The ECE Department’s PhD graduate research program is partitioned into three main areas of concentration and research:

A. **Signals and Communications** – including the following graduate level courses:
   1) ECE 440 Introduction to Random Processes
   2) ECE 441 Detection & Estimation Theory
   3) ECE 442 Network Science Analytics
   4) ECE 444 Digital Communications
   5) ECE 445 Wireless Communications
   6) ECE 446 Digital Signal Processing
   7) ECE 447 Digital Image Processing
   8) ECE 448 Wireless Sensor Networks
   9) ECE 449 Machine Vision
   10) ECE 450 Information Theory
   11) ECE 451 (BME 451) Biomedical Ultrasound
   12) ECE 452 (BME 453) Medical Imaging-Theory and Implementation
   13) ECE 453 Ultrasound Imaging
   14) ECE 457 Digital Video Processing
   15) ECE 471 Computational Models of Musical Processes
   16) ECE 472 Audio Signal Processing
   17) ECE 473 Computational Methods of Music
   18) ECE 475 Audio Software Design I
   19) ECE 476 Audio Software Design II
   20) ECE 477 Computer Audition
   21) ECE 479 Audio Recording – Technology and Fundamentals

B. **Integrated Electronics and Computer Engineering** – including the following graduate level courses:
   1) ECE 400 Computer Organization
   2) ECE 401 Advanced Computer Architecture
   3) ECE 402 Memory Systems
   4) ECE 404 Microprocessor Architecture
   5) ECE 405 Advanced Digital Design Using FPGA
   6) ECE 406 GPU Parallel Programming Using C/C++
   7) ECE 407 Advanced GPU Project Development
   8) ECE 409 (CSC 446) Machine Learning
   9) ECE 429 Audio Electronics
   10) ECE 431 Computational Methods
   11) ECE 455 Software Analysis and Improvement
   12) ECE 461 Intro to VLSI
   13) ECE 462 Advanced CMOS VLSI Design
   14) ECE 463 VLSI Error Control Systems
   15) ECE 464 Fundamentals of VLSI Testing
   16) ECE 465/565 Performance Issues in VLSI/IC Design & Analysis
   17) ECE 466 RF and Microwave Integrated Circuits
   18) ECE 467 Advanced Analog Integrated Circuit Design
   19) ECE 468 Advanced Analog CMOS Integrated Circuit Design II
   20) ECE 469 High Speed Integrated Electronics
C. **Physical Electronics, Electromagnetism, and Acoustics** – including the following graduate level courses:

1) ECE 421 (OPT 421) Optical Properties of Materials  
2) ECE 423 Semiconductor Devices  
3) ECE 424 Intro to Cond Matter Physics  
4) ECE 426 (OPT 468) Waveguides & Optoelectronic Devices  
5) ECE 428 (OPT 425) Radiation and Detectors  
6) ECE 432 Acoustics  
7) ECE 433 Musical Acoustics  
8) ECE 434 Microelectromechanical Systems  
9) ECE 435 Introduction to Opto-Electronics  
10) ECE 436 Nanophotonic and Nanomechanical Devices  
11) ECE 438 Nonlinear Acoustics  
12) ECE 474 (BME 474) Biomed Sensors, Circuits & Instrumentation  
13) ECE 520 Spin-based electronics: theory, devices & applications

The ECE Department Chair selects an area chair for each of the concentration areas to be responsible for conducting/overseeing an area exam in their respective area.

All first year PhD students must satisfy the following requirements for continuation in the PhD program:

1. **2+1+1 Course Requirement**: All PhD students must take and pass at least 2 graduate level courses (400-level) from their respective concentration area and at least one graduate level course from each of the two remaining areas. The courses must be taken during the first year of study\(^1\). The specific courses are to be selected by the students in agreement with their research advisors.

2. **Area Exam**: All PhD students must take an oral exam by the end of April of the first year of study\(^1\). The format of the oral exam (e.g., a question/answer session, a paper presentation or both) shall be determined by the concentration area chair and shall be conducted in front of at least two faculty in the respective research area. No later than the end of the first semester, all students taking the area exam must be informed of the exam format and schedule and must be provided with general guidelines on what is expected of them during the exam (e.g., presentation skills, reading comprehension, critical thinking, creativity, technical competence in the area, ability to think on feet). Upon completion of the oral exam, the exam committee shall provide evaluations of the student’s performance to be included in student’s academic folder. The exam committee members shall not share the evaluations with the student taking the exam. An ECE faculty meeting is to be held no later than May of the first year of study to evaluate the course and area exam performance of all first year PhD students. For each of the students, the faculty shall decide to either allow their continuation in the PhD program or decide on remedial actions if deemed necessary.

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\(^1\) Students may petition to extend the time for completing these requirements. It is expected that part-time students and those with a non-ECE background may need additional time.