Electrical and Computer Engineering

Graduate Student Handbook
Spring 2017 – Fall 2017
TEXAS A&M UNIVERSITY
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People to Contact

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Department Head

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Associate Dept. Head

Dr. S. Miller  
Co-Director of ECE Graduate Programs

Dr. J. Hu  
Co-Director of ECE Graduate Programs

Ms. Katie Bryan  
Academic Advisor IV

Ms. Melissa Sheldon  
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Payroll Administration

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Graduate Student Representatives:

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Graduate Studies Committee

**Dr. S. Miller:** Co-Director of ECE Graduate Program
(Information Science and Systems)

**Dr. K. Entesari:**
(Analog & Mixed Signals)

**Dr. R. Nevels:**
(Electromagnetics & Microwave)

**Dr. R. Righetti:**
(Bio Medical Imaging and Genomic Signal Processing)

**Dr. O. Eknoyan:**
(Device Science and Nanotechnology)

**Dr. M. Ehsani:**
(Electric Power and Power Electronics)

**Dr. P. Li:**
(Computer Engineering and Systems)

**Dr. S. Savari:**
(Information Science and Systems)
Research Area Websites

Analog & Mixed Signals
http://engineering.tamu.edu/electrical/research/analog-mixed-signal

Biomedical Imaging, Sensing & Genomic Signal Processing
http://engineering.tamu.edu/electrical/research/biomedical-imaging-sensing-genomic-signal-processing

Computer Engineering & Systems Group
http://engineering.tamu.edu/electrical/research/computer-engineering-systems-group

Electromagnetics & Microwaves Group
http://engineering.tamu.edu/electrical/research/electromagnetics-microwaves-group

Electric Power Systems & Power Electronics
http://engineering.tamu.edu/electrical/research/electric-power-systems-power-electronics

Device Science and Nanotechnology
http://engineering.tamu.edu/electrical/research/device-science-and-nanotechnology

Information Science and Systems
http://engineering.tamu.edu/electrical/research/information-science-and-systems
Howdy Portal (howdy.tamu.edu)

The Howdy website is used by the students to register for classes, pay bills, apply for financial aid, and to find other information regarding the university

**Home Tab**
- Used for general information about events going on around the university
- Emergency notifications and updates are viewable here as well as a link to register for Code Maroon (i.e. The Emergency Notification System)

**Applicant Tab**
- Admission Portal
- Manage Application
- Scholarships, ISS & OGAPS

**My Record Tab**
- Register for classes, see what classes are available, and view restrictions/details about a class
- View unofficial transcript, order official transcript, view and print degree evaluations
- Links to optional services such as parking, athletics, funding, research being conducted or campus directory
- Allow access for non-student to view grades

**My Finances Tab**
- Access account to check balance, pay tuition, view refunds or pay any other outstanding bill
- Apply for loans, scholarships, and other forms of financial aid
- Allow access for non-students to view and/or pay tuition, or any other bills on the student’s account

**Student Life Tab**
- Register for parking, sporting events pass, or on campus dining
- Get information on housing both on and off campus
- Get information as well as links for employment opportunities on and off campus
- Other helpful links such as the student recreation center or computing center
Electrical Engineering
Graduate Degrees
Requirements for Graduate Electrical Engineering Degrees
in the Department of Electrical and Computer Engineering

Master of Engineering Degree

1. Total Number of Hours (30)

   - Classroom hours must be taken from courses within the College of Engineering and/or College of Science.
   - At least 18 classroom hours must be ECEN courses.

3. Transfer hours allowed from another institution (6)
   - Transfer hours must be from a peer institution.
   - Transfer hours are subject to the approval of the GSC.

4. Undergraduate hours allowed (9)
   - Only 400 level undergraduate courses can be included on degree plan.
   - Courses must be from the College of Engineering and/or College of Science.

5. Seminar (681), Internship (684), Directed Studies (685) no more than (3) hours allowed (combined).
   - Research (691) hours are not allowed on an MEN degree plan.

6. ** A Final Project Report is required to be submitted to the Graduate Office.
   - A graded project from any ECEN and CSCE graduate course can be used to fulfill this requirement. The project requires a grade, the professor’s signature, and the name of the student highlighted. It must be submitted in the graduating semester; see ecampus page for submission deadlines and other requirements.

7. Composition of supervisory committee
   - The Graduate Coordinator will be the chair of all MEN committees. No other committee members are needed.
Requirements for Graduate Electrical Engineering Degrees
in the Department of Electrical and Computer Engineering

Master of Science Degree

1. Total Number of Hours (32)

   - Classroom hours must be taken from courses within the College of Engineering and/or
     College of Science.
   - At least 15 classroom hours must be ECEN courses.

3. A minimum of 5 hours of research (ECEN 691) must be included on the degree plan. A
   maximum of 8 research hours can be included. All 691s must be ECEN.

4. Transfer hours allowed from another institution (6)
   - Transfer hours must be from a peer institution.
   - Transfer hours are subject to the approval of the GSC.

5. Undergraduate hours allowed (9)
   - Only 400 level undergraduate courses can be included on degree plan.
   - Courses must be from the College of Engineering and/or College of Science.

6. Seminar (681), Internship (684), Directed Studies (685): no more than (3) hours allowed
   (combined).

7. Final defense of thesis is required for all MS students.
   - A thesis proposal must be approved by the supervisory committee and submitted to the
     Graduate Office at least 1 month before the defense.
   - Date and location of the thesis defense must be scheduled through the Graduate Office at
     least 1 month in advance so that official notification can be provided to OGAPS.
   - Thesis must be submitted to committee members at least two weeks before defense.
   - Please see ecampus page for details.

8. Composition of supervisory committee – four members total
   - At least two members from within the ECEN Department and within the student’s focus area.
   - At least one member from within the ECEN Department but outside the student’s focus area.
   - At least one member from outside the ECEN Department
   - Note: Committee Chair must be ECEN faculty.
Requirements for Graduate Electrical Engineering Degrees
in the Department of Electrical and Computer Engineering

Doctor of Philosophy Degree

1. Total Number of Hours (64 or 96)
   - For students who already hold a Master’s degree, 64 total hours are required.
   - For “direct PHD” students, 96 hours are required.

2. A minimum of 18 (or 42) classroom hours (excludes 681, 684, 685, and 691).
   - 18 hours required for students with a previous Master’s degree and 42 for direct PHD students.
   - Classroom hours must be taken from courses within the College of Engineering and/or College of Science.
   - At least 4 (or 24) classroom hours must be ECEN courses.

3. A maximum of (6-8) transfer hours allowed from another institution
   - Transfer hours must be from a peer institution.
   - Transfer hours are subject to the approval of the GSC.

4. Undergraduate hours allowed (9)
   - Only 400 level undergraduate courses can be included on degree plan.
   - If you used 400 level hours on your Master’s degree plan, then you must reduce the number of allowed undergraduate hours by that amount.

5. No more than 3 credit hours of Internship (684) are allowed.
   - PhD students cannot take 684 after dissertation defense.

6. No more than 2 credit hours of Directed Studies (685) are allowed.
   - Students working on a research project should enroll in Research (691) hours.

7. All PhD students are required to pass the Departmental Qualifying Examination
   - Incoming 64 hour PHD students are required to take the exam within one year of starting the program.
   - Students entering the program with a previous degree outside of Electrical or Computer Engineering or a 96 hour PHD are allowed, with the approval of their advisor, an extra year and will be required to take the exam by the end of the second year.
   - Those students that fail the examination are given a second opportunity to retake the exam which must be taken at the next opportunity in which the exam is offered.
   - Those that fail the examination twice will be removed from the PHD program.
   - More details of the Qualifying Exam are given later in this handbook.
   - Degree Plans are to be filed within one semester after passing the Qualifier for both 64 and 96 hour PHD students.
8. All PhD students are required to pass a **Preliminary Examination**.
   - 64 hours PhD students are required to schedule their prelim exam by the end of their 4th semester (excluding summers) and 6th semester for those with previous degree outside of Electrical or Computer Engineering and 96 hour PhD’s.
   - Students who have not scheduled their prelim by the appointed time will be blocked from further registration until they do so.
   - Date and location of the prelim must be scheduled through the Graduate Office *at least 1 month in advance* so that official notification can be provided to OGAPS.
   - Student must download the checklist and signature page from the OGAPS web site. The checklist must be signed by your advisor and Graduate Coordinator prior to the exam.
   - The prelim exam consists of a written and an oral examination.
   - For students who have passed the departmental Qualifying Exam, the written portion of the prelim exam can be waived subject to the approval of the student’s supervisory committee.
   - Students who fail the prelim exam will have one opportunity to retake the exam within 6 months of the original exam date.
   - *The proposal must be submitted to the Graduate Office within 5 business days after the prelim.* See pages 58-59 and ecampus page for details.

9. **Final Defense** of dissertation is required for all PhD students.
   - A dissertation proposal must be approved by the supervisory committee and submitted to the Graduate Office prior to the defense. This proposal is submitted in conjunction with the preliminary exam; it should be submitted to the Graduate Office within 10 days after the prelim.
   - Date and location of the final defense must be scheduled through the Graduate Office *at least 1 month in advance* so that official notification can be provided to OGAPS.
   - Dissertation must be submitted to committee members at least two weeks before defense.
   - Please see ecampus page for details.

10. **Composition of supervisory committee**
    - At least two members from within the ECEN Department and within the student’s focus area.
    - At least one member from within the ECEN Department but outside the student’s focus area.
    - At least one member from outside the ECEN Department.
    - Note: Committee Chair must be ECEN faculty.
Degree Plans
Degree Plans

A degree plan consists of:

- Degree program (e.g., Master of Science in Electrical Engineering)
- A list of courses to be taken to fulfill the degree requirements.
- A list of faculty who will form the supervisory committee.

Degree plan submission deadlines (excluding summers):

- All degree plans and petitions are submitted via DPSS (Document Processing Submission System) on the OGAPS website: [https://ogsdpss.tamu.edu/](https://ogsdpss.tamu.edu/)
- MEN/MS students must file a degree plan prior to the pre-registration period, starting your second (2nd) semester. Pre-registration dates are found on the Registrar’s website.
- 64 hour PhD students must file a degree plan within one year from the date they started the program or one semester after passing the PhD qualifier. For those with a previous degree outside of Electrical or Computer Engineering and 96 hour PhD’s must file a degree plan two years from the date they started the program or one semester after passing the PhD qualifier.
- Students who have not filed a degree plan by the deadlines indicated above will be blocked from registering for future semesters.
- The block will not be removed until the degree plan has been submitted.

Degree plan approval:

- Must be approved by all committee members, the Graduate Coordinator (or the Department Head), and the Office of Graduate and Professional Studies (OGAPS).
- Course changes can be made to the degree plan through petition which must be approved by all committee members.
- Changes of committee members must be approved by all members of the committee (both incoming and outgoing).

Other degree plan & course information:

- There is no limit to ECEN 689 courses that can be added to the degree plan for MEN, MS, or PHD students.
- Courses cannot be “converted” into other courses (ECEN 685 or 681 cannot be “converted” into ECEN 691 credit).
- Any changes to a degree plan, including course or committee member changes, take time to process. Keep this in mind as you make any changes and wait for approvals.
- Students are responsible for checking OGAPS deadlines each semester: [http://ogaps.tamu.edu/Buttons/Calendars](http://ogaps.tamu.edu/Buttons/Calendars)

The Office of Graduate and Professional Studies (OGAPS) website has important information regarding degree plans and degree completion: [http://ogaps.tamu.edu/](http://ogaps.tamu.edu/)
Miscellaneous Requirements
Miscellaneous Requirements

Foundation Courses
- Required of students with non-electrical or computer engineering undergraduate degrees.
- Do not count towards graduate degree requirements.
- Specific foundation courses required should be determined in consultation with your advisor.

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<th>Computer Engineering Foundation Courses</th>
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<td>ECEN 214, Electrical Circuit Theory</td>
<td>ECEN 248 Intro to Digital Systems Design</td>
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<tr>
<td>ECEN 314 Signals and Systems</td>
<td>ECEN 325 Electronics</td>
</tr>
<tr>
<td>ECEN 322 Electric and Magnetic Fields</td>
<td>CSCE 211 Data Structures &amp; Implementations</td>
</tr>
<tr>
<td>Two additional courses from one of the following areas of specialization:</td>
<td>CSCE 311 Analysis of Algorithms</td>
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<tr>
<td>• Electronics</td>
<td>ECEN 350 (or CSCE 321) Computer Architecture</td>
</tr>
<tr>
<td>• Power</td>
<td></td>
</tr>
<tr>
<td>• Electro-physics, electro-optics, microwaves</td>
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<tr>
<td>• Communications, Control, Signal Processing</td>
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Preregistration - All students currently enrolled MUST pre-register for future semesters during the pre-registration periods (in order to ensure sufficient enrollment).
- Preregistration dates can be found at http://registrar.tamu.edu/

Restricted Courses
- STAT 651, STAT 652, and STAT 685 are for non-science majors and are not allowed on EE or CE degree plans.
- Business courses will not be allowed on ELEN or CEEN degree plans (exception: MEN students in CEEN can include one course from the ISYS department).
- ELI registration does not count towards A&M hours.
- Traditionally no courses from Engineering Technology will be allowed because of the non-calculus based curriculum.
- Additional restrictions which apply to CE majors:
  ➢ CSCE 601 and 602 may not be taken for credit.
  ➢ Credit for both CSCE 614 and ECEN 651 is not allowed. CSCE 614 is only allowed in special circumstances with the advisor’s approval.
  ➢ Credit for CSCE 619 and CSCE 612 may not be allowed in addition to EEN 602. Please check with your advisor.

No credit will be given for the following foundation courses ECEN 214, ECEN 248, ECEN 314, ECEN 325, ECEN 350, CSCE 321, CSCE 211 and CSCE 311.
**Internships – ECEN 684**

- An internship can be taken after the student has had the opportunity to establish a solid theoretical base for the internship experience; e.g. after two semesters or 18 credit hours. If an internship is taken, you will receive graduate credit for 684 (1 credit hour per semester of internship). ECEN 684 must be on your degree plan and approved by your advisor prior to starting the internship.
- Students may take 1 ECEN distance learning course while on internship if the location is more than 60 miles away from Bryan/College Station.
- A report of your activities and an evaluation by your supervisor must be submitted to the Grad Office before a course grade is given.
- International students must submit CPT (Curricular Practical Training) paperwork to the Graduate Office in advance. CPT forms can be found at [http://iss.tamu.edu/](http://iss.tamu.edu/).
- Please see ecampus page for additional details and FAQs on CPT processing.

**Directed Studies – ECEN 685**

- Enrollment in directed studies (ECEN 685) requires approval of the instructor in whose section you are enrolling. The instructor must be ECEN faculty.
- The 685 request form is available on the ECEN ecampus site. A hard copy with original signatures of both the instructor and student must be submitted to the Graduate Office prior to enrollment. This form will describe the scope of the project and will indicate the basis on which a letter grade will be assigned.

**Change of Degree Programs**

- If you have received financial support from the department (through either an RA, TA, GANT, fellowship or scholarship), you may not switch to the MEN program from the MS or PHD program.
- If you are in the MEN program you may switch to the MS or PHD program with the approval of a supervising professor. Also, a transfer to the PHD program requires a minimum GPR of 3.6.
- MS students switching to the PHD program have two options:
  - 1) Change during MS program: Identify a PHD advisor and submit petition for degree change via DPSS. The Graduate Office must have email confirmation from PHD advisor.
  - 2) Change after MS program: Submit a [Letter of Intent](http://iss.tamu.edu/) (found on the OGAPS website) to the Graduate Office after defending. The Graduate Office must have email confirmation from PHD advisor.

**Change of Focus Area**

- You may not change your focus area during your first semester.
- After your first semester, you may change focus areas with the approval of both groups. Approval via email from group leaders is sufficient.

**Class Schedule Changes**

- Students may not request course changes after the 12\(^{th}\) class day of a new semester without providing the following to the Grad Office: statement explaining why course change is being requested, email from student’s advisor approving the schedule change, email from the instructor approving the student be added to the course.
- Late Fee Waivers will not be provided unless under extenuating circumstances.
Financial Aid
Financial Aid

- Many forms of financial aid are available to graduate students in the ECE department:
  - Research Assistantship (RA)
    - Offered by individual faculty members.
    - Pay rate varies from $1,350-$2,000 per month for Master’s and PHD students (for 20 hours per week).
    - Usually pays tuition.
  - Teaching Assistantship (TA)
    - Offered through the department.
    - Pays $1350/month for MS students and $1450/month for PhD students (for 20 hours per week). (To be updated)
    - Tuition paid for PHD’s only. (To be updated)
    - Apply through the ECE website at: https://edocs.tamu.edu/forms/ECEN-TA-Application/?ticket=ST-ZCOt7bYWSXmDV6Un4vuQTFBM0j2wqk59-cas-node-4
  - Graduate Assistant Non-Teaching (GANT) – Offered through a variety of sources.
  - Fellowships – Offered through OGAPS, the College of Engineering, the Department, and individual faculty.
  - One-Time Scholarships
    - $1,000 - offered on a competitive basis through the department.
    - Qualifies student to pay in-state tuition rate.
      - Awarded at beginning of fall semester to incoming students.
    - Apply through the ECE website at: https://records.ece.tamu.edu/TASchApp/ScholarshipApp/ScholarshipApp.php
  - Assistantships (RA, TA, GANT) require up to 20 hours per week of service.
  - Those receiving financial aid will be required to maintain full time status:
    - 9 semester hours during Fall/Spring
    - 6 hours during 10 week summer session
    - 3 hours during each 5 week summer session (Cannot combine course work from 10 week and 5 week in the summer session)
  - TA’s should make requests for continued funding by submitting the online application each semester.
  - RA’s should check with funding source on number of hours to register for.
  - If you received funding from the department, you cannot change your status to the Master Engineering Program from the Master of Science or Ph.D. program.
  - Students in non-degree status or probationary status are NOT eligible for financial aid.
Probation
Probation

- A Grade Point Ratio (GPR) equal to or better than 3.0 is required to maintain good academic standing. For purposes of probationary action, GPR is measured in three different manners:
  - Semester GPR,
  - Cumulative GPR,
  - Degree Plan GPR.

- A student will be placed on probation and blocked from pre-registration if any of the three indicated GPRs falls below 3.0. The student will be allowed to register once they have signed an acknowledgement letter stating that they understand the terms of the probation.

- One semester is allowed to correct the GPR deficiency and return it back up to 3.0 or better.

- If a student’s GPR deficiency is not corrected after one semester, the Graduate Studies Committee (GSC) will meet to discuss the case and may recommend a dismissal from the graduate program.

- A student being removed from the graduate program will be notified by the Graduate Office of such action. They will have 30 days from the date of notification to file an appeal to the Graduate Studies Committee. If the student does not appeal the decision or the GSC does not uphold the appeal, the GSC will then request the removal of the student from the program.

- A student who is on probation will not be allowed to hold any type of departmental financial support.
English Language Proficiency
**English Language Proficiency**

An international graduate student whose native language is not English must fulfill an English proficiency requirement through either English Proficiency Verification or English Language Certification. *This proficiency requirement should be met early in a student’s program, and it must be completed before scheduling either the final examination for the master’s degree or the preliminary examination for the doctoral degree.*

Two levels of English Proficiency Status for a graduate student include: English Proficiency Verified and English Proficiency Certified. **English Proficiency Certification is required by the State of Texas,** before a graduate student is eligible to serve as a Graduate Assistant-Teaching, or any other position considered to be a teaching position (e.g., instructor, lecturer, etc.). All other students must be either English Proficiency Verified or English Proficiency Certified.

**English Proficiency Verification** can be achieved by presenting:

- a TOEFL score of at least 80 on TOEFL iBT (550 paper-based), or
- an IELTS score of at least 6.0, or
- a GRE Verbal Reasoning score of at least 146 (400 on the old scale), or
- GMAT Verbal score of at least 22, or
- a PTE Academic score of at least 53, or
- acquiring alternative verification from the Office of Graduate and Professional Studies via a departmental request. An international graduate student holding a master’s degree from an accredited U.S. institution qualifies for alternative verification.

Individual colleges may choose to establish minimum TOEFL standards that exceed the University minimum for English Proficiency Verification. Scores from TOEFL examinations administered more than two years before submission of the application for admission shall not be eligible for English Proficiency Verification.

**English Proficiency Certification** can be achieved by:

- scoring at least 80 on each of the sections (reading, listening, written composition and oral skills) of the English Language Proficiency Examination (ELPE),
- acquiring alternative certification from the Office of Graduate and Professional Studies via a departmental request.

A student who has received a baccalaureate degree following four years of study at an accredited U.S. institution or institutions qualifies for alternative certification. All other requests for alternative certification require strong department justification and review in compliance with Office of Graduate and Professional Studies policies and guidelines.

An international student who has completed an equivalent English training program at
an institution other than Texas A&M may request English Proficiency Verification or Certification.

Verification or Certification is requested through the Departmental Graduate Advisor. The student should provide the Departmental Graduate Advisor with documentation to support Verification or Certification. If the department concurs with the request, the Departmental Graduate Advisor will submit a letter recommending and requesting Verification or Certification (with documentation attached) to the Office of Graduate and Professional Studies. The Office of Graduate and Professional Studies will determine on a case-by-case basis whether Verification or Certification is granted.
Areas of Specialization
Analog and Mixed-Signals
Area Leader: Dr. K. Entesari

Recommended Courses

Fall
(Undergraduate courses)
ECEN 454 Digital Integrated Circuit Design
ECEN 457 Operational Amplifiers
ECEN 474 VLSI Circuit Design
(Graduate courses)
ECEN 620 Network Theory
ECEN 622 Active Network Synthesis
ECEN 665 Integrated CMOS RF Circuits and Systems

Spring
(Graduate courses)
ECEN 607 Advanced Analog Circuit Design Techniques
ECEN 610 Mixed Signal Interfaces
ECEN 625 Millimeter-Wave Integrated Circuits
ECEN 650 High Frequency GaAs/SiGe Analog IC Design
ECEN 651 Microprogrammed Control of Digital Systems
ECEN 654 Very Large Scale Integrated Systems Design
ECEN 671 Solid State Devices
ECEN 720 High Speed Links Circuits and Systems
Other courses that may be taken:
ECEN 458 Active Filter Analysis and Design
ECEN 609 Adaptive Control
ECEN 606 Nonlinear Control Systems
ECEN 639 Microwave Circuits
ECEN 644 Discrete –Time Systems
ECEN 680 Testing and Diagnosis of Digital Systems

Master of Engineering:
(Undergraduate/graduate courses)
ECEN 474 VLSI Circuit Design
ECEN 607 Advanced Analog Circuit Design Techniques
ECEN 610 Mixed Signal Interfaces
ECEN 620 Network Theory
ECEN 665 Integrated CMOS RF Circuits and Systems
At least two from the following:
ECEN 457 Operational Amplifiers
ECEN 622 Active Network Synthesis
ECEN 625 Millimeter-Wave Integrated Circuits
ECEN 650 High Frequency GaAs/SiGe Analog IC Design
ECEN 654 Very Large Scale Integrated Systems Design
ECEN 671 Solid State Devices
ECEN 720 High Speed Links Circuits and Systems
ECEN 689 (Special Topics)
Biomedical Imaging & Genomic Signal Processing
Area Leader: Dr. S. Wright

Recommended Courses

**Master of Science:**

*(Undergraduate)*

- ECEN 410 Introduction to Medical Imaging
- ECEN 411 Introduction to Magnetic Resonance Imaging and Magnetic Resonance Spectroscopy
- ECEN 412 Ultrasound Imaging
- ECEN 414 Biosensors
- ECEN 419 Genomic Signal Processing
- ECEN 444 Digital Signal Processing
- ECEN 447 Digital Image Processing
- ECEN 451 Antenna Engineering
- ECEN 452 Ultra High Frequency Techniques
- ECEN 463 Magnetic Resonance Engineering (Stacked with 763)

*(Graduate)*

- ECEN 601 Linear Network Analysis
- ECEN 617 Advanced Signal Processing for Medical Imaging
- ECEN 635 Electromagnetic Theory
- ECEN 636 Phased Arrays
- ECEN 637 Numerical Methods in Electromagnetics
- ECEN 642 Digital Image Processing
- ECEN 644 Discrete-Time Systems
- ECEN 645 Pattern Recognition by Neural Networks
- ECEN 648 Principles of Magnetic Resonance Imaging
- ECEN 649 Pattern Recognition
- ECEN 660 BioMems & Lab-on-a-Chip
- ECEN 661 Modulation Theory
- ECEN 662 Estimation and Detection Theory
- ECEN 663 Data Compression with Applications to Speech and Video
- ECEN 669 Engineering Applications in Genomics
- ECEN 678 Statistical Optics
- ECEN 760 Introduction to Probabilistic Graphical Models
- ECEN 761 Biosensors Lab
- ECEN 762 Ultrasound Imaging
- ECEN 763 Magnetic Resonance Engineering (Stacked with 463)

**Master of Engineering:**

MEN students must take at least five ECEN courses chosen from the list above or from 689 courses in the biomedical imaging area.
Two of these five must be chosen from the following courses:

(Undergraduate/graduate courses)
- ECEN 410/764 Medical Imaging
- ECEN 411 Intro. MRI and MRS
- ECEN 412 Ultrasound Imaging
- ECEN 444 Digital Signal Processing
- ECEN 447 Digital Image Processing
- ECEN 642 Digital Image Processing
- ECEN 646 Statistical Communication Theory
- ECEN 649 Pattern Recognition

Please check the webpage [http://bio.ece.tamu.edu](http://bio.ece.tamu.edu).
Electromagnetics & Microwaves
Area Leader: Dr. R. Nevels

**Recommended Courses for Master of Science and Master of Engineering**

(Undergraduate courses)

ECEN 351 Applied Electromagnetic Theory
ECEN 451 Antenna Engineering
ECEN 452 Ultra High Frequency Techniques
ECEN 453 Microwave Solid-State Circuits and Systems
ECEN 480 RF and Microwave Wireless Systems

(Graduate courses)

ECEN 626 Antenna Theory and Technique
ECEN 635 Electromagnetic Theory
ECEN 636 Phased Arrays
ECEN 637 Numerical Methods in Electromagnetics
ECEN 638 Antennas and Propagation
ECEN 639 Microwave Circuits
ECEN 641 Microwave Solid State Integrated Circuits
ECEN 730 CMOS RFIC Engineering
ECEN 735 Electromagnetic Field Theory
Electric Power & Power Electronics
Area Leader: Dr. H. Toliyat

Recommended Courses

**Master of Science:**

(Undergraduate courses)
ECEN 415 Physical and Economical Operations of Sustainable Energy Systems
ECEN 459 Power System Fault Analysis and Protection
ECEN 460 Power System Operation and Control
ECEN 438 Power Electronics
ECEN 441 Electronic Motor Drives
ECEN 442/742 DSP Based Electromechanical Motion Control

(Graduate courses)
ECEN 611 General Theory of Electromechanical Motion Devices
ECEN 612 Computer Aided Design of Electromechanical Motion Devices
ECEN 613 Rectifier and Inverter Circuits
ECEN 614 Power Systems State Estimation
ECEN 615 Methods of Electric Power Systems Analysis
ECEN 616 Power System Electromagnetic Transients
ECEN 630 Analysis of Power Electronics Systems
ECEN 632 Motor Drive Dynamics
ECEN 643 Electric Power System Reliability
ECEN 666 Power System Faults and Protective Relaying
ECEN 667 Power System Stability
ECEN 668 High Voltage Direct Current (HVDC) Transmission
ECEN 677 Control of Electric Power Systems
ECEN 679 Computer Relays for Electric Power Systems
ECEN 686 Electric and Hybrid Vehicles
ECEN 689 Special Topics
ECEN 710 Switching Power Supplies
ECEN 711 Sustainable Energy & Vehicle Engineering
ECEN 712 Power Electronics for Photovoltaic Energy Systems
ECEN 715 Physical and Economical Operations of Sustainable Energy Systems
ECEN 742/442 DSP Based Electromechanical Motion Control

**Master of Engineering:**
15 credit hours to be taken in the Electric Power and Power Electronics courses that are listed above.
Device Science and Nanotechnology
Area Leader: Dr. P.R. Hemmer

Recommended Courses

Master of Science:

(Undergraduate courses in Solid State)
ECEN 370 Electronic Properties of Materials
ECEN 472 Microelectronic Circuit Fabrication
ECEN 473 Microelectronic Device Design

(Graduate courses in Solid State)
ECEN 656 Physical Electronics
ECEN 658 Low Noise Electronic Design
ECEN 671 Solid State Devices
ECEN 673 Fundamentals of Microelectronics
ECEN 770 Organic Semiconductor
ECEN 771 Fluctuations & Noise Electronics
ECEN 772 Introduction to Microelectromechanical Devices and Systems

(Undergraduate courses in Electro-optics)
ECEN 462 Optical Communication Systems
ECEN 464 Optical Engineering

(Graduate courses in Electro-optics)
ECEN 631 Fiber-Optic Devices
ECEN 657 Quantum Electronics
ECEN 670 Fiber-Optic Networks
ECEN 672 Semiconductor Lasers and Photodetectors
ECEN 675 Integrated Optoelectronics
ECEN 678 Statistical Optics

Non-ECEN
PHYS 408 Thermodynamics and Statistical Mechanics
PHYS 412 Quantum Mechanics I
PHYS 606 Quantum Mechanics
PHYS 617 Physics of Solid State
STAT 601 Statistical Analysis
MATH 601 Methods of Applied Mathematics I
MATH 602 Methods and Applications of Partial Differential Equations
**Master of Engineering - Solid State:**

(Undergraduate courses in Solid State)
ECEN 472 Microelectronic Circuit Fabrication
ECEN 473 Microelectronic Device Design

(Graduate courses in Solid State)
ECEN 656 Physical Electronics
ECEN 658 Low Noise Electronic Design
ECEN 671 Solid State Devices
ECEN 673 Fundamentals of Microelectronics
ECEN 770 Organic Semiconductor
ECEN 772 Introduction to Microelectromechanical Devices and Systems

Non-ECEN
MATH 601 Methods of Applied Mathematics I
MATH 602 Methods and Applications of Partial Differential Equations

**Master of Engineering - Electro-optics:**

(Undergraduate courses in Electro-optics)
ECEN 462 Optical Communication Systems
ECEN 464 Optical Engineering

(Graduate courses in Electro-optics)
ECEN 601 Linear Network Analysis
ECEN 602 Computer Communication and Networking
ECEN 631 Fiber-Optic Devices
ECEN 657 Quantum Electronics
ECEN 670 Fiber-Optic Networks
ECEN 672 Semiconductor Lasers and Photodetectors
ECEN 675 Integrated Optoelectronics
ECEN 678 Statistical Optics

Non-ECEN
PHYS 412 Quantum Mechanics I
PHYS 606 Quantum Mechanics
STAT 601 Statistical Analysis
MATH 417 Numerical Analysis I
MATH 601 Methods of Applied Mathematics I
MATH 602 Methods and Applications of Partial Differential Equations
MATH 610 Numerical Methods in Partial Differential Equations

Alternatives:
ECEN 639 Microwave Circuits
ECEN 689 Special Topics
Information Science and Systems  
Area Leader: Dr. S.P. Bhattacharyya

**Recommended first-level graduate courses**

ECEN (undergraduate courses)  
410, 412, 419, 420, 421, 444, 447, 448, 455, 478

ECEN (graduate courses)  
601, 604, 605, 629, 642, 644, 646, 647, 649, 655, 661, 662, 663, 683

**Foundation Courses (no graduate credit)**

ECEN 214 Electrical Circuit Theory  
ECEN 248 Introduction to Digital Systems Design  
ECEN 303 Random Signals & Systems  
ECEN 314 Signals and Systems  
ECEN 325 Electronics  
ENGL 301 Technical Writing

**Tentative List of Courses for Graduate ISS Students**

**Communications/Information Theory**

ECEN 601 Linear Network Analysis – (a better title is Mathematical Methods in Communications and Signal Processing)  
ECEN 604 Channel Coding for Communications Systems  
ECEN 646 Statistical Communication Theory (Probability and Random Processes)  
ECEN 629 Convex Optimization for Electrical Engineering  
ECEN 647 Information Theory  
ECEN 655 Advanced Topics in Channel Coding  
ECEN 661 Modulation Theory (a better title is Digital Communications)  
ECEN 663 Data Compression with Applications to Speech & Video  
ECEN 683 Wireless Communications Systems  
ECEN 689 Special Topics – change from year to year  
ECEN 760 Introduction to Probabilistic Graphical Models

**Signal and Image Processing:**

ECEN 601 Linear Network Analysis  
ECEN 629 Convex Optimization for Electrical Engineering  
ECEN 642 Digital Image Processing  
ECEN 644 Discrete-Time Systems  
ECEN 646 Statistical Communication Theory (Probability and Random Processes)  
ECEN 649 Pattern Recognition  
ECEN 662 Estimation and Detection Theory  
ECEN 663 Data Compression with Applications to Speech & Video  
ECEN 760 Introduction to Probabilistic Graphical Models
**Controls:**
ECEN 601 Linear Network Analysis
ECEN 605 Linear Control Systems (name change: Linear Systems)
ECEN 606 Nonlinear Control Systems
ECEN 608 Modern Control
ECEN 609 Adaptive Control
ECEN 628 Linear System Theory (name change: Robust Control)
ECEN 633 Optimum Control Systems

**Genomics:**
ECEN 669 Engineering Applications in Genomics

**Networks:**
ECEN 423 Computer and Wireless Communication Network
ECEN 602 Computer Communications and Networking
ECEN 619 Internet Protocols and Modeling
ECEN 621 Mobile Wireless Networks
ECEN 689 Special Topics – changes from year to year

**MATH / STAT/MEEN/NUEN:**
MATH 415 Modern Algebra I
MATH 416 Modern Algebra II
MATH 446 Principles of Analysis
MATH 447 Principles of Analysis II
STAT 601 Statistical Analysis
MATH 606 Theory of Probability I
MATH 607 Real Variables I
MATH 608 Real Variables II
MATH 619 Applied Probability
MATH 651 Optimization I
MATH 652 Optimization II
MATH 653 Algebra I
MATH 654 Algebra II
MEEN 641 Quantitative Feedback Theory
MEEN 651 Control System Design
MEEN 652 Multivariable Control System Design
MEEN 674 Modern Control
MATH 601 Methods of Applied Mathematics I
NUEN 689 (Special Topics)

**Hardware/VLSI:**
ECEN 449 Microprocessor System Design
ECEN 454 Digital Integrated Circuit Design
ECEN 468 Advanced Logic Design

You may want to talk to professors in the Computer Engineering department about courses that will suit your background and interests.
Graduate Degrees
Computer Engineering and Systems
Requirements for Graduate Computer Engineering Degrees
in the Department of Electrical & Computer Engineering

A. MASTER OF ENGINEERING IN COMPUTER ENGINEERING (Non-Thesis)

1. Total number of hours (30)
   • Classroom hours must be taken from courses within the College of Engineering and/or College of Science.
   • One course from the ISYS Dept. in the College of Business is allowed.
   • A minimum of 24 classroom hours from the Departments of CSCE and ECEN
   • At least 13 of these 24 hours must be in ECEN.
   • At least 6 courses from the CEEN MEN student course list – see p. 42.

3. Transfer hours allowed from another institution (6)
   • Transfer hours must be from a peer institution
   • Transfer hours are subject to approval of the Graduate Studies Committee.

4. Undergraduate hours allowed (6)
   • Only 400 level undergraduate courses can be included on degree plan.
   • Courses must be from the College of Engineering and/or College of Science.

5. One hour of seminar is allowed (ECEN/CSCE 681) but is NOT required.

6. Seminar (681), Internship (684), Directed Studies (685) no more than (3) hours allowed (combined).
   • Research (691) are not allowed on the MEN degree plan.

7. ** A Final Project Report is required to be submitted to the Graduate Office.
   • A graded project from any ECEN and CSCE graduate course can be used to fulfill this requirement. The project requires a grade, the professor’s signature, and the name of the student highlighted. It must be submitted in the graduating semester; see ecampus page for submission deadlines and other requirements.

8. Composition of supervisory committee
   • The Graduate Coordinator will be the chair of all MEN committees. No other committee members are needed.

9. Additional course requirements are listed in D.
B. MASTER OF SCIENCE IN COMPUTER ENGINEERING (Thesis)

1. Total number of hours (32)
   - A minimum of 21 classroom hours from the College of Engineering and/or College of Science.
   - **Courses on degree plan must be approved by Thesis Advisor.**

3. Transfer hours allowed from another institution (6)
   - Transfer hours must be from a peer institution.
   - Transfer hours are subject to approval of the Graduate Studies Committee.

4. Undergraduate hours allowed (6)
   - Only 400 level undergraduate courses can be included on the degree plan.
   - **Courses must be approved by Thesis Advisor.**

5. Seminar, seminar, and research (681, 685, & 691)
   - 8 hours maximum of these courses
   - 4 hours minimum of 691
     - Note: If co-chair is outside of ECEN, research credits must be split 50/50 between chair and co-chair.
   - 1 hour of seminar (ECEN/CSCE 681) is required
   - No more than 3 hours (in combination) of ECEN 681, 684, and 685.

6. Final defense of thesis is required for all MS students.
   - A thesis proposal must be approved by the supervisory committee and submitted to the Graduate Office **at least 1 month before the defense.**
   - Date and location of the thesis defense must be scheduled through the Graduate Office **at least 1 month in advance** so that official notification can be provided to OGAPS.
   - Thesis must be submitted to committee members at least two weeks before defense.
   - Please see ecampus page for details.

7. Composition of supervisory committee – at least 3 members total
   - At least two members within Computer Engineering Group from ECEN
   - At least one member from outside ECEN
   - Note: Committee Chair must be ECEN faculty. Co-chair may be from outside department.

8. Additional course requirements are listed in D.
C. Ph.D. IN COMPUTER ENGINEERING

1. Total number of hours (64 or 96)
   - For students who already hold a Master’s Degree, 64 total hours are required.
   - For “direct PhD” students, 96 hours are required.

2. A minimum of 18 (or 42) classroom hours (excludes 681, 684, 685, and 691).
   - 18 hours required for students with a previous Master’s degree and 42 for direct PHD students.
   - Classroom hours must be taken from courses within the College of Engineering and College of Science.
   - **Courses on degree plan must be approved by Dissertation Advisor.**

3. A maximum of (6) transfer hours allowed from another institution.
   - Transfer hours must be from a peer institution.
   - Transfer hours are subject to the approval of the Graduate Studies Committee.

4. Undergraduate hours allowed (8 hours / 2 courses)
   - Only 400 level courses can be included on degree plan.
   - If you used 400 level hours on your Master’s degree plan, then you must reduce the number of allowed undergraduate hours by that amount.

5. No more than 3 credit hours of Internship (684) are allowed.
   - PHD students cannot take 684 after dissertation defense.

6. Three (3) hours of Seminar (ECEN/CSCE 681) are required.

7. No more than 2 credit hours of Directed Studies (685) are allowed.
   - Students working on a research project should enroll in Research (691) hours.

8. All PhD students are required to pass the **Departmental Qualifying Examination**
   - Incoming 64 hour PHD students are required to take the exam within one year of starting the program.
   - Students entering the program with a previous degree outside of Electrical or Computer Engineering or a 96 hour PHD are allowed, with the approval of their advisor, an extra year and will be required to take the exam by the end of the second year.
   - Those students that fail the examination are given a second opportunity to retake the exam which must be taken at the next opportunity in which the exam is offered.
   - Those that fail the examination twice will be removed from the PHD program.
   - More details of the Qualifying Exam are given later in this handbook.
   - Degree Plans are to be filed within one semester after passing the Qualifier for both 64 and 96 hour PHD students.

9. All PhD students are required to pass a **Preliminary Examination**.
   - 64 hours PhD students are required to schedule their prelim exam by the end of their 4th semester (excluding summers) and 6th semester for those with previous degree outside of Electrical or Computer Engineering and 96 hour PhD’s.
• Students who have not scheduled their prelim by the appointed time will be blocked from further registration until they do so.
• Date and location of the prelim must be scheduled through the Graduate Office at least 1 month in advance so that official notification can be provided to OGAPS.
• Student must download the checklist and signature page from the OGAPS website. The checklist must be signed by your advisor and Graduate Coordinator prior to the exam.
• The prelim exam consists of a written and an oral examination.
• For students who have passed the departmental Qualifying Exam, the written portion of the prelim exam can be waived subject to the approval of the student’s supervisory committee.
• Students who fail the prelim exam will have one opportunity to retake the exam within 6 months of the original exam date.
• The proposal must be submitted to the Graduate Office within 5 business days after the prelim. See pages 58-59 and ecampus page for details.

10. Final Defense of dissertation is required for all PhD students.
• A dissertation proposal must be approved by the supervisory committee and submitted to the Graduate Office prior to the defense. This proposal is submitted in conjunction with the preliminary exam; it should be submitted to the Graduate Office within 10 days after the prelim.
• Date and location of the final defense must be scheduled through the Graduate Office at least 1 month in advance so that official notification can be provided to OGAPS.
• Dissertation must be submitted to committee members at least two weeks before defense.
• Please see ecampus page for details.

11. Composition of supervisory committee – at least 4 members total
• At least two members from within Computer Engineering Group from ECEN.
• At least one member not in CE Group, but in ECEN Department.
• At least one member from outside the ECEN Department.

12. Additional course requirements are listed in D.
D. ADDITIONAL COURSE REQUIREMENTS

- STAT 651 and STAT 652 (statistics courses) are for non-science majors and are not allowed. Traditionally no courses will be admitted from Engineering Technology because of the non-calculus based curriculum and no approved graduate program.

- Credit for CSCE 614 may not be allowed in addition to ECEN 651. Please check with your research advisor.

- Credit for CSCE 619 and CSCE 612 may not be allowed in addition to ECEN 602. Please check with your advisor.

- No credit will be given for CSCE 601 & 602.

- No credit will be given for the following foundation courses ECEN 214, ECEN 248, ECEN 314, ECEN 325, ECEN 350, CSCE 321, CSCE 211 and CSCE 311.

REVISED 12/9/16 caw
Computer Engineering and Systems Courses
Computer Engineering & Systems Group
Area Leader: Dr. J. Hu

Recommended first-level graduate courses

ECEN (undergraduate courses)
   468

CSCE (undergraduate courses)
   410

ECEN (graduate courses)
   602, 621, 651, 653, 654, 687, 714, 754, 749

CSCE (graduate courses)
   614, 629, 662

Foundation Courses (no graduate credit)
ECEN 214  Electrical Circuit Theory
ECEN 248  Introduction to Digital Systems Design
ECEN 314  Signals & Systems
ECEN 325  Electronics
ECEN 350  Computer Architecture and Design
ECEN 423  Computer and Wireless Communications Networks
CSCE 211  Data Structures and Their Implementations
CSCE 311  Analysis of Algorithms

Tentative List of Courses for Graduate CEEN Students
12/9/16

Hardware/VLSI:
ECEN 454/714 Digital Integrated Circuit Design
ECEN 468 Advanced Digital System Design
ECEN 749 Microprocessor System Design
ECEN 624 IC Design Tools
ECEN 654 VLSI System Design
ECEN 680 Test and Diagnosis of Digital Systems
ECEN 687 Introduction to VLSI Logic Synthesis
ECEN 699 Advances in VLSI Logic Synthesis
ECEN 751 Advanced Computational Methods for Integrated System Design
ECEN 752 Advances in VLSI Circuit Design
CSCE 661 Integrated Systems Design Automation
Networks:
ECEN 602 Computer Comm. And networking
ECEN 619 Internet Protocols and Modeling
ECEN 621 Mobile Wireless Networks
ECEN 627 Multimedia Systems and Networks
CSCE 663 Real-Time Systems
CSCE 665 Advanced Networking and Security
CSCE 664 Wireless and Mobile Systems
ECEN 689 Special Topics Courses (provided by Computer Engineering & Systems Group)

Computer Architecture:
ECEN 651 Microprogrammed Control of Digital Syst. (not CSCE 614)
ECEN 653 Computer Arithmetic Unit Design
ECEN 659 Parallel/Distributed Numerical Algorithms and Applications
ECEN 676 Advanced Computer Architecture
CSCE 605 Compiler Design

Systems and Software:
CSCE 410 Operating Systems
CSCE 606 Software Engineering
CSCE 629 Analysis of Algorithms
CSCE 662 Distributed Processing Systems
CSCE 670 Information Retrieval and Storage

Network & Systems Theory:
ECEN 434/754 Optimization for Electrical & Computer Engineering Applications
ECEN 663 Data Compression with Applications to Speech and Video
ECEN 750 Theory and Applications of Network Coding
ECEN 753 Stochastic Systems
ECEN 689 Special Topics Courses (provided by Computer Engineering & Systems Group)

Math / Stat:
MATH 415 Modern Algebra I
MATH 416 Modern Algebra II
MATH 446 Principles of Analysis
MATH 447 Topics in Analysis II
STAT 601 Statistical Analysis
MATH 606 Theory of Probability I
MATH 607 Real Variables I
MATH 608 Real Variables II
MATH 652 Optimization II

English:
ENGL 301 Technical Writing (no graduate credit)
Tentative List of Courses for CEEN MEN Students
(Must take at least 6 courses out of the list below)

12/9/19

Hardware/VLSI:
ECEN 449/749 Microprocessor System Design
ECEN 454/714 Digital Integrated Circuit Design
ECEN 468 Advanced Digital System Design
ECEN 654 VLSI System Design
ECEN 680 Test and Diagnosis of Digital Systems
ECEN 687 Introduction to VLSI Logic Synthesis
ECEN 699 Advances in VLSI Logic Synthesis
ECEN 751 Advanced Computational Methods for Integrated System Design
ECEN 752 Advances in VLSI Circuit Design

Networks:
ECEN 602 Computer Comm. And networking
ECEN 619 Internet Protocols and Modeling
ECEN 621 Mobile Wireless Networks
ECEN 627 Multimedia Systems and Networks
CSCE 663 Real-Time Systems
CSCE 665 Advanced Networking and Security
CSCE 664 Wireless and Mobile Systems
ECEN 689 Special Topics Courses (provided by Computer Engineering & Systems Group)

Computer Architecture:
ECEN 651 Microprogrammed Control of Digital Syst. (not CSCE 614)
ECEN 653 Computer Arithmetic Unit Design
ECEN 676 Advanced Computer Architecture
CSCE 605 Compiler Design

Systems and Software:
CSCE 410 Operating Systems
CSCE 606 Software Engineering
CSCE 629 Analysis of Algorithms
CSCE 662 Distributed Processing Systems
CSCE 670 Information Retrieval and Storage

Networking & Systems Theory:
ECEN 434/754 Optimization for Electrical & Computer Engineering Applications
ECEN 663 Data Compression with Applications to Speech and Video
ECEN 750 Design and Analysis of Communication Networks
ECEN 753 Theory and Applications of Networking Coding
ECEN 755 Stochastic Systems
ECEN 689 Special Topics Courses (provided by Computer Engineering & Systems Group)
PHD Qualifiers
Department of Electrical and Computer Engineering
PhD Qualifying Examination

The Departmental Qualifying Exam is based on material covered in a set of nine fundamental undergraduate courses in Electrical and Computer Engineering.

ECEN 214 – Electrical Circuit Theory
ECEN 248 – Introduction to Digital Systems Design
CSCE 221 – Data Structures and Algorithms
ECEN 303 – Random Signals and Systems
ECEN 314 – Signals and Systems
ECEN 322 – Electric and Magnetic Fields
ECEN 325 – Electronics
ECEN 350 – Computer Architecture and Design
ECEN 370 – Electronic Properties of Materials

Any student that has graduated from either of the undergraduate programs in our department should have taken at least 8 of these courses. Students who have degrees from peer programs should have taken courses similar to many of these.

Exam Format: The exam consists of two questions from each of the areas listed above. Each question is designed to be completed in 20-25 minutes. Each student is required to answer any 6 of the 18 questions on the exam. This insures that each student has at least some proficiency outside of their main focus area, but does not require students to study extensively outside of their area of expertise. The exam is closed book, in-class, and time limited to 3 hours. Students must use department-issued calculators for the exam; personal calculators are not permitted. Students can check-out an ECEN calculator 1 week prior to the exam to become accustomed to it if needed.

Exam Syllabus – Included at the end of this document is an exam syllabus explicitly outlining the material that might be tested for each of the courses listed above. Hence the students will have an explicit list of topics to prepare for rather than a general “material from course xxx” type statement.

Timing: The exam is offered twice a year, once in mid-January shortly before the start of the spring semester, and once in mid-June. In both cases, the exam date is about one month after the end of finals. This encourages students not to spend more than one month preparing for the exam. 1-2 months before the test dates, the Graduate Office will send an email with a link for students to sign up for the exam. Incoming PHD students are required to take the exam within one year of starting the program. Students entering the program with a previous degree outside of Electrical or Computer Engineering will be allowed, with the approval of their advisor, an extra year and will be required to take the exam by the end of the second year. Those students that fail the examination will be given a second opportunity to retake the exam which must be taken at the next opportunity in which the exam is offered. Those that fail the examination twice will be removed from the PHD program. Current MS or MENG students are not allowed to take the qualifying exam.
**Grading:** The faculty who composed each problem will grade their perspective problems in the written exams. Once grading is complete, the GSC will meet to determine passing thresholds for the examination. The GSC may elect to normalize grades from each problem in order to maintain fairness across the various problems. Results of the exam will be available within four weeks of the date of the exam. Appeals regarding the results of the exam by either students or faculty must be submitted in writing to the Graduate Office and will be handled by the GSC.

**Note:** PHD students who pass the Qualifier are required to submit degree plans within 1 semester after passing the exam.
PhD Qualifying Examination
Electric Circuit Analysis – ECEN 214

1. Basic Circuit Theory
   a. Ideal Voltage/Current Sources
   b. Circuit elements and governing equations: Resistors, capacitors, inductors
   c. Kirchhoff’s Laws

2. Basic Circuit Analysis
   a. Node-Voltage method
   b. Mesh-current method
   c. Source transformation
   d. Thevenin/Norton equivalent circuits
   e. Maximum power transfer
   f. Superposition

3. DC Transient Circuit Analysis
   a. Natural response of an RL circuit
   b. Natural response of an RC circuit
   c. Step response of an RL circuit
   d. Step response of an RC circuit
1. Logic gates and Boolean Algebra
   a. Theorems of Boolean Algebra
   b. Variables, literals, minterms, maxterms, cubes
   c. Two-level logic minimization
   d. Incompletely specified logic functions
   e. Canonical representations of logic functions

2. Combinational Logic
   a. Shannon’s Expansion Theorem
   b. Multi-level logic optimization
   c. Timing analysis
   d. Special circuits – MUXes, Decoders, Encoders, PLAs, FPGAs, CPLDs,

3. Arithmetic Circuits
   a. Addition
   b. Subtraction and 2's complement
   c. Multiplication
   d. Division
   e. Arithmetic Sums-of-products
   f. Floating point arithmetic

4. Sequential Design
   a. Latches, Flip-flops, Registers
   b. Counters
   c. State machines
   d. Incomplete specification and non-determinism

5. MOS based Logic Circuits
   a. Basic MOS based realization of logic elements
   b. Circuit design styles
   c. Design of gates and memory elements
PhD Qualifying Examination
Data Structures and Algorithms – CSE 221

1. Data Structures
   a. Stacks
   b. Queues
   c. Linked lists
   d. The tree abstract data type and data structures for representing trees
   e. Properties of binary trees
   f. Binary search trees
   g. AVL trees
   h. Red-black trees
   i. The priority queue abstract data type
   j. The heap data structure
   k. Hash tables
   l. Data structure of graphs
      i. The edge list
      ii. The adjacency list
      iii. The adjacency matrix

2. Algorithms
   a. Sorting
      i. Merge-sort
      ii. Quick-sort
   b. The Huffman coding algorithm
   c. Solving the longest common subsequence problem using dynamic programming
   d. Basic algorithms on trees
      i. Pre-order traversal
      ii. Post-order traversal
   e. Graph traversal
      i. Depth-first search
      ii. Breadth-first search
   f. Topological order and sorting of directed acyclic graphs
   g. Shortest paths: Dijkstra’s algorithm
   h. Minimum spanning trees
      i. Kruskal’s algorithm
      ii. Prim’s algorithm

3. Complexity Analysis
   a. Asymptotic notations: the “big-Oh” notation
   b. Asymptotic analysis using the big-Oh notation
PhD Qualifying Examination
Probability and Random Variables – ECEN 303

1. **Discrete Probability**
   a. Joint/Conditional probabilities
   b. Independence
   c. Bayes’ theorem
   d. Discrete random variables

2. **Continuous Random Variables**
   a. Cumulative distribution functions (CDFs) and probability density functions (PDFs)
   b. Gaussian random variables, standardized Gaussian integrals
   c. Conditional distribution and density functions
   d. Expected values, moments and conditional expected values
   e. Transformations of random variables
   f. Characteristic functions and moment generating functions
   g. Chernoff Bounds

3. **Multiple random variables**
   a. Joint and conditional CDFs and PDFs
   b. Independence
   c. Jointly Gaussian random variables
   d. Transformations of multiple random variables
   e. Random sequences – definitions of convergence modes and relationships between various modes
   f. Law of large numbers
   g. Central limit theorem
1. **Signals**
   a. Mathematical description and pictorial representation of commonly used continuous-time signals and discrete time signals such as rectangular signal, unit step, dirac-delta, ramp, sinusoidal, complex exponential signals, sinc
   b. Even and odd signals, periodic signals
   c. Transformations of the independent variable – shift in time, scaling of the time axis
   d. Signal energy, power, auto-correlation, cross correlation, sifting property of the impulse

2. **Basic properties of systems**
   a. Systems with and without memory, linearity, invertibility, causality, stability, time invariance.

3. **Linear Time – Invariant Systems**
   a. Impulse response of a system
   b. Convolution in discrete-time and continuous-time
   c. Properties of LTI systems – commutative property, distributive property, associative property, invertibility, causality, stability
   d. LTI systems described by differential (or, difference) equations
   e. Block diagram representation of systems represented by differential (or, difference) equations
   f. Eigen functions of LTI systems

4. **Fourier series representation of periodic signals**
   a. Determination of trigonometric and complex exponential Fourier series for continuous time and discrete time periodic signals
   b. Convergence of the Fourier series
   c. Properties of the FS – linearity, shifting in time, scaling of the time axis, multiplication, conjugation, conjugate symmetry, Parseval’s identity (See also section of properties of the Fourier Transform)

5. **Continuous-time and discrete-time Fourier transform**
   a. Development of the Fourier transform of an aperiodic signal
   b. Dirichlet conditions, convergence of the Fourier transform
   c. Computing the Fourier transform from the definition
   d. Memorize Fourier transform of basic signals such as rectangular signal, sinc, delta, exponential signal
   e. Properties of the Fourier transform – linearity, time shift, frequency shift, scaling of the time axis and frequency axis, conjugation and symmetry, time reversal, differentiation and integration, duality, Parseval’s relation. Be conversant in using the properties of Fourier transforms to compute the FT of signals that can be obtained from simpler signals through a series of the above operations.
   f. Convolution and multiplication property
g. Inverse Fourier transform – be able to compute this from definition as well as from looking up the transform for elementary signals. Be able to use partial fraction expansions to compute the Inverse Fourier transform.

h. Magnitude and phase representation of the Fourier transform and frequency response of LTI systems

6. **Applications of the Frequency domain analysis of signals and systems**
   b. Sampling – Nyquist theorem, effects of aliasing, ideal reconstruction of the signal from its samples
   c. Modulation – Amplitude modulation, Hilbert transform, DSB and SSB carrier modulation

7. **Laplace Transforms**
   a. Definition, region of convergence, inverse Laplace transform
   b. Pole-Zero plot
   c. Properties of the Laplace transform -- linearity, time shift, frequency shift, scaling of the time axis and frequency axis, conjugation and symmetry, time reversal, differentiation and integration, duality, Parseval’s relation, initial and final value theorems
   d. Solving differential equations using Laplace transforms

8. **Z-transforms**
   a. Definition of direct z-transform, region of convergence (ROC), inverse z-transform using partial fraction expansion
   b. Pole-zero plot
   c. Properties of Z-transform -- linearity, time shift, z-scaling, time reversal, conjugation, z-differentiation, convolution, stability and its relation to causality and ROC
   d. Transfer function of discrete-time systems and analysis of systems described by constant coefficient difference equations
PhD Qualifying Examination
Electric and Magnetic Fields Syllabus (ECEN 322)

1. Vector Analysis
   a. Rectangular, cylindrical and spherical coordinate systems
   b. Gradient of scalar fields
   c. Divergence of vector fields
   d. Curl of vector fields
   e. Divergence theorem
   f. Stokes’ theorem

2. Maxwell’s Equations and Fields
   a. Static and dynamic
   b. Time-varying, static, and time-harmonic fields
   c. Boundary conditions
   d. Poisson and Laplace’s equations
   e. Continuity equation
   f. Constitutive relations
   g. Current relations

3. Wave Equations and Waves
   a. Time-varying and time-harmonic wave equations
   b. Helmholtz’s equations
   c. Plane electromagnetic waves in lossless and lossy media
   d. Parameters and properties of plane waves propagating in media (fields, velocity, propagation constant, etc.)
   e. Material properties (loss, skin depth, etc.)
   f. Poynting vector
   g. Instantaneous and average power flow
   h. Normal and oblique incidence of plane waves at boundaries
   i. Reflection and transmission coefficients
   j. Standing waves and voltage standing wave ratio (VSWR)
   k. Incident, reflected and transmitted waves

4. Transmission Lines
   a. Transmission-line equations
   b. Transmission-line equivalent circuit
   c. Wave propagation on transmission lines
   d. Transmission-line parameters (resistance, inductance, conductance and capacitance per unit length; characteristic impedance, propagation constant, wavelength, velocity, dispersion, distortion, etc.)
   e. Input impedance of transmission lines
   f. Open- and short-circuited transmission lines
   g. Reflection coefficient, voltage standing wave ratio (VSWR)

5. Smith Chart
   a. Construction of Smith chart
   b. Determination of reflection coefficient, VSWR, input impedance/admittance, and maximum/minimum voltage locations using Smith chart
   c. Design single-stub impedance matching network using Smith chart
PhD Qualifying Examination
Electronic Circuits Syllabus – ECEN 325

1. Linear circuit analysis
   a. Magnitude and phase bode plots
   b. Phase and magnitude margin
   c. Root locus and stability
   d. Basics on feedback theory and properties

2. Operational Amplifiers
   a. Basic linear circuits employing operational amplifiers
   b. Instrumentation amplifier – differential and common mode gain, and CMRR
   c. 1st and second order filters – lowpass, bandpass and highpass
   d. OPAMP finite parameters – input and output impedance, finite DC gain and their effects
   e. Open loop and closed loop parameters – gain, input impedance and output impedance

3. Diodes
   a. Basic non-linear model
   b. Linear models and Taylor series expansions
   c. Rectifiers, peak detectors and other non-linear applications
   d. AC-to-DC conversion – half and full wave rectifiers and filters, ripple

4. Bipolar Junction Transistor
   a. Basic non-linear model
   b. Linear models and Taylor series expansions – □-Hybrid and T models
   c. DC and AC analysis
   d. Basic configurations- common-emitter, common-base and common-collector
   e. Input and output impedance, and voltage and power gain
   f. High-frequency transistor model – effects of the transistor and coupling capacitors
   g. Amplifier’s linearity

5. CMOSTransistors
   a. Basic non-linear model
   b. Linear models and Taylor series expansions – □-Hybrid and T models
   c. DC and AC analysis
   d. Basic configurations- common-source, common-gate and common-drain
   e. Input and output impedance, and voltage and power gain
   f. High-frequency transistor model – effects of the transistor and coupling capacitors
   g. Amplifier’s linearity
PhD Qualifying Examination
Computer Organization and Design - ECEN 350

1. Instruction Set Architectures
   a. Representing Instructions on the computer
   b. Arithmetical and Logical Instructions
   c. Memory access instructions
   d. Control flow instructions
   e. Function call instructions

2. Computer Arithmetic
   a. Signed and unsigned numbers
   b. Floating point numbers
   c. Addition and subtraction
   d. Multiplication and Division
   e. Floating point operations

3. Translating and starting a program
   a. Compilers, compiler optimization
   b. Object code generation
   c. Assemblers
   d. Linking
   e. Run-time execution environment

4. Performance evaluation
   a. CPU performance and its factors
   b. Performance metrics
   c. Performance factors
   d. Comparing performance
   e. SPEC benchmarks

5. Datapath and Control, and ALU design
   a. Single-cycle implementation
   b. Multi-cycle implementation
   c. Microprogramming

6. Pipelining
   a. Pipelined datapath
   b. Pipelined control
   c. Pipeline hazards
      ii. Structural
      iii. Control
      iv. Data hazards
      v. Hazard detection and resolution

7. Memory Hierarchy
   a. Overview of SRAM and DRAM design
   b. Basic of caches
   c. Framework for memory hierarchy
   d. Measuring memory performance

8. Peripherals and disk storage
1. The Free Electron Model in Metals
   a. Density of States and Fermi-Dirac distribution
   b. The work function, Thermionic emission
   c. The Schottky effect
   d. Field emission
   e. The photoelectric effect

2. Band Models of Solids
   a. The Kronig-Penney model
   b. Energy-momentum (E-k) diagram
   c. The effective mass, group velocity, concept of holes
   d. Divalent and trivalent metals

3. Semiconductors
   a. Characteristic properties of intrinsic and extrinsic semiconductors
   b. Measurement of semiconductor properties: Mobility, Conductivity, Energy gap, Carrier lifetime

4. Principles of Semiconductor Devices
   a. The pn junction under equilibrium and under voltage bias
   b. Junction capacitance
   c. Metal-Semiconductor junction: I-V characteristics and junction capacitance

5. Properties of Dielectric materials
   a. Macroscopic approach
   b. Microscopic approach
PhD Prelim Examination
Department of Electrical and Computer Engineering
PhD Prelim Examination

Before scheduling your prelim, you must update your degree plan to remove courses you haven’t taken. You can file a petition through DPSS to do this.

Scheduling the Exam: Unlike the qualifying exam, the PhD prelim exam must be scheduled individually by each student through the Graduate Office. After consulting with your committee, email the Graduate Advisor the date/time of your prelim at least 1 month in advance. The Graduate Office will schedule a conference room and process a memo to notify your committee. **Please see ecampus for specific directions on scheduling your prelim.**

What to Bring: You need to download the Prelim Exam Checklist and Report forms from the OGAPS website. You must print and bring these forms with you the day of the prelim. Please pre-type all relevant information on the forms before printing (UIN, committee members’ names, check-list items). At the bottom of page 1 under “Advisory Committee Chair” you will type the name of your chair in the blue box. Next to that under “Department Head” you will type “Dr. M. Begovic” in the blue box. When your chair returns your paperwork to our office, I will get Dr. Begovic’s signature on the line above before I submit it to OGAPS. On page 2, type in your name, UIN, date of prelim, and your committee members’ names in the blue boxes. Leave the “votes” section blank. See ecampus for details.

Exam Format: The prelim exam has two parts. During the oral part of the prelim exam, the student is expected to make an oral presentation on the thesis topic to the student’s thesis committee. For students who have passed the Qualifying Exam, the written portion of the prelim can be waived subject to the approval of the student’s supervisory committee. Each student is expected to submit a written thesis proposal to the thesis committee before the prelim exam.

Exam Syllabus – There is no set syllabus for the PhD prelim exam.

Timing: PhD (64 hour) students who already have a Master’s degree in Electrical Engineering should take the exam within 2 years of beginning their graduate program. PhD (96 hours) students who only hold a Bachelor’s degree or no degree in Electrical Engineering when they start their PhD program should take the exam within 3 years of beginning their graduate program. If a student started in a Master’s program and then converted to the PhD program, the student should take the prelim exam within 2 years after switching to the PhD program.

Grading: Each member of the thesis committee will provide a PASS/FAIL vote. The student is deemed to pass or fail the exam depending on whether the majority of the votes are pass or fail, respectively.

When to File the Proposal: The proposal must filed within 5 business days after the prelim; this is departmental policy. Complete and print the Proposal Cover Sheet. Please pre-type your information and the names of your committee members on this form before printing. For “Department Head” type “Dr. M. Begovic” in the blue box. You must
obtain the signatures of your committee members on this form before bringing to the Graduate Office. Once complete, bring the Proposal Cover Sheet and 2 hard copies of your proposal to the Graduate Office. The 2 copies of the proposal should be stapled and double-sided print. Do not staple the proposal cover page. The Graduate Office will send your proposal to OGAPS for approval. Please see ecampus for details.

**Note:** The PhD prelim exam is similar to what is called the proposal exam in some universities.

Reference the steps listed on the OGAPS website for Prelim Exam Requirements and Doctoral Degree Requirements. Also, please refer to the ECEN Graduate Students ecampus page.
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