Welcome from the Department Chair

To our Graduate Students:

On behalf of the ECE Department faculty and staff, I wish to welcome you to Lehigh University. We trust that you will have a successful and rewarding experience in the Department of Electrical and Computer Engineering. During your stay at Lehigh, we encourage you to get to know all ECE faculty and your fellow students, to develop both breadth and depth in your professional training.

The 2015-2016 Department Handbook was prepared to assist you during your graduate experience at Lehigh. The ECE Department Handbook supplements but does not supersede the College of Engineering and Applied Science Graduate Student Handbook. I encourage you to refer to both the University Catalog and the Graduate Student Handbook for further information.

Welcome to Lehigh University!

Filbert J. Bartoli
Department Chair
Electrical & Computer Engineering
Department Personnel

Prof. Fil Bartoli, Chair
Prof. Doug Frey, Assoc. Chair
Prof. Svetlana Tatic-Lucic, Faculty Graduate Coordinator
Prof. Meghanad Wagh, CompE Faculty Grad. Coor.
Prof. Doug Frey, Assoc. Chair
Prof. Svetlana Tatic-Lucic, Faculty Graduate Coordinator
Prof. Meghanad Wagh, CompE Faculty Grad. Coor.

Ms. Ruby Scott, Administrative Specialist
Ms. Diane Hubinsky, Graduate Coordinator
Ms. Christine Lake, Undergraduate Coordinator
Mr. David Morrisette, Systems Administrator

P.C. Rossin College of Engineering & Applied Sciences
Graduate Personnel

Prof. John Coulter, Interim Dean
Prof. Raymond Pearson, Interim Assoc. Dean of Graduate Studies
Ms. Brianne Lisk, Admin. Coordinator, Graduate Studies
## Academic Year Calendar

<table>
<thead>
<tr>
<th>Event</th>
<th>Fall 2015 Semester</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Day of Class</td>
<td>Monday, August 24</td>
</tr>
<tr>
<td>Last Day for Web Registration</td>
<td>Sunday, August 30</td>
</tr>
<tr>
<td>Summer degree award date</td>
<td>Sunday, August 30</td>
</tr>
<tr>
<td>Labor Day-classes held</td>
<td>Monday, September 7</td>
</tr>
<tr>
<td>Last Day to drop/add without a “W”</td>
<td>Friday, September 4</td>
</tr>
<tr>
<td>Deadline to apply for January Degree</td>
<td>Thursday, October 1</td>
</tr>
<tr>
<td>Pacing Break</td>
<td>Monday-Tuesday, October 12-13</td>
</tr>
<tr>
<td>Registration for Spring 2015</td>
<td>Monday-Friday, November 9-20</td>
</tr>
<tr>
<td>Last Day for January Doctoral candidates to deliver dissertation drafts to Dean</td>
<td>Tuesday, November 10</td>
</tr>
<tr>
<td>Last Day to drop class with a “W”</td>
<td>Tuesday, November 10</td>
</tr>
<tr>
<td>Thanksgiving Break</td>
<td>Wednesday-Friday, November 25-27</td>
</tr>
<tr>
<td>Last Day of Classes</td>
<td>Friday, December 4</td>
</tr>
<tr>
<td>Last Day for January MS candidates to electronically upload their Thesis and deliver final paperwork to the Registrar’s Office</td>
<td>Friday, December 4</td>
</tr>
<tr>
<td>Last Day for January Doctoral Candidates to complete all degree requirements</td>
<td>Friday, December 4</td>
</tr>
<tr>
<td>Final Exams Begin</td>
<td>Tuesday, December 8</td>
</tr>
<tr>
<td>Final Exams End</td>
<td>Wednesday, December 16</td>
</tr>
</tbody>
</table>
## Academic Year Calendar (Cont.)

<table>
<thead>
<tr>
<th>Event</th>
<th>Spring 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>January Degree Award Date</td>
<td>Sunday, January 24</td>
</tr>
<tr>
<td>First Day of Class</td>
<td>Monday, January 25</td>
</tr>
<tr>
<td>Last Day for Web Registration</td>
<td>Sunday, January 31</td>
</tr>
<tr>
<td>Last Day to drop/add without a “W”</td>
<td>Friday, February 5</td>
</tr>
<tr>
<td>Last day to apply for University Day Degree</td>
<td>Monday, February 1</td>
</tr>
<tr>
<td>Spring Break</td>
<td>Monday-Friday, March 14-18</td>
</tr>
<tr>
<td>Registration for Summer and Fall</td>
<td>Monday-Friday, April 11-April 22</td>
</tr>
<tr>
<td>Last Day of Classes</td>
<td>Friday, May 6</td>
</tr>
<tr>
<td>Last Day to drop class with a “W”</td>
<td>Friday, May 6</td>
</tr>
<tr>
<td>Last Day for May Doctoral Candidates to complete all degree requirements</td>
<td>Friday, May 6</td>
</tr>
<tr>
<td>Last Day for May MS candidates to electronically upload their thesis and deliver final paperwork to the Registrar’s office</td>
<td>Friday, May 6</td>
</tr>
<tr>
<td>Final Exams Begin</td>
<td>Tuesday, May 10</td>
</tr>
<tr>
<td>Final Exams End</td>
<td>Wednesday, May 18</td>
</tr>
<tr>
<td>University Day Commencement</td>
<td>Monday, May 23</td>
</tr>
<tr>
<td>Deadline to apply for September Degree</td>
<td>Friday, July 1</td>
</tr>
</tbody>
</table>
**Admissions**

**Deadlines:**
Fall applications - January 15th for financial aid (TA, RA, Fellowships). April 1st for admission only
Spring applications - November 1st for everyone

**Financial Aid:**
The department offers three types of financial aid: research assistantships, teaching assistantships, and fellowships. These are exclusively for PhD applicants, except in very rare exceptions as determined by the Department. All generally include a monthly stipend and tuition.

**General Information:**
Offers of admission may be deferred for up to one full academic year.
Tuition rates for the 2015-2016 academic year are $1,380/credit. All full-time students and International students are required to take 9 credits each semester to maintain full-time status (for exceptions, please see the College Handbook). International students who are admitted without financial aid will be required to submit an affidavit of support in the amount of roughly $41,115 which includes tuition, living expenses, insurance, and other fees for one year before any visa documents will be issued.

**Applications:** All applications must be submitted online. If you have questions concerning the program or application process, please contact the department at inceegr@lehigh.edu. The correct mailing address for transcripts is as follows:

Lehigh University
ECE Graduate Coordinator
19 Memorial Drive West
Bethlehem, PA 18015

Incomplete or late applications **will not** be processed or reviewed. This includes applications without the $75 application fee which **CANNOT** be waived for any reason. Once the application is submitted you will receive an e-mail confirming its receipt. Please allow time for mailing delays and processing before receipt of e-mail. All communication will be done via e-mail, so please provide one current e-mail address. Decisions for Fall semester will be announced starting in March. Decisions for the Spring semester will be announced mid-November.

All the Admissions information and application can be found on our website: [http://www3.lehigh.edu/engineering/ece/admissions/graduate.asp](http://www3.lehigh.edu/engineering/ece/admissions/graduate.asp)
Degrees Offered:

MS, MEng, PhD in Electrical Engineering
MS, PhD in Computer Engineering
MS in Photonics
MS in Wireless & Network Engineering

Minimum Requirements:

BS in EE or related field

Course Experience Needed (Lehigh Equivalent):
  Basic Circuit Theory (ECE 81)
  Signals and Systems (ECE 108)
  Electronic Circuits (ECE 123)
  Circuits and Systems (ECE 125)
  Physical Electronics (ECE 126)
  Statistics (MATH 231 or 309)

GPA
  3.0/4.0 required for PhD applicants
  2.75/4.0 required for MS/MENG applicants

Minimum Test Requirements
  GRE General Test
    75th percentile or better on Quantitative
  iBT TOEFL
    79 composite score
    20 Writing, 20 Speaking, 20 Reading, 15 Listening

At the present moment, we are not accepting IELTS scores in place of TOEFL.

Application Fee: US $75 which cannot be waived for any reason.
Data Sheet: asks for personal data, proposed program information, test data, educational background, and work experience.
Transcripts: upload to online application. If accepted, an official transcript is required from all undergraduate and graduate programs attended. All transcripts must be received in sealed envelopes.
Letters of Recommendation: 2 letters of recommendation are required. If you are currently in school, letters from academic advisors and other professors are preferred. If you are currently in industry, letters from employers are acceptable. All letters should be uploaded to the application. We provide two recommendation forms in the PDF0
application that you may choose to use, however, letters on recommenders' letterhead is also acceptable.

**Test scores:** official test scores sent from ETS or copies of official test scores are acceptable. Scores must be current and valid. TOEFL scores expire after 2 years and expired scores **WILL NOT** be accepted. GRE test scores expire after 5 years. TOEFL test scores will be waived ONLY if an International Applicant has completed a degree program at a U.S. university.

**Essay/Statement of Purpose:** a brief statement of career and research objectives. Essays should articulate clearly your experience and goals. Half a page to two pages is sufficient.

**Application for financial aid:** **MUST** be completed in order to be considered for any kind of aid.

**Supplemental Information:** applicants should also include a resume or CV, current research or creative work, list of published works, and extracurricular activities.

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**Procedures for New Graduate Students**

**Check In and Starting dates**
Students are expected to be on campus at least one week prior to the start of classes in time for new student orientations, testing, and registration. International students must report to the Office of International Students & Scholars, located in Coxe Hall, immediately upon arrival on campus.

**Required Orientations**
Plan on attending all the orientations from the Graduate Life office for incoming students. [https://gradlife.web.lehigh.edu/orientation#Orientation%20Schedules](https://gradlife.web.lehigh.edu/orientation#Orientation%20Schedules)
The department office will hold an orientation in the week before classes begin.

**English Speaking**
For safety reasons, spoken English is the expected language in all labs. Failure to confirm creates a safety risk for all involved. This is in violation and could result in meeting with the lab supervisor.

**Seminars**
ALL full time graduate students in the department are **required** to attend department seminars. Seminar announcements are sent to your Lehigh e-mail accounts. Seminars are generally scheduled at 4:00. Full time students must attend at least 75% of all the seminars offered in a semester. **Attendance will be taken.**
Academic Requirements

**Full-Time Certification**
All International graduate students must maintain full-time status while attending Lehigh. Full-time students must be registered for 9 credits (3 Courses) each semester or satisfy the requirements to be certified full-time. If you need to be certified full-time you may pick up the appropriate form in the Department office and speak with the Graduate Coordinator to make sure you satisfy all requirements. Domestic students who must maintain full-time status for insurance purposes, etc. must also be registered for 9 credits per semester or certified full-time.

All RAs and TAs must be full-time students as stated in your offer letter. Failure to do so will make you ineligible for any assistantships.

**Registration**
All current students are asked to register for their semester courses at a specified date during the previous semester. This date is listed on the Academic Calendar. Failure to do so will result in a late fee of $100 assessed by the Registrar.

New graduate students register the week before classes begin.

All students will have the first week of classes to add and drop online if they wish. Students also have the second week of classes to add and drop but must fill out a paper form and acquire signatures for approval.

**Advisors**
All students are required to consult with their advisor before they register for courses each semester. The advisor will review the courses and supply the student with their Registration PIN#. New Registration PIN numbers are assigned each semester.

New Masters graduate students are assigned an advisor when they arrive on campus. This advisor is the current Graduate Faculty Advisor. If a Masters student decides to submit a thesis as part of their program, they will need to identify a faculty member who is willing to supervise their research, and that faculty member will become their academic advisor as well.

Please be advised that our faculty have many commitments, and the availability of faculty for research supervision is not guaranteed and depends on the specialty within their area.

**Graduation**
When a student is ready to graduate you will need to complete an Application for Degree form. These forms are available online through the portal. To access the form, log on to the Portal, click the Banner Icon, and click the Student Services tab. Applications must be submitted by the deadlines listed on the Academic Calendar. Once this form is complete, please see the Graduate Coordinator for additional requirements.
Masters Program Guidelines

The Electrical and Computer Engineering Department offers Master’s degrees in Electrical Engineering, Computer Engineering, Photonics and Wireless & Network Engineering.

Master’s Degree
The MS degree is a 30 credit program. If you choose to do a Thesis, you will take up to 6 credits of thesis hours in place of 2 courses. Theses must be approved and turned in to the Registrar by the set deadline which can be found on the Academic Calendar. A print out of Thesis guidelines and sample signature and title pages can be obtained in the Department Office. The MEng degree does not require a thesis.

Candidates for the Master’s degree have six years to complete their program. MS students may transfer up to 9 approved credits from a previous MS program into their Lehigh program as long as they have not been used for a previous degree. This can be accomplished by completing a petition form once you arrive. Lehigh undergraduates may transfer up to 6 credits of 300 or 400-level courses taken during their undergraduate studies. Please see the College Handbook for full rules regarding this policy. Each program has their own department requirements, and all programs within the P.C. Rossin College of Engineering and Applied Sciences must follow the college requirements as well. Check online for the College of Engineering Graduate Student Handbook.

The ECE Department has a core curriculum requirement for graduate students in each of the degree programs. The purpose of this requirement is to guarantee that all students pursuing graduate studies in the department acquire an appropriate breadth of knowledge of their discipline.

Requirements for Master of Engineering and Master of Science Degrees
In meeting the requirements for the Master of Science or Master of Engineering degree, the student must satisfy the following common requirements, as outlined in the Graduate Student Handbook.

1. All candidates for a Master’s degree must submit the form entitled Program for Master's Degree as soon as possible after accruing 15 credit hours of courses but no later than the semester before the student graduates. This form is eventually approved by the Registrar. The timing for completion of this form is critical, as it allows for corrections to a student’s course plan if necessary.

2. The minimum program for all Master’s degrees includes:
   - Not less than 30 credit hours of graduate work; audit credits may not be used toward the degree. Research or thesis registration counts as part of the 400-level course requirement.
• Not less than 24 credit hours of 300- and 400-level coursework of which at least 18 hours is at the 400-level.
• Not less than 18 credit hours in Electrical & Computer Engineering
• Not less than 15 credit hours of 400-level coursework in Electrical & Computer Engineering

3. Eighteen (18) credit hours in the major field of Electrical & Computer Engineering are required. These courses must be 300- and 400-level courses. The remaining twelve (12) credit hours may also be taken in Electrical & Computer Engineering (300- and 400-level courses), or they may be taken in any other field in engineering in which courses for graduate credit are offered, subject to the approval of the student's advisor.

4. A graduate student may include in his or her program courses numbered 200 or higher outside of the department and 300 or higher in the department. A graduate student registered in 200 or 300 level courses may be assigned additional work at the discretion of the instructors. Courses taken outside of the department are subject to approval by the advisor and the Departmental Graduate Committee.

5. The Master’s degree is not granted unless the candidate has earned grades of B- or better in at least eighteen hours of the work in his/her program and in all 300-level courses in Electrical & Computer Engineering. No course in which the grade earned is less than C- is credited towards the degree.

6. A student who receives more than four grades below B- in courses numbered 200 or higher becomes ineligible to qualify for the Master’s degree or to register for any other 400-level courses.

**MS / MEng EE Department Requirements**

To satisfy the core curriculum requirements in Electrical Engineering, students must select three (3) courses from the following five (5) different areas:

- ECE 401 Advanced Computer Architecture
- ECE 402 Advanced Electromagnetic Theory
- ECE 420 Advanced Circuits and Systems
- ECE 441 Fundamentals of Wireless Communications
- ECE 451 Physics of Semiconductor Devices

In addition to the three core courses, elective courses can be selected from the offered courses for that term.
**MS in Wireless Communications and Network Engineering**
The Master of Science degree in Wireless Communications and Network Engineering at Lehigh University is designed to prepare the next generation of engineers for the communications and networking industries. The curriculum aims to produce graduates that can contribute to the design and analysis of communication systems in the broadest context. To accommodate the student’s study of various aspects of wireless communications and networking, we have limited the number of required core courses to allow maximum flexibility in pursuing specific interests.

**Required Core Courses**

- **ECE 342** Communication Theory 1
- **ECE 441** Fundamentals of Wireless Communications
- **ECE 404** Computer Networks

**Advanced Courses**

1. **ECE 342** must be the first course taken and the core courses should precede advanced courses.

2. In addition to the core courses, the students will take advanced courses that are aimed to furnish the student with a deeper knowledge of more specific types and aspects of information networks.

**MS Degree in Photonics**
The Master of Science Degree in Photonics is an interdisciplinary program designed to provide students with a broad training in the various aspects of photonics, including topics in electrical engineering, materials science, and physics. Admission to the program requires a B.S. or M.S. in either the engineering or physical sciences.

Applications should be directed to one of the three sponsoring departments (Electrical and Computer Engineering, Materials Science and Engineering, or Physics). Procedures and admission criteria are the same as those followed by the home department. International students must satisfy minimum university language requirements. The admissions process is under the supervision of the individual department to which you apply.

**Required Courses**(15 credits):

- **PHY 352** (3 Credits) Modern Optics (or PHY 482, Applied Optics)
- **PHY 355** (3 Credits) Nonlinear Optics
- **ECE 402** (3 Credits) Advanced Electromagnetics (or PHY 421, Elec & Magnetism I)
- **ECE 451** (3 Credits) Physics of Semiconductor Devices (or PHY 363, Physics of Solids)
MAT 416 (3 Credits) Optical Prop of Materials

Selected pre-requisites for the required courses may be waived by the program director for students with equivalent background.

A minimum of three courses must be selected from the following list:

- ECE 425 (3 Credits) Semiconductor Laser I
- ECE 426 (3 Credits) Semiconductor Laser II
- ECE 438 (3 Credits) Quantum Electronics
- ECE 450 (3 Credits) Nanophotonics & Plasmonics
- ECE 450 (3 Credits) Optoelectronic Phys & Lightwave
- ECE 450 (3 Credits) Introduction to Photovoltaic Energy Systems
- ECE 450 (3 Credits) Applied Quantum Mechanics for Engineers
- ECE 468 (3 Credits) Biophotonics and Optical Biomedical Imaging
- CSE 420 (3 Credits) Biomedical Image Computing
- MAT 302 (3 Credits) Electronic Properties of Materials
- MAT 334 (4 Credits) Electron Microscopy & Microanalysis
- MAT 427 (4 Credits) Electron Microscopy (TEM and SEM)
- PHY 331 (2 Credits) Integrated Bioelectronics/Biophotonics Laboratory
- PHY 422 (3 Credits) Elec & Magnetism II
- PHY 369 (3 Credits) Quantum Mechanics I
- PHY 424 (3 Credits) Quantum Mechanics II

**MS Computer Engineering Course Requirements:**

To satisfy the Computer Engineering core, a student must complete, with a grade of B or higher, the following 4 courses:

- ECE 319 Digital System Design
- ECE 401 Advanced Computer Architecture
- CSE 303/403 Theory of Operating Systems
- CSE 340 Design and Analysis of Algorithms

**AND** 2 courses in the Computer Hardware/Architecture area, 2 courses in a second area, and 1 course in a third area. In each of the three areas at least one course must be at the 400 level. Some courses may be listed in multiple categories; they can be used in only one. Each category also allows for appropriate CSE and ECE special topics courses and equivalent courses taken at other schools with approval of the computer engineering division. Courses taken as part of an undergraduate degree may be used to satisfy the core requirements. A list of courses and what category they fall under can be found on the website: [http://www3.lehigh.edu/engineering/cse/academics/grad/computereng/2005.asp](http://www3.lehigh.edu/engineering/cse/academics/grad/computereng/2005.asp)
Doctor of Philosophy Degree

A Ph.D. candidate is generally expected to devote three or more academic years to graduate study. In no case is the degree awarded to one who has spent less than two full academic years of graduate work.

All post-baccalaureate work toward the doctorate must be completed within 10 years. Doctoral students whose graduate study is carried out entirely at Lehigh University must register for a minimum of 72 credits beyond the Bachelor’s degree. Students who have earned a Master’s degree at another institution must register for a minimum of 48 credits. If they decide to get another Master’s degree at Lehigh University, they must register for 72 credits after enrollment.

All Ph.D. candidates are also required to complete the Core Course Requirements stated in the Master’s section above.

**Electrical Engineering Ph.D. candidates:**

To satisfy the core curriculum requirements in Electrical Engineering, students must select three (3) courses from the following five (5) different areas:

- ECE 401 Advanced Computer Architecture
- ECE 402 Advanced Electromagnetic Theory
- ECE 420 Advanced Circuits and Systems
- ECE 441 Fundamentals of Wireless Communications
- ECE 451 Physics of Semiconductor Devices

**Additionally, PhD candidates cannot take more than nine credits of the Independent Study courses.**

**Qualifier Exams**

All students in the Ph.D. program must take the appropriate Qualifier Exam in the spring following their first year of study as a Ph.D. student. They are only offered in the Spring. This exam requires demonstration of competency in selected areas. The exams are offered in six (6) different areas:

- Circuits & Systems
- Electromagnetics/Optoelectronics
- Signal Processing & Communication
- Solid State Devices
- Computer Architecture
- Power & Energy Systems
Each area has an assigned faculty member who will oversee the examination and communicate with those students signed up for the exam. Exams will typically consist of reading assigned research papers, writing a response paper and taking an oral exam with the examining committee. The Examining Committee will consist of at least three faculty members. The topics can be related to one’s research thrust, but not identical to the thesis topic.

The exam is on a pass/fail basis. Students who do not pass the exam the first time will be able to take the exam again after a 5 month waiting period. This will be organized with the help of the Graduate Coordinator and the Qualifier Committee involved on an individual basis. If a student fails to retake the Qualifier Exam within a 12 month period, that student will be removed from the Ph.D. program, and will be forced to reapply. If a student does not pass after the second attempt they will be unable to continue in the Ph.D. program.

**Admission to Candidacy**
Once a Ph.D. student has passed their Qualifier Exam they may begin preparing to apply for Candidacy. An information packet on the application process can be picked up in the Department Office. A prospective candidate must submit a written program proposal to their **Doctoral Committee** (guidelines on the formation and membership of this committee can be found in the College Handbook) that includes a discussion of proposed dissertation research. Once the Committee approves the proposal, the candidate submits the proposal along with a completed signature page and the Application to Candidacy form to the College of Engineering Graduate Dean’s Office. The Graduate Dean will then notify the student and their committee members in writing of the decision.

Once the student has completed their credit hour requirement for the Ph.D. degree (72 or 48) they may apply for Maintenance of Candidacy two times per year from that point on. This means that the student is only required to be registered for one (1) credit Maintenance of Candidacy from that point on until they complete their program.

**General Exam**
The general examination for the doctorate is designed to test both the student’s capacity and his or her proficiency in the field of study. The examination is not necessarily confined to the content of courses that have been taken at Lehigh University or elsewhere. The examination is held, no later than seven months prior to the time when the candidate plans to receive the degree. The student’s doctoral committee is in charge of the examination, which may be both written and oral.

Should a candidate fail in the general examination, he or she may be permitted by the doctoral committee to present him or herself for a second examination not earlier than five months after the first. If the results of the second trial are also unsatisfactory, no further examination is set and the candidate is judged to have failed.
**Dissertation and Defense**

Ph.D. candidates are required to write a dissertation prepared under the direction of their advisor (also typically the Chair of their Doctoral Committee). Guidelines can be found in the College Handbook and all associated dates are listed on the Academic Calendar.

A print out of guidelines and sample title and signature pages can also be obtained in the Department Office.

**Computer Engineering Ph.D.**

Candidates must complete the Core Requirements in the Master’s section which can be found at the following web address:


General College guidelines and requirements for the Ph.D. degree can be found in the College Graduate Student Handbook which can be found online.

Computer Engineering Ph.D. students may also take a qualifier in additional areas more specific to their research as long as they have three faculty members in either the Electrical & Computer Engineering Department or Computer Science & Engineering Department agree to form a committee to offer the specific exam.

The exam is on a pass/fail basis. Students who do not pass the exam the first time will be able to take the exam again after a 5 month waiting period. This will be organized with the help of the Graduate Coordinator and the Qualifier Committee involved on an individual basis. If a student fails to retake the Qualifier Exam within a 12 month period, that student will be removed from the Ph.D. program, and will be forced to reapply. If a student does not pass after the second attempt they will be unable to continue in the Ph.D. program.