What is Electrical and Computer Engineering?

Biomedical/bioengineering

Biomedical Imaging and Biomedical Signal Processing
Career Path

Electrical and Computer Engineers are about 45% of the entire American engineering workforce! (By far larger than any other engineering field, so lots of job opportunities)

ELE=Electrical Engineering
CPE=Computer Engineering
ECE=Electrical and Computer Engineering
CPEs and ELEs command some of the highest starting salaries!

<table>
<thead>
<tr>
<th>Degree</th>
<th>Starting Salary</th>
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<tbody>
<tr>
<td>ECE = Electrical and Computer Engineering</td>
<td>$50,000</td>
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<tr>
<td>CPE = Computer Engineering</td>
<td>$60,000</td>
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<tr>
<td>ELE = Electrical Engineering</td>
<td>$70,000</td>
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<tr>
<td>Mechanical</td>
<td>$40,000</td>
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<tr>
<td>Civil</td>
<td>$30,000</td>
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<tr>
<td>Chemical</td>
<td>$20,000</td>
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ELE = Electrical Engineering
CPE = Computer Engineering
ECE = Electrical and Computer Engineering
ECE salary advantage grows with M.S. degree

Masters Degree Salaries

Median Salary, M.S. Degree
2003 National Science Foundation Survey

EDU ECE offers 5 year BS/MS!

ECE salary advantage grows with M.S. degree

ELE=Electrical Engineering
CPE=Computer Engineering
ECE=Electrical and Computer Engineering
ECE at the top of the Ph.D. earning scale!

UD ECE offers Ph.D. degree

Doctoral Degree Salaries

2005 survey by the National Association of Colleges and Employers

ECE = Electrical and Computer Engineering
CPE = Computer Engineering
ELE = Electrical Engineering
CME = Mechanical Engineering
Mech = Mechanical Engineering
Civil = Civil Engineering
**Bottom line:**

- There are more jobs in ECE than in any other engineering field, with nearly the highest salaries at all education levels.
- ECE as a whole is expected to keep growing at a rapid pace:
  - *ELE and comp. hardware* 9 - 17% until 2014
  - *CPE (software)* 27% until 2014
Electrical and Computer Engineering is Fun!
“The professors in ECE are amazing people with an intense enthusiasm to convey their knowledge and experience; while the students benefit from their willingness to take time out to aid individuals.”

“I would encourage anyone willing to tackle the rigors of undergraduate engineering to enter the Department of Electrical and Computer Engineering at UD; as it is bound to be one of the best decisions of your life. It was for me.”
- Rebecca Ossio, B.S. in ELE 2006 (Now working in industry on the B2 Spirit, one of the most advanced planes in the US Air Force).

“Over the past few years the electrical and computer engineering department at UD has become my home. Small class sizes and friendly professors have created an environment where the students get to know their professors on a personal as well as a professional level.”

“This academic atmosphere allows for collective learning with other students and friendships that will last for the rest of my life. I have nothing but praise for the department that has molded me into the engineer I am today.”
- David Krivonak, B.S. ELE & CPE 2007 (Now with Sprint Nextel: Network Engineer I)
1. Great careers commanding top salaries
2. Broad-based ABET Accredited curriculum prepares you for all areas of Electrical and Computer Engineering (ECE)
3. More technical electives & lab courses than other engineering majors, plus hot concentration areas (electro-optics & planned bioengineering concentration)
4. Award winning faculty and top notch facilities in ECE
5. Small classes, lots of personalized attention (low student to faculty ratio)
6. Excellent job, co-op and graduate school placement. Well structured co-op program
7. Multi-disciplinary design experience through industry funded design clinic projects
8. 5 year Accelerated BS/MS dual degree program (Plus “MBA ready” program)
9. Active student organizations such as IEEE, EKN, and service learning opportunities through ETHOS
10. Fun cutting edge field that plays a major role everywhere in modern society
State of the art **ABET Accredited curriculum** with extensive laboratory courses


**Robotics and Electro-optics Concentrations** available

**Bioengineering and Renewable Energy Concentrations** planned

Projects based learning in courses

**Multi-disciplinary design experience** through the industry funded design clinic projects

**Award winning faculty** (More than 15 awards in the last 5 years)

Active student organizations such as **IEEE, and Eta Kappa Nu**

Service learning opportunities through **ETHOS**
Dr. Vijayan K. Asari

Computer Vision, Pattern Recognition, Machine Learning

Dr. Asari's research includes a wide range of topics in computer vision, pattern recognition, and machine learning. His main focus is in the areas of wide area surveillance and biometrics. This includes scene visibility improvement, video stabilization, distortion correction, scene change detection, object detection and tracking, face and iris recognition, action and behavior recognition, and brain signal analysis for emotion recognition. He is also active in the area of low power and high performance hardware acceleration methodologies for real-time applications.
Dr. Eric J. Balster

Embedded Data Processing Laboratory (EDPL)

Dr. Balster’s research focuses on processing of large scale imagery for real-time computation. This type of processing includes: compression, enhancement, mosaic generation, and registration of imagery. Typically, the processing of such large imagery requires the use of acceleration cards for parallel computation and faster throughput. Much of the work involved with using these types of cards requires translation from a software implementation to a hardware description language (HDL) implementation of such algorithms.

EDPLs Large-Scale Persistent Surveillance System

EDPLs JPEG2000 Compression card

Large-Scale Imaging of the Dayton Area
Dr. Partha Banerjee
Nonlinear Optics, Metamaterials, Holography

Dr. Banerjee's research includes a wide range of topics such as nonlinear optics, optical processing, digital holography and digital holographic interferometry, and metamaterials. Currently he is working on two SBIR Phase II and two SBIR Phase I projects involving digital holographic interferometry (Army, Air Force) and metamaterial lens (DARPA). The metamaterial lens described here comprises nanoparticle dispersed liquid crystals which can show polaritonic and plasmonic properties, leading to a overall negative refractive index. The work on digital holographic interferometry involves determination of airplane attitudes, the exact 3-d shape of droplets, and detection of cracks. Dr. Banerjee is the general chair of the Digital Holography Meeting of the Optical Society of America in Miami in 2010, and topical editor of Applied Optics. He is a Fellow of the OSA and SPIE, and has written over 100 technical journal articles and authored 4 books.

References: Banerjee & Nehmetallah JOSA B '06, '07; Banerjee et al JOSA B '08. 2. Banerjee et al SPIE Proc. '07, '08; Banerjee & Chatterjee JOSA B '09; Aylo, Banerjee & Nehmetallahl, JOSA B '10.
Nanoenergetics: novel high-energy release materials on nanoscale:
Zero-metallic nanoparticles for propellants, fuel additives, munitions
(DTRA, AFOSR, AFRL/Propulsion/Munitions)
- Hydrogen generation using Al NPs (high efficiency, 2 patents in progress)
  (AFOSR, AFRL)
- Functionalized Carbon quantum dots as catalysts for photon harvesting for photovoltaics on nanoscale
  (AFRL, proposals submitted to various agencies)
- II-VI compound NPs optochemical sensing
  (AFRL, DTRA/team/white paper accepted/proposal invited)
Dr. Russell Hardie

Digital Signal and Image Processing

Dr. Hardie's research includes a wide range of topics in digital signal and image processing. His focus is in the area of signal and image restoration and enhancement. This includes developing innovative algorithms for overcoming limitations of non-ideal sensors through post-processing. He is also active in the areas of hyperspectral and medical image processing. Hyperspectral image processing work includes anomaly detection, change detection, and image fusion. The medical image processing research has focused on the detection and segmentation of pulmonary nodules from computed tomography images and chest radiographs.
Dr. Keigo Hirakwa http://academic.udayton.edu/hirakawa

Intelligent Signal Systems Laboratory

Research at ISSL is aimed at understanding the increasingly large role that signal systems play in the real-world. We connect the applied design efforts with the first principle ideas of mathematics and statistics to enable new capabilities in image processing, computer vision, biomedical imaging, and sensors.

- Use statistical modeling of image features to fix artifacts.
- Use human visual system model to hide errors.
- Use color science models to increase display resolution.
- Complete a signal processing task together.
- Display hardware and human eye complete a signal processing task together.
- Use human visual system model to hide errors.

Example: LCD display design. Same number of pixels, but increased spatial and color resolution.
Control Systems and Robotics

Dr. Ordóñez’s research spans the fields of systems, controls, sensors and robotics. His focus is on nonlinear systems, nonlinear control, and the connection of control tools and concepts to related areas such as coordinated behavior of autonomous robots, machine learning, image processing, intelligent sensing and optimization. He has sought to build a link between nonlinear control and robotics, encompassing applications such as bipedal humanoid-like motion, control of air vehicles, and vision-based control of electro-mechanical systems. His recent research on Extremum Seeking Control attempts to merge the traditionally disjoint areas of control and optimization, and to create a theoretical framework for intelligent decision-making in autonomous systems.
Dr. Robert Penno
Ka Band Multifunction Radar

Problem (Overview)
- The landing approach of many airborne platforms is often complicated by inclement weather and other factors. A single radar type is inadequate in providing an accurate description for landing in such conditions.

Approach being used
- Data obtained from a single antenna aperture, which is processed via multiple radar types, e.g. GMTI, SAR and RBGM, is then integrated to form a more comprehensive, real-time picture of the runway conditions.

Solution (Overview)
- A team of two UD undergraduate students, one part-time UD graduate student, under the tutelage of this UD professor is joined by a member of UDRI, to process data collected under another program.

Potential Impact/Results
- Successful implementation of this concept could provide significant improvements in the safe landing of both commercial and military aircraft.
- Funded by: Initially, IDCAST is underwriting the work/study costs of the undergraduate students as well as time for the UDRI expertise. If successful, it is expected that subsequent government funding would be available.
Objective:
• Develop frequency and phase agile circuits based on low voltage, high Q Barium Strontium Titanate (BST) varactor devices

Impact:
• Tunable filters for receiver front-end
• Low phase-error low-voltage phase control circuits (360 degree phase shift with ~ 5 V.

Highlights:
• Large area (4”) BST thin films with superior tunable (>4 : 1) properties
• High Q as high as 200 at 10 GHz
• Low leakage currents (<10 nA below 5 V dc bias)
• Temperature dependence ~5% over 20 C to 100 C
• Filed 3 Patents in the BST varactor devices
• Technology licensed by Analog Bridge Inc.
• CRADA between Analog Bridge, AFRL, and UD
• Research funded by AFRL, DARPA, and Analog Bridge (IDCAST)
* Currently supported by a DARPA Phase II program
Infrared Micro-Optic Structures
- Transitioned to commercialization

Infrared Polarimetric Sensors
- Transitioned to commercialization

Infrared Micro-Filters

Micro-Inductors with Negative Inductances

Ultra-low index Nano-rod silica films

Bio-sensors for single molecule detection

Super-resolution imaging through thin film structures

Transparent metals (metallo-dielectrics)

MEMS cantilever sensors

Nano-metallic silver film

SiO$_2$ cantilevers on Si

GaP thin films

GaP film on 3” fused silica wafer

Micro-polarizers on 6” wafers

Spiral micro-inductor
Dr. Tarek Taha
High Performance Neuromorphic Computing

Problem (Overview)
Current computing systems perform poorly at a variety of tasks that humans, primates and other animals excel at. These include image recognition, language processing, and learning.

Approach being used:
- Utilize supercomputing clusters for massive brain-scale simulations.
- Develop special purpose highly parallel chips for neural simulations.

Solution (Overview)
Develop computing systems that mimic the processes taking place in brains. Since the brain has a very large number of neurons that are highly interconnected, simulating brains is highly challenging.

Funded by: NSF, AFOSR, AFRL

Potential Impact/Results
- Smarter everyday use products.
- Smarter robots.
- Supercomputers with far more powerful problem solving capabilities.
Reconfigurable Computing Projects (Balster, Scarpino)

- VTC acceleration with FPGAs (2000)
- P-Frame simplification (2005) *Predator transition*
  - JPIP image communication protocol (2007) *AF transition*
  - FPGA compression acceleration (2008) *AF transition*
  - FPGA decompression acceleration (2009) *AF transition*
- DREAM board development (2006) *AFRL/RY transition*
Make solar energy economical (Photovoltaic cells)
Provide energy from fusion
Develop carbon sequestration Methods
Manage the nitrogen cycle (GPS based)
Provide access to clean water
Restore and improve urban infrastructure (sensors, and sensor networks for remote health monitoring)
Advance health informatics (Telemedicine, Wireless Integrated Microsystems)
Engineer better medicines (MEMS and Nanotechnology)
Reverse-engineer the brain (Neuro-morphic computing, CAD tools)
Prevent nuclear terror (Better detectors, imaging)
Secure cyberspace (CPE and CPS)
Enhance virtual reality (CPE and CPS)
Advance personalized learning (e-books, etc.)
Engineer the tools of scientific discovery (Advanced visualization tools)