

2024-2025

---

# GRADUATE STUDENT HANDBOOK

---



**ELECTRICAL & COMPUTER  
ENGINEERING**

TEXAS A&M UNIVERSITY

# **Table of Contents**

People to Contact

Research Area Websites

Student Organizations

HOWDY Portal

ELEN Graduate Degrees

Degree Plans

Miscellaneous Requirements

Financial Aid

Probation

English Language Proficiency

Areas of Specialization

CEEN Graduate Degrees

Computer Engineering & Systems Courses

PHD Qualifying Exam

PHD Prelim Examination

Certificates

Graduate Courses by Area

Course Descriptions

## People to Contact

Dr. Costas Georgiades	Interim Department Head
Dr. Aniruddha Datta	Co-Director of ECE Graduate Programs
Dr. Jiang Hu	Co-Director of ECE Graduate Programs
Dr. Zixiang Xiong	Associate Department Head
Mr. Stavros Kalafatis	Associate Department Head
Ms. Katie Bryan	Assistant Director of Graduate Programs
<ul style="list-style-type: none"><li>○ Current registered students</li><li>○ Degree plans</li><li>○ MS and PHD defense processing, PHD prelims</li><li>○ MS non-thesis final projects</li></ul>	
<b>TBD</b>	Academic Advisor III
<ul style="list-style-type: none"><li>○ Current registered students</li><li>○ International student issues, ISS forms</li><li>○ Distance Learning</li></ul>	
Ms. Deshaun Tolbert	Academic Advisor III
<ul style="list-style-type: none"><li>○ Admissions</li><li>○ Prospective students</li><li>○ Fellowships &amp; Scholarships</li></ul>	
Ms. Anni Brunker	Payroll Administration

## Research Area Websites

### **Analog and Mixed Signals**

<https://engineering.tamu.edu/electrical/research/analog-mixed-signal.html>

### **Biomedical Imaging, Sensing and Genomic Signal Processing**

<https://engineering.tamu.edu/electrical/research/biomedical-imaging-sensing-genomic-signal-processing.html>

### **Computer Engineering and Systems Group**

<https://engineering.tamu.edu/electrical/research/computer-engineering-systems-group.html>

### **Electromagnetics and Microwaves Group**

<https://engineering.tamu.edu/electrical/research/electromagnetics-microwaves-group.html>

### **Energy and Power**

<https://engineering.tamu.edu/electrical/research/energy-and-power.html>

### **Device Science and Nanotechnology**

<https://engineering.tamu.edu/electrical/research/device-science-and-nanotechnology.html>

### **Information Science and Learning Systems**

<https://engineering.tamu.edu/electrical/research/information-science-and-systems.html>

## Student Organizations

### **Electrical and Computer Engineering Graduate Student Association (ECE-GSA)**

The goal of the ECE-GSA is to represent the graduate students in the Department Electrical and Computer Engineering and to facilitate building a sense of community, especially among graduate students and with faculty. All graduate students in the Department of Electrical and Computer Engineering are implicitly members of ECE-GSA. We are actively looking for motivated and enthusiastic students to be part of the ECE-GSA. For more information on ECE-GSA, contact [ecegsa.tamu@gmail.com](mailto:ecegsa.tamu@gmail.com).

## **Howdy Portal**

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
- Scholarships, ISS & GPS

### **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, and campus directory
- Allow access for non-student to view grades
- Check for holds on your account

### **My Finances Tab**

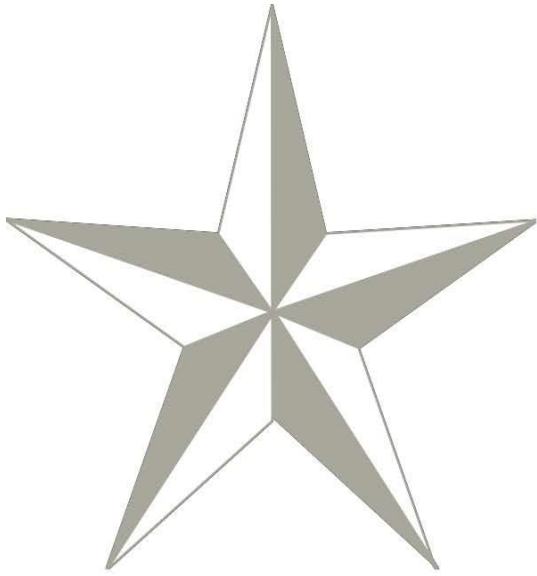
- Access account to check balance, pay tuition, view refunds or pay any other outstanding bill
- Apply for loans, scholarships, and other forms of financial aid
- Allow access for non-students to view and/or pay tuition, or any other bills on the student's account

### **Student Life Tab**

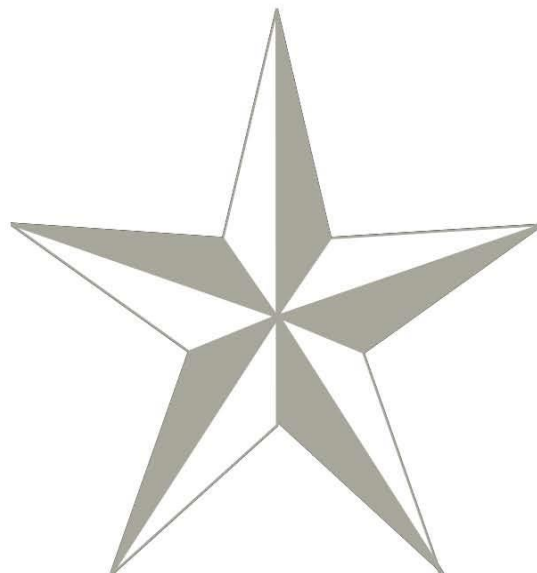
- Register for parking, sporting events pass, or on campus dining
- Get information on housing both on and off campus
- Get information as well as links for employment opportunities on and off campus
- Other helpful links such as the student recreation center or computing center

### **ECEN Graduate Students TEAMS**

- Access critical program information by bookmarking the [Microsoft TEAM for ECEN Graduate Students](#).
- Only students who have been admitted to the program can view the TEAM; student must use their TAMU email to access it.
- Students are strongly encouraged to review the materials on TEAMS, organized by category.
- If students have questions that are not answered in this handbook or on TEAMS, please contact the Graduate Office.



# **Electrical Engineering Graduate Degrees**



## MASTER OF SCIENCE IN ELECTRICAL ENGINEERING (NON-THESIS)

1. Total Number of Hours (30)
2. A minimum of 27 classroom hours (excludes 681, 684, and 685).
  - Classroom hours must be taken from courses within the College of Engineering (all departments) and/or College of Arts & Sciences (only MATH, STAT, PHYS, CHEM, BIOL)
  - At least 18 classroom hours must be ECEN courses.
3. Transfer hours allowed from another institution (6)
  - Transfer hours must be from a U.S. peer institution; they cannot have been used on a previous degree plan.
  - Students must send syllabi, transcript, and TAMU course equivalent to the Graduate Office. Transfer hours are subject to the approval of the GSC.
4. Undergraduate hours allowed (2 courses or 8 hours)
  - Only 400 level undergraduate courses can be included on degree plan.
  - Courses must be from the College of Engineering and/or College of Arts & Sciences as specified in point 2.
5. Seminar (681), Internship (684), Directed Studies (685) no more than (3) hours allowed (combined).
  - Research (691) hours are not allowed on an MS non-thesis 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 a completed cover page. It must be submitted in the graduating semester; see TEAMS page for submission deadlines and other requirements.
7. Composition of supervisory committee
  - The Graduate Coordinator will be the chair of all MS non-thesis committees. No other committee members are needed.
8. Requirements for the on-campus and distance education degree programs are the same. **However, on-campus degree programs cannot have more than 50% distance education courses on the degree plan.** Students are responsible for understanding this policy and submitting degree plans accordingly. **International students have additional restrictions on distance education courses, in which case they should consult ISSS at the start of their program.**

## MASTER OF SCIENCE IN ELECTRICAL ENGINEERING (THESIS)

- Total Number of Hours (32)
- A minimum of 24 classroom hours (excludes 681, 684, 685, and 691).
  - Classroom hours must be taken from courses within the College of Engineering (all departments) and/or College of Arts & Sciences (only MATH, STAT, PHYS, CHEM, BIOL)
  - At least 15 classroom hours must be ECEN courses.
- 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.
- Transfer hours allowed from another institution (6)
  - Transfer hours must be from a U.S. peer institution; they cannot have been used on a previous degree plan.
  - Students must send syllabi, transcript, and TAMU course equivalent to the Graduate Office. Transfer hours are subject to the approval of the GSC.
- Undergraduate hours allowed (2 courses or 8 hours)
  - Only 400 level undergraduate courses can be included on degree plan.
  - Courses must be from the College of Engineering and/or College of Arts & Science as specified in point 2.
- Seminar (681), Internship (684), Directed Studies (685): no more than (3) hours allowed (combined).
  - If you are considering going on internship (684), please consult your research advisor before making plans.
- 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 via ARCS **at least 1 month before the defense**. The link can be found on the GPS website.
  - The Request and Announcement of Final Exam must be scheduled through the Graduate Office via ARCS **at least 1 month in advance**.
  - Thesis draft must be emailed to committee members at least two weeks before defense.
  - **Please see TEAMS page for details, specifically “MS Defense Steps - ARCS” Document. Contact the Graduate Office if you have questions.**
- 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 the on-campus and distance education degree programs are the same. **However, on-campus degree programs cannot have more than 50% distance education courses on the degree plan.** Students are responsible for understanding this policy and submitting degree plans accordingly. **International students have additional restrictions on distance education courses, in which case they should consult ISSS at the start of their program.**

## PHD IN ELECTRICAL 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 (all departments) and/or College of Arts & Sciences (only MATH, STAT, PHYS, CHEM, BIOL)
  - At least 9 (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 U.S. peer institution; they cannot have been used on a previous degree plan.
  - Students must send syllabi, transcript, and TAMU course equivalent to the Graduate Office. Transfer hours are subject to the approval of the GSC.
4. Undergraduate hours allowed (2 courses or 8 hours)
  - Only 400 level undergraduate courses can be included on degree plan.
5. No more than 3 credit hours of Internship (684) are allowed.
  - PHD students cannot take 684 after dissertation defense.
  - If you are considering going on internship (684), please consult your research advisor before making plans.
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**
  - All incoming PHD students (64 and 96 hour) are required to take the exam within one year of starting the program.
    - There are two types of Qualifying Exams available. The research advisor will select which Track the student takes. Students without a research advisor default to Track 1.

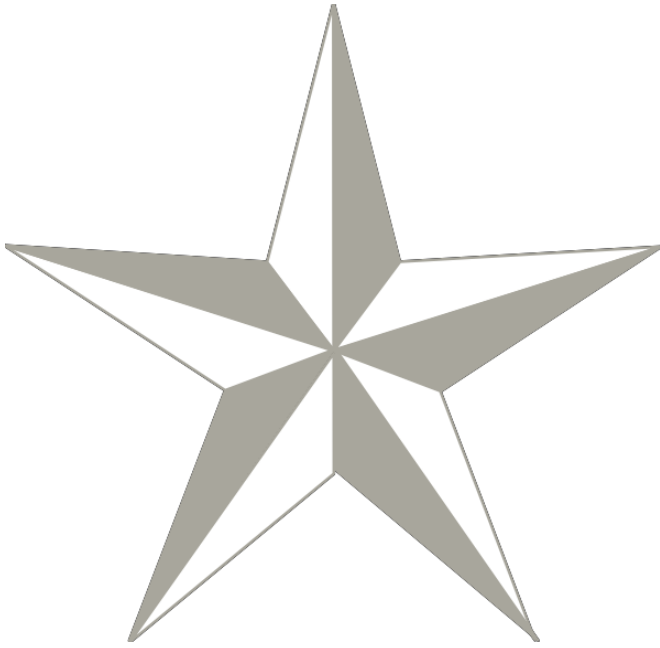
- **Track 1:** Written exam consisting of questions from undergraduate courses. This exam is administered in January and June of each year. More details on Track 1 are provided later in the handbook.
  - **Track 2:** Written and oral exam in which the separately formed committee provides a student research articles to analyze then give a presentation. More details on Track 2 are provided later in the handbook.
  - Students entering the program with a previous degree outside of Electrical or Computer Engineering are allowed, with written approval from 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.
  - 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 with a degree plan on file are required to submit an **Annual PHD Review**.
- The Graduate Office will provide this document to the student and his/her research advisor at the beginning of each spring semester.
  - PHD students are responsible for meeting with their research advisor to discuss progress.
  - After the student and research advisor sign the review document, the student should submit it to the Graduate Office by the specified deadline, which is typically early May. Failure to submit the document on time will result in a registration hold on the student's account.
  - The research advisor rates the student's progress as O (Outstanding), S (Satisfactory) and U (Unsatisfactory). **The first time a U is issued:**
    - The student will receive a probation letter from the Graduate Office.
    - The student writes a statement explaining the U and details plans for the next year.
    - The advisor writes a statement explaining the U and details plans for the next year.
    - These items are then automatically brought before the GSQ committee for review.**The second time a U is issued:**
    - The GSQ committee will meet to decide on a remedy.
      - Possible remedies include dismissal, suggestion to change advisors, etc.
9. All PHD students are required to pass a **Preliminary Examination**.
- 64 hour PHD students are required to schedule their prelim exam by the end of their 4<sup>th</sup> semester (excluding summers) and 6<sup>th</sup> 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.
  - You must initiate the Prelim Checklist and Report, and Proposal Approval Form via ARCS. The link can be found on the GPS website. Initiate these items at least 2 business days before your prelim.
  - Notify the Graduate Office of your prelim date/time/details at least 1 month in advance.
  - Students who fail the prelim exam will have one opportunity to retake the exam within 6 months of the original exam date.
  - **Please see TEAMS page for details, specifically the "Prelim Steps - ARCS" document.**

10. **Final Defense** of dissertation is required for all PHD students.

- The date and location of the final defense must be provided to the Graduate Office **at least 1 month in advance**.
- You must initiate the Request and Announcement of Final Exam via ARCS **at least 1 month in advance**. The link can be found on the GPS website.
- Dissertation draft must be emailed to committee members at least two weeks before defense.
- Dissertation Approval Form and Copyright Form must be initiated via ARCS as well. Please see GPS website for deadlines.
- **Please see TEAMS page for details, specifically the “PhD Defense Steps - ARCS” document.**

11. 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.
- 
- Requirements for the on-campus and distance education degree programs are the same. **However, on-campus degree programs cannot have more than 50% distance education courses on the degree plan.** Students are responsible for understanding this policy and submitting degree plans accordingly. **International students have additional restrictions on distance education courses, in which case they should consult ISSS at the start of their program.**



## **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 GPS website: <https://ogsdps.tamu.edu/>
- MS thesis AND non-thesis students must file a degree plan prior to the pre-registration period, starting your second (2<sup>nd</sup>) 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. Those with a previous degree outside of Electrical or Computer Engineering and 96 hour PHDs 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, and the Graduate and Professional School (GPS).
- Course changes can be made to the degree plan by submitting a longform petition which must be approved by all committee members.
- Changes of committee members, also made by submitting a longform petition, must be approved by all members of the committee (first by outgoing then by incoming).
- Changes in major, department, or degree are made by submitting an MDD petition.

Other degree plan & course information:

- There is no limit to ECEN 689 courses that can be added to the degree plan for MS or PHD students.
- Courses cannot be “converted” into other courses (ECEN 685 or 681 cannot be “converted” into ECEN 691 credit).
- \*\*Students cannot add more than 2 credits over the requirement on their degree plan. For example, MS thesis students must have 32 credits but cannot add more than 34 on the degree plan. MS non-thesis students must have 30 credits but cannot add more than 32 credits on the degree plan, 64 hour PHDs cannot add more than 66 credits, and 96 hour PHDs cannot add more than 98.\*\*
- Students are responsible for checking GPS deadlines each semester:  
<http://grad.tamu.edu/Buttons/Calendars>

Distance education courses:

- Requirements for the on-campus and distance education degree programs are the same. **However, on-campus degree programs cannot have more than 50% distance education courses on the degree plan.** Students are responsible for understanding this policy and submitting degree plans accordingly. **International students have additional restrictions on distance education courses, in which case they should consult ISSS at the start of their program.**

The Graduate and Professional School (GPS) website has important information regarding degree plans and degree completion: <http://grad.tamu.edu/>



## **Miscellaneous Requirements**



# Miscellaneous Requirements

## *Foundation Courses*

- Required of students with non-electrical or computer engineering undergraduate degrees.
- 200 and 300 level courses do not count towards graduate degree requirements.

The following guidelines have been established by the Graduate Studies Committee for degree programs of masters-level students without an undergraduate electrical engineering education:

1. Candidates in all MS and Ph.D. degree areas will be required to take the following electrical engineering courses for a total of 18 credit hours (CR). Service courses (e.g. ECEN 306) cannot be substituted for any of the following courses.
  - ECEN 214 - Electric Circuit Theory (4 CR)
  - ECEN 248 - Introduction to Digital Systems Design (4 CR)
  - ECEN 314 - Signals and Systems (3 CR)
  - ECEN 322 - Electric & Magnetic Fields (3 CR)
  - ECEN 325 - Electronics (4 CR)
2. Candidates will be required to take at least two courses from one of the following areas of specialization or demonstrate the equivalent material has been covered in their undergraduate degree program. Service courses cannot be substituted for any of the below courses.
  - Electronics: 326, 457, 474
  - Power: 438, 441, 459, 460, 467
  - Electrophysics, Electrooptics, Microwaves: 370, 451, 453, 462, 464, 465, 466, 472, 473
  - Communications, Control, Signal Processing: 420, 444, 445, 446, 447, 455
  - Computer Engineering: 350, 449, 454, 468, 469, 475

**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 ELEN or CEEN degree plans.
- Business courses will not be allowed on ELEN or CEEN degree plans (exception: MS non-thesis students in CEEN can include one course from the ISYS department).
- Traditionally no courses from Engineering Technology (ESET) will be allowed because of the non-calculus based curriculum.
- Additional restrictions which apply to CEEN 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 research advisor's approval.



- 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 the following foundation courses ECEN 214, ECEN 248, ECEN 314, ECEN 325, ECEN 350, CSCE 321, CSCE 211 and CSCE 311.
- For “stacked courses” where there is a graduate version and an undergraduate version of the same course, graduate student should register for the graduation section.

### ***Internships – ECEN 684***

- For international students: If you take an internship, 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. You are eligible to go on internship after completing two semesters in the program.
- For domestic students: If you take an internship, it is your choice if you want to receive graduate credit for 684 (1 credit hour per semester of internship). If you do want credit for internship, ECEN 684 must be approved by your advisor prior to starting the internship.
- Students may take ECEN distance learning courses while on internship.
- If you are considering going on internship, please consult your research advisor before making plans. This applies to MS thesis and PhD students.
- An Internship Report 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 <https://global.tamu.edu/iss/>
- Please see TEAMS page for additional details and FAQs on CPT processing. Students must fill out the Department Form according to the TEAMS example prior to submitting CPT paperwork to the Graduate Office.
- **Department contact for CPT: TBD**

### ***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 or joint-faculty.
- The 685 request form is available on the ECEN TEAMS site. An electronic copy with 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.
- Department contact for ECEN 685: Katie Bryan [katie@tamu.edu](mailto:katie@tamu.edu)

### ***Change of Degree Programs***

- If you are in the MS non-thesis program you may switch to the MS thesis or PHD program with the approval of a supervising professor.
- Masters students who want to switch to the PHD program have two options:
  - 1) Change during MS program: Identify a PHD advisor and submit an MDD petition via [DPSS](#). The Graduate Office must have email confirmation from PHD advisor before approving the MDD petition.
  - 2) Change after MS program: Submit a Letter of Intent (found on the GPS website) to the Graduate Office **after defending**. The Graduate Office must have email confirmation from PHD advisor.

- PHD and MS (thesis) students switching to MS (non-thesis):
  - 1) If you have a degree plan on file, submit an MDD petition via DPSS. After the MDD petition is approved by GPS, submit an MS (non-thesis) degree plan.
  - 2) If you do **not** have a degree plan on file, simply submit the MS (non-thesis) degree plan directly.

### ***Change of Focus Area & Major***

- You may not change your focus area during your first semester.
- After your first semester, you may change focus areas with the approval of the group leader representing the group you wish to join. Approval via email from the group leader to the Grad Office is sufficient.
- ELEN students who want to change to CEEN may apply by following the directions posted on TEAMS See directions in the “ECEN Forms” folder.
- Students interested in changing departments should contact the advising office of the new department for requirements.

### ***Class Schedule Changes***

- Students may not request course changes after the 12<sup>th</sup> 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 MS and PHD students (for 20 hours per week).
    - Usually pays tuition.
  - Teaching Assistantship (TA)
    - Offered through the department; course instructors can make recommendations.
    - International students must pass ELPE to be eligible.
    - Pays \$2,250 per month for MS and PHD students (for 20 hours per week).
    - Tuition and fees paid for both MS and PHD students.
    - Apply through the ECE website or TEAMS page.
  - Fellowships – Offered through GPS, 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.
- 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)
- TAs should make requests for continued funding by submitting the online application each semester.
- RAs should check with funding source on number of hours to register for.
- Students in non-degree status or probationary status are NOT eligible for financial aid.

The department recommends (but does not require) that all PhD students TA at least one semester during their program. To be considered for a TA position, students must be qualified. International students must meet Level 1 of English language proficiency prior to applying for a TA position. In addition, all students must be registered full time and in good academic standing. Students may apply via the department application. Note: Only admitted and registered students have access to the online TA application link.



# 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 two different manners:
  - Cumulative GPR
  - Degree Plan GPR
- A student will be placed on probation and blocked from pre-registration if either of the two indicated GPRs falls below 3.0. The student will be required to sign 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 student will receive notification of dismissal from the ECEN Graduate Program.
- A student being removed from the graduate program will be notified by the Graduate Office of such action. They will have 14 calendar days from the date of notification to file an appeal to the Graduate Studies Quality Committee (GSQ). If the student does not appeal the decision or the GSQ does not uphold the appeal, the GSQ will then request the final removal of the student from the program.
- A student who is on probation will not be allowed to hold a department TA position.



# **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 Graduate and Professional School 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 an 80 or higher on the oral skills section of the English Language Proficiency Examination (ELPE) OR scoring a 26 or higher on the TOEFL speaking section.
- acquiring alternative certification from the Graduate and Professional School 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 Graduate and Professional School 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 Graduate and Professional School. The Graduate and Professional School will determine on a case-by-case basis whether Verification or Certification is granted.



## **Areas of Specialization**



# **Analog and Mixed-Signals**

**Area Leader: Dr. Oscar Moreira**

## **Recommended Courses (thesis and non-thesis)**

### **Graduate courses:**

ECEN 704 VLSI Circuit Design  
ECEN 620 Network Theory  
ECEN 665 Integrated CMOS RF Circuits and Systems  
ECEN 607 Advanced Analog Circuit Design Techniques  
ECEN 610 Mixed -Signal Interfaces  
ECEN 720 High Speed Links Circuits and Systems

### Other graduate courses that may be taken:

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 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

### **Undergraduate courses:**

ECEN 457 Operational Amplifiers  
ECEN 471 Power Management  
ECEN 454 Digital Integrated Circuit Design  
ECEN 489 SPTP Vehicular Electronics  
ECEN 489 SPTP RF Circuits for Wireless Communications  
ECEN 489 SPTP Data Conversion Systems and Circuits  
ECEN 489 SPTP Audio Engineering

# Biomedical Imaging and Genomic Signal Processing

Area Leader: Dr. Raffaella Righetti

## 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 (Stacked with 761)  
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)  
**ECEN 489** Neuro-Electronic System (Stacked with 689)

#### (Graduate)

ECEN 601 Linear Network Analysis (Mathematical Methods in Signal Processing)  
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 (Advanced Digital Communications)  
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 (Stacked with 414)  
ECEN 762 Advanced Ultrasound Imaging Techniques  
ECEN 763 Magnetic Resonance Engineering (Stacked with 463)  
ECEN 765 Machine Learning with Networks  
ECEN 766 Algorithms in Structural Informatics  
ECEN 769 Material Informatics  
ECEN **689** Neuro-Electronic System (Stacked with 489)

### MS non-thesis:

It is recommended you choose at least five ECEN courses from the list above or from 689 courses in the biomedical imaging area.

It is recommended that two of these five 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 (Probability and Random Processes for Information Science)

ECEN 649 Pattern Recognition

# **Electromagnetics and Microwaves**

**Area Leader: Dr. Robert Nevels**

## **Recommended Courses for Master of Science (thesis and non-thesis)**

### **(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

# **Energy and Power**

**Area Leader: Dr. Tom Overbye**

## **Recommended Courses**

### **Master of Science (thesis):**

#### **(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 438/738 Power Electronics  
ECEN 441/741 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 and Vehicle Engineering  
ECEN 712 Power Electronics for Photovoltaic Energy Systems  
ECEN 715 Physical and Economical Operations of Sustainable Energy Systems  
ECEN 738/438 Power Electronics  
ECEN 741/441 Electronic Motor Drives  
ECEN 742/442 DSP Based Electromechanical Motion Control

### **Master of Science (non-thesis):**

15 credit hours recommended from the Energy and Power courses that are listed above.

# Device Science and Nanotechnology

Area Leader: Dr. Phil Hemmer

## Recommended Courses

### Master of Science (thesis):

#### (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 Science (non-thesis)- 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 Science (non-thesis)–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 (Mathematical Methods in Signal Processing)

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 Learning Systems**

**Area Leader: Dr. Chao Tian**

## **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 and 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 (Mathematical Methods in Signal Processing)

ECEN 604 Channel Coding for Communications Systems

ECEN 646 Statistical Communication Theory (Probability and Random Processes for Information Science)

ECEN 629 Convex Optimization for Electrical Engineering (Applied Convex Optimization)

ECEN 647 Information Theory

ECEN 655 Advanced Topics in Channel Coding

ECEN 661 Modulation Theory (Advanced Digital Communications)

ECEN 663 Data Compression with Applications to Speech & Video

ECEN 683 Wireless Communications Systems

ECEN 689 Special Topics

ECEN 760 Introduction to Probabilistic Graphical Models

### **Signal and Image Processing:**

ECEN 601 Linear Network Analysis (Mathematical Methods in Signal Processing)

ECEN 629 Convex Optimization for Electrical Engineering (Applied Convex Optimization)

ECEN 642 Digital Image Processing

ECEN 644 Discrete-Time Systems

ECEN 646 Statistical Communication Theory (Probability and Random Processes for Information Science)

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 (Mathematical Methods in Signal Processing)  
ECEN 605 Linear Multivariable Systems  
ECEN 606 Nonlinear Control Systems  
ECEN 608 Modern Control  
ECEN 609 Adaptive Control  
ECEN 628 Robust and Optimal Control  
ECEN 633 Optimum Control Systems

**Genomics:**

ECEN 669 Engineering Applications in Genomics

**Networks:**

ECEN 423 Computer and Wireless Communication Network  
ECEN 602 Computer Communication and Networking  
ECEN 619 Internet Protocols and Modeling  
ECEN 621 Mobile Wireless Networks  
ECEN 689 Special Topics

**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 and Systems Group about courses that will suit your background and interests.*



**Graduate Degrees**  
**Computer Engineering and Systems**



## MASTER OF SCIENCE IN COMPUTER ENGINEERING (NON-THESIS)

- Total Number of Hours (30)
- A minimum of 27 classroom hours (excludes 681, 684, and 685).
  - Classroom hours must be taken from courses within the College of Engineering (all departments) and/or College of Arts & Sciences (only MATH, STAT, PHYS, CHEM, BIOL)
  - 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 ME student course list.*
- Transfer hours allowed from another institution (6)
  - Transfer hours must be from a U.S. peer institution; they cannot have been used on a previous degree plan.
  - Students must send syllabi, transcript, and TAMU course equivalent to the Graduate Office. Transfer hours are subject to the approval of the GSC.
- Undergraduate hours allowed (2 courses or 8 hours)
  - Only 400 level undergraduate courses can be included on degree plan.
  - Courses must be from the College of Engineering and/or College of Arts & Sciences as specified in point 2.
- One hour of seminar is allowed (ECEN/CSCE 681) but is NOT required.
- Seminar (681), Internship (684), Directed Studies (685) no more than (3) hours allowed (combined).
- Research (691) hours are not allowed on an MS non-thesis degree plan.
- \*\* 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 a completed cover page. It must be submitted in the graduating semester; see TEAMS page for submission deadlines and other requirements.
- Composition of supervisory committee
  - The Graduate Coordinator will be the chair of all MS non-thesis committees. No other committee members are needed.
- Requirements for the on-campus and distance education degree programs are the same. **However, on-campus degree programs cannot have more than 50% distance education courses on the degree plan.** Students are responsible for understanding this policy and submitting degree plans accordingly. **International students have additional restrictions on distance education courses, in which case they should consult ISSS at the start of their program.**

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 unless approved by your 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, and CSCE 221.

## MASTER OF SCIENCE IN COMPUTER ENGINEERING (THESIS)

1. Total number of hours (32)
2. A minimum of 24 classroom hours (excludes 681, 684, 685, & 691).
  - Classroom hours must be taken from courses within the College of Engineering (all departments) and/or College of Arts & Sciences (only MATH, STAT, PHYS, CHEM, BIOL)
  - ***Courses on degree plan must be approved by Research Advisor.***
3. Transfer hours allowed from another institution (6)
  - Transfer hours must be from a U.S. peer institution; they cannot have been used on a previous degree plan.
  - Students must send syllabi, transcript, and TAMU course equivalent to the Graduate Office. Transfer hours are subject to the approval of the GSC.
4. Undergraduate hours allowed (6)
  - Only 400 level undergraduate courses can be included on the degree plan.
  - ***Courses must be approved by Research Advisor.***
5. Seminar, directed studies, 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.
    - If you are considering going on internship (684), please consult your research advisor before making plans.
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 via ARCS **at least 1 month before the defense**. The link can be found on the GPS website.
  - The Request and Announcement of Final Exam must be scheduled through the Graduate Office via ARCS **at least 1 month in advance**.
  - Thesis draft must be emailed to committee members at least two weeks before defense.
  - **Please see TEAMS page for details, specifically “MS Defense Steps” Document.**
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 (or CSCE joint faculty appointment). Co-chair may be from outside department.
- Requirements for the on-campus and distance education degree programs are the same. **However, on-campus degree programs cannot have more than 50% distance education courses on the degree plan.** Students are responsible for understanding this policy and submitting degree plans accordingly.

**International students have additional restrictions on distance education courses, in which case they should consult ISSS at the start of their program.**

**8. 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 unless approved by your 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, and CSCE 221.



## PHD 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 (all departments) and/or College of Arts & Sciences (only MATH, STAT, PHYS, CHEM, BIOL)
  - ***Courses on degree plan must be approved by Research Advisor.***
3. A maximum of (6) transfer hours allowed from another institution.
  - Transfer hours must be from a U.S. peer institution; they cannot have been used on a previous degree plan.
  - Students must send syllabi, transcript, and TAMU course equivalent to the Graduate Office. Transfer hours are subject to the approval of the GSC.
4. Undergraduate hours allowed (2 courses or 8 hours)
  - Only 400 level courses can be included on degree plan.
5. No more than 3 credit hours of Internship (684) are allowed.
  - PHD students cannot take 684 after dissertation defense.
  - If you are considering going on internship (684), please consult your research advisor before making plans.
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**
  - All incoming PHD students (64 and 96 hour) are required to take the exam within one year of starting the program.
    - There are two types of Qualifying Exams available. The research advisor will select which Track the student takes. Students without a research advisor default to Track 1.
    - **Track 1:** Written exam consisting of questions from undergraduate courses. This exam is administered in January and June of each year. More details on Track 1 are provided later in the handbook.
    - **Track 2:** Written and oral exam in which the separately formed committee provides a student research articles to analyze then give a presentation. More details on Track 2 are provided later in the handbook.
  - Students entering the program with a previous degree outside of Electrical or Computer Engineering are allowed, with written approval from 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.
  - 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 with a degree plan on file are required to submit an **Annual PHD Review**.
- The Graduate Office will provide this document to the student and his/her research advisor at the beginning of each spring semester.
  - PHD students are responsible for meeting with their research advisor to discuss progress.
  - After the student and research advisor sign the review document, the student should submit it to the Graduate Office by the specified deadline, which is typically early May. Failure to submit the document on time will result in a registration hold on the student's account.
  - The research advisor rates the student's progress as O (Outstanding), S (Satisfactory) and U (Unsatisfactory). **The first time a U is issued:**
    - The student will receive a probation letter from the Graduate Office.
    - The student writes a statement explaining the U and details plans for the next year.
    - The advisor writes a statement explaining the U and details plans for the next year.
    - These items are then automatically brought before the GSQ committee for review.**The second time a U is issued:**
    - The GSQ committee will meet to decide on a remedy.
      - Possible remedies include dismissal, suggestion to change advisors, etc.
10. All PHD students are required to pass a **Preliminary Examination**.
- 64 hour PHD students are required to schedule their prelim exam by the end of their 4<sup>th</sup> semester (excluding summers) and 6<sup>th</sup> 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.
  - You must initiate the Prelim Checklist and Report, and Proposal Approval Form via ARCS. The link can be found on the GPS website. Initiate these items at least 2 business days before your prelim.
  - Notify the Graduate Office of your prelim date/time/details at least 1 month in advance.
  - Students who fail the prelim exam will have one opportunity to retake the exam within 6 months of the original exam date.
  - **Please see TEAMS page for details, specifically the "Prelim Steps - ARCS" document.**
11. **Final Defense** of dissertation is required for all PHD students.
- The date and location of the final defense must be provided to the Graduate Office **at least 1 month in advance**.
  - You must initiate the Request and Announcement of Final Exam via ARCS **at least 1 month in advance**. The link can be found on the GPS website.
  - Dissertation draft must be emailed to committee members at least two weeks before defense.
  - Dissertation Approval Form and Copyright Form must be initiated via ARCS as well. Please see GPS website for deadlines.
  - **Please see TEAMS page for details, specifically the "PhD Defense Steps - ARCS" document.**
12. 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.
- Note: Committee Chair must be ECEN faculty (or CSCE joint faculty appointment). Co-chair may be from outside department.

**13. Requirements for the on-campus and distance education degree programs are the same. However, on-campus degree programs cannot have more than 50% distance education courses on the degree plan.** Students are responsible for understanding this policy and submitting degree plans accordingly. **International students have additional restrictions on distance education courses, in which case they should consult ISSS at the start of their program.**

#### 14. 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 unless approved by your 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, and CSCE 221.
- No credit will be given for the following foundation courses ECEN 214, ECEN 248, ECEN 314, ECEN 325, ECEN 350, and CSCE 221.



## **Computer Engineering and Systems Courses**



# **Computer Engineering and Systems Group**

**Area Leader: Dr. Kevin Nowka**

## **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 – with advisor approval, 629, 662

## **Foundation Courses (no graduate credit)**

ECEN 214     Electrical Circuit Theory  
ECEN 248     Introduction to Digital Systems Design  
ECEN 314     Signals and Systems  
ECEN 325     Electronics  
ECEN 350     Computer Architecture and Design  
CSCE 221     Data Structures and Algorithms

## **Tentative List of Courses for Graduate CEEN MS (thesis) & PHD Students**

### Hardware/VLSI:

CSCE 616 Introduction to Hardware Design Verification  
ECEN 468 Advanced Digital System Design  
ECEN 654 VLSI Systems Design  
CSCE 661 Integrated Systems Design Automation  
ECEN 680 Test and Diagnosis of Digital Systems  
ECEN 687 Introduction to VLSI Physical Design Automation  
ECEN 689 Special Topics Courses in Hardware/VLSI  
CSCE 689 Special Topics Courses in Hardware/VLSI  
ECEN 699 Advances in VLSI Logic Synthesis  
CSCE 714 Advanced Hardware Design Functional Verification  
ECEN 719 Advanced Digital Systems Design  
ECEN 714/454 Digital Integrated Circuit Design  
ECEN 749/449 Microprocessor Systems Design  
ECEN 751 Advanced Computational Methods for Integrated System Design

ECEN 752 Advances in VLSI Circuit Design  
ECEN 759 Hardware Security

Networks:

ECEN 602 Computer Communication and Networking  
ECEN 619 Internet Protocols and Modeling  
ECEN 621 Mobile Wireless Networks  
CSCE 663 Real-time Systems  
CSCE 664 Wireless and Mobile Systems  
CSCE 665 Advanced Networking and Security  
ECEN 689 Special Topics Courses in Networks  
CSCE 689 Special Topics Courses in Networks

Computer Architecture:

CSCE 605 Compiler Design  
ECEN 651 Microprogrammed Control of Digital Systems (not CSCE 614)  
ECEN 653 Computer Arithmetic Unit Design  
ECEN 659 Parallel/Distributed Numerical Algorithms and Applications  
ECEN 676 Advanced Computer Architecture  
ECEN 689 Special Topics Courses in Computer Architecture  
CSCE 689 Special Topics Courses in Computer Architecture

Systems and Software:

CSCE 410 Operating Systems (OR CSCE 611 Operating Systems and Applications)  
CSCE 606 Software Engineering  
CSCE 629 Analysis of Algorithms  
CSCE 662 Distributed Processing Systems  
CSCE 670 Information Retrieval and Storage  
ECEN 689 Special Topics Courses in Systems and Software  
CSCE 689 Special Topics Courses in Systems and Software  
CSCE 735 Parallel Computing

Network and Systems Theory:

ECEN 663 Data Compression with Applications to Speech and Video  
ECEN 689 Special Topics Courses in Networking and Systems Theory  
CSCE 689 Special Topics Courses in Networking and Systems Theory  
ECEN 757 Distributed Systems and Cloud Computing  
ECEN 750 Design and Analysis of Communication Networks  
ECEN 753 Theory and Applications of Network Coding  
ECEN 754/434 Optimization for Electrical and Computer Engineering  
ECEN 755 Stochastic Systems  
ECEN 756 Game Theory

Math / Stat:

MATH 415 Modern Algebra I  
MATH 416 Modern Algebra II  
MATH 446 Principles of Analysis I  
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

Data Science:

ECEN 689 Special Topics Courses in Data Science  
CSCE 689 Special Topics Courses in Data Science  
ECEN 748 Data Stream Algorithms and Applications  
ECEN 758 / CSCE 676 / STAT 639 Data Mining and Analysis

Seminar:

ECEN 681 Computer Engineering Seminar (with advisor's approval)

**Tentative List of Courses for CEEN MS (non-thesis) Students**

(Must take at least 6 courses out of the list below) 10.31.23

Hardware/VLSI:

CSCE 616 Introduction to Hardware Design Verification  
ECEN 468 Advanced Digital System Design  
ECEN 654 VLSI Systems Design  
CSCE 661 Integrated Systems Design Automation  
ECEN 680 Test and Diagnosis of Digital Systems  
ECEN 687 Introduction to VLSI Physical Design Automation  
ECEN 689 Special Topics Courses in Hardware/VLSI  
CSCE 689 Special Topics Courses in Hardware/VLSI  
ECEN 699 Advances in VLSI Logic Synthesis  
CSCE 714 Advanced Hardware Design Functional Verification  
ECEN 719 Advanced Digital Systems Design  
ECEN 714/454 Digital Integrated Circuit Design  
ECEN 749/449 Microprocessor System Design  
ECEN 751 Advanced Computational Methods for Integrated System Design  
ECEN 752 Advances in VLSI Circuit Design  
ECEN 759 Hardware Security

Networks:

ECEN 602 Computer Comm. and Networking  
ECEN 619 Internet Protocols and Modeling  
ECEN 621 Mobile Wireless Networks  
CSCE 663 Real-time Systems  
CSCE 664 Wireless and Mobile Systems  
CSCE 665 Advanced Networking and Security  
ECEN 689 Special Topics Courses in Networks  
CSCE 689 Special Topics Courses in Networks

Computer Architecture:

CSCE 605 Compiler Design

ECEN 651 Microprogrammed Control of Digital Systems (not CSCE 614)  
ECEN 653 Computer Arithmetic Unit Design  
ECEN 659 Parallel/Distributed Numerical Algorithms and Applications  
ECEN 676 Advanced Computer Architecture  
ECEN 689 Special Topics Courses in Computer Architecture  
CSCE 689 Special Topics Courses in Computer Architecture

Systems and Software:

CSCE 611/410 Operating Systems  
CSCE 606 Software Engineering  
CSCE 629 Analysis of Algorithms  
CSCE 662 Distributed Processing Systems  
CSCE 670 Information Retrieval and Storage  
CSCE 735 Parallel Computing

Networking & Systems Theory:

ECEN 663 Data Compression with Applications to Speech and Video  
ECEN 757 Distributed Systems and Cloud Computing  
ECEN 689 Special Topics Courses in Networking and Systems Theory  
CSCE 689 Special Topics Courses in Networking and Systems Theory  
ECEN 750 Design and Analysis of Communication Networks  
ECEN 753 Theory and Applications of Network Coding  
ECEN 754/434 Optimization for Electrical & Computer Engineering Applications  
ECEN 755 Stochastic Systems  
ECEN 756 Game Theory

Data Science:

CSCE 633 Machine Learning  
ECEN 689 Special Topics Courses in Data Science  
CSCE 689 Special Topics Courses in Data Science  
ECEN 740 Machine Learning Engineering  
ECEN 743 Reinforcement Learning  
ECEN 748 Data Stream Algorithms and Applications  
ECEN 758 / CSCE 676 / STAT 639 Data Mining and Analysis





# PHD Qualifiers



## Department of Electrical and Computer Engineering

### PHD Qualifying Examination

There are two types of Qualifying Exams offered, Track 1 and Track 2. The research advisor will select which track the student will take. Students without a research advisor will default to Track 1.

#### **Track 1 (Written Exam)**

The Track 1 Qualifying Exam is based on material covered in a set of ten 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
- ECEN 340 – Electronic Energy Conversion

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 20 questions on the exam. This ensures 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 may use department-issued calculators for the exam or personal calculators from a pre-approved list. Students can check-out a departmental calculator 1 week prior to the exam to become accustomed to it if needed. If the student answers more than 6 questions, only the first 6 questions are graded.

**Exam Location:** The exam is administered at the Texas A&M College Station and Qatar campuses. When you sign up for the test online, you will indicate your campus location.

**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. Incoming PHD students (64 and 96 hour) are required to take the exam within one year of starting the program. If a student is on internship when the exam is administered, they are required to make arrangements in advance with their employer to return to campus to take the exam. Students entering the program with a previous degree outside of Electrical or Computer Engineering will be allowed, with written approval from 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 students are not allowed to take the qualifying exam.

STARTING SEMESTER IN PHD PROGRAM	WHEN TO TAKE TRACK 1 QUALIFYING EXAM
Fall	June of the next year
Spring	January of the next year
Summer	June of the next year

**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 six 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 (either Track 1 or 2) are required to submit degree plans within 1 semester after passing the exam. Failure to submit the degree plan within this time frame will result in a registration hold.

### **Track 2 (Written and Oral Exam):**

**Purpose:** The purpose of this exam format is to assess the students' critical thinking ability to solve research problems and their ability to make concise presentation of their conclusions.

**Timing of the exam:** The student must take the exam within two semesters of beginning their graduate studies in ECEN. **Committee:** A three-person committee will be formed, consisting of two faculty members from the department and the advisor. The chair of the committee will be a faculty member who is not the student's advisor. The group leader will select the two other members of the committee.

**Format:** There will be two exam components: a written component and an oral exam component following a short presentation by the student.

- Three research papers that are interlinked around a particular research area will be selected by the committee. These papers should not be directly linked to the research project the student is conducting. It is assumed that the student will read additional reference papers to properly understand these papers.
- Written component: The written paper should address, for example (but not limited to), the following sets of questions:
  - o What challenges is the research described in the papers trying to overcome?
  - o What is the contribution of the paper to the field? How do you know this is a significant contribution to the field?
  - o Is the conclusion drawn by the authors supported by the data they provided?
  - o Did the authors provide sufficient information for other researchers in the field to verify their work?
  - o What challenges in the field has the papers still not addressed, which require further research?

- Oral component: The committee will question the student for up to 1 hour with the objective of assessing their critical thinking and communication skills in solving and presenting research problems. The committee must base their questions on the papers, fundamental references covered in the paper, and fundamental background information.

**Timing:** Students should have 6 weeks of preparation time upon given the research papers, and the committee members should have one week to evaluate the written component. Thus, the student will first schedule the oral exam time, and the student should be given the research paper assignment 7 weeks before the oral exam time, with the written part of the exam due one week before the oral exam date. **Track 2 should be taken within a two month period, twice a year: June and July OR January and February.** The exam should be administered and results reported to the Graduate Office within either of these two month time frames. The deadline for the research advisor to notify the Graduate Office of a decision for the student to take Track 2 is one month prior to these dates – so the months of May and December.

STARTING SEMESTER IN PHD PROGRAM	WHEN TO TAKE TRACK 2 QUALIFYING EXAM
Fall	June - July of the next year
Spring	January - February of the next year
Summer	June - July of the next year

**Grading:** A simple pass/fail vote by the members, with the majority vote deciding the outcome.

**Number of times the exam can be taken:** The student has two opportunities, with a chance for their PhD advisor to appeal for a third exam with approval by the Graduate Studies Committee, as in Track 1.

**Note:** PHD students who pass the Qualifier (either Track 1 or 2) are required to submit degree plans within 1 semester after passing the exam. Failure to submit the degree plan within this time frame will result in a registration hold.

# **PHD Qualifying Examination (Track 1)**

## **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. Ideal Op Amp Circuits**

- a. Ideal op amp equations
- b. Analysis of common op amp configurations
  - i. Inverting/non-inverting amplifiers
  - ii. Summing amplifiers
  - iii. Difference amplifiers

### **4. DC Transient Circuit Analysis**

- a. Natural and step responses of first order RC and RL circuits.
- b. First order op amp circuits
- c. Natural and step responses of second order RLC circuits

### **5. AC Circuit Analysis**

- a. Phasors
- b. Impedance
- c. Finding sinusoidal steady state solutions using phasors

# **PHD Qualifying Examination**

## **Digital System Design – ECEN 248**

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 – CSCE 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



# **PHD Qualifying Examination**

## **Signals and Systems – ECEN 314**

### **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**

- a. Filtering – Frequency response and impulse response of ideal filters, first order and second order approximations to filters.
- 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

# **PHD Qualifying Examination**

## **Electric and Magnetic Fields - 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 – 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. 1<sup>st</sup> 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 -  $\pi$  - 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. CMOS Transistors**

- a. Basic non-linear model
- b. Linear models and Taylor series expansions -  $\pi$  - 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 Instruction Set Architectures
  - 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. Addition and subtraction
  - c. Multiplication and Division
  - d. 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**
  - a. Single-cycle implementation
- 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**

# PHD Qualifying Examination

## Electronic Energy Conversion - ECEN 340

- **Overview**

At the end of this section, students should understand the role that energy conversion plays in our modern society, the present day sources of electric energy, how it is transmitted, how it is consumed, its history and current trends.

- **Review of phasors, complex power, and basic electronics**

The purpose of this section is to briefly review topics covered in earlier courses. At the end of this section students should be able to analyze single phase, sinusoidal, constant frequency circuits.

- **Three-phase circuits, three-phase power, wye-delta conversion, per phase analysis**

At the end of this section students should be able to analyze balanced three-phase circuits using per phase analysis, and be able to use capacitors to do power factor correction.

- **Static magnetic circuits, self and mutual inductance**

At the end of this section students should be able to analyze magnetic circuits and solve circuits that include mutual inductance.

- **Ideal transformers, practical transformers, equivalent circuits**

At the end of this section students should be able to explain the operation of a transformer, explain the rationale for the transformer equivalent circuit parameters, and be able to calculate the equivalent circuit from test parameters.

- **Electromechanical systems, energy, co-energy, energy cycles, computation of forces and torques, electromechanical system dynamics**

At the end of this section students should be able to explain the basic principles of electromechanical energy conversion, compute forces and torques of electric origin in magnetic devices, and simulate dynamic systems using such electromechanical devices.

- **Synchronous and induction machines**

At the end of this section students should be able to explain the operation of synchronous and induction machines, and they should also be able to analyze their steady-state operation.

- **DC-DC conversion, buck, boost, buck-boost**

At the end of this section students should be able to explain the applications of dc-dc conversion, explain the operation of three types of dc-dc converters (buck, boost and buck-boost), and design basic dc-dc converters to meet output constraints.

- **Inverters and Rectifiers**

At the end of this section students should be able to explain the need for rectifiers and inverters, explain their basic operation, and solve simple design problems.

- **Solar Photovoltaic (PV) Application**

At the end of this section students should be able to explain the operation of solar PV systems and be able to do simple designs of solar PV systems.

- **Wind Energy Application**

At the end of this section students should be able to explain the operation of wind energy systems, describe their societal and environmental impacts, and solve basic power flow problems associated with the integration of wind energy systems into the existing electric grid.

# **PHD Qualifying Examination**

## **Electronic Properties of Materials - ECEN 370**

### **1. Electrons at metal-vacuum interface**

- a. Electron reflection/transmission at metal-vacuum interface
- b. Electrons inside a potential (quantum) well
- c. Electron tunneling through a potential barrier

### **2. The free electron model in metals**

- a. Density of states, Fermi-Dirac distribution, work function
- b. Thermionic emission
- c. Schottky effect
- d. Field emission
- e. Photoelectric effect

### **3. Band Models of Solids**

- a. Conduction band, valence band, band gap
- b. Electrical conduction of electrons in an energy band
- c. Energy band diagrams of metals, semiconductors and insulators
- d. Energy-momentum (E-k) curves
- e. Effective mass
- f. Holes

### **4. Semiconductors**

- a. Intrinsic and extrinsic semiconductors
- b. Dopants of semiconductors
- c. Electron/hole concentration in intrinsic and extrinsic semiconductors
- d. Fermi level of intrinsic and extrinsic semiconductors
- e. Conductivity of semiconductors

### **5. Principles of Semiconductor Devices**

- a. Energy band diagram of a p-n junction at equilibrium and under bias
- b. Built-in field, built-in potential, transition region width
- c. I-V characteristics at equilibrium and under bias
- d. Junction capacitance





# **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. Students must be registered at least 1 credit hour in the semester in which they take the prelim.

**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**. **\*\*Please see TEAMS for specific directions on scheduling your prelim.\*\***

**What to submit:** You will initiate the Prelim Checklist and Report via ARCS, found on your HOWDY portal. website. Please see the “Prelim Steps - ARCS” document on TEAMS 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 research 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 hour) 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. Students can have up to 6 credits of coursework remaining in order to schedule their prelim.

**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.** You will submit your Proposal Approval Form via ARCS. The link can be found on your HOWDY portal. **\*\*Please see TEAMS “Prelim Steps - ARCS” document for detailed directions. \*\***

## **Graduate Certificates**

### **ANALOG AND MIXED-SIGNAL INTEGRATED CIRCUIT DESIGN ONLINE CERTIFICATE**

1. Total Number of Hours (12)
2. Two mandatory courses:
  - ECEN 607 Advanced Analog Circuit Design Techniques
  - ECEN 704 (Analog) VLSI Circuit Design
3. Two elective courses must be taken among the following options:
  - ECEN 610 Mixed Signal Interfaces
  - ECEN 620 Network Theory
  - ECEN 622 Active Network Synthesis
  - ECEN 665 Integrated CMOS RF Circuits and Systems
  - ECEN 720 High-Speed Links Circuits and Systems

### **ELECTRIC ENERGY SYSTEMS ONLINE CERTIFICATE**

1. Total Number of Hours (12)
2. Four elective courses must be taken among the following options:
  - ECEN 613 Rectifier and Inverter Circuits
  - ECEN 614 Power System State Estimation
  - ECEN 615 Electric Power Systems Analysis Methods
  - ECEN 667 Power System Stability
  - ECEN 715 Physical and Economical Operations of Sustainable Energy Options

Coming in Fall 2024:

CERT-DICD: Digital Integrated Circuit Design – Certificate (F2F for EE majors)

CERT-SCMF: Semiconductor Manufacturing – Certificate (F2F for EE majors)

CERT-EFMC: Electromagnetic Fields and Microwave Circuit Design – Certificate (F2F, online)



## **Graduate Courses by Area**



Course #	Title	Area of Specialization	Notes
681	Seminar	All Areas	
684	Professional Internship	All Areas	
685	Directed Studies	All Areas	
689	Special Topics	All Areas	
691	Research	All Areas	
607	Advanced Analog Circuit Design Techniques	Analog and Mixed Signals	
610	Mixed-Signal Interfaces	Analog and Mixed Signals	
620	Network Theory	Analog and Mixed Signals	
622	Active Network Synthesis	Analog and Mixed Signals	
625	Millimeter-Wave Integrated Circuits	Analog and Mixed Signals	
650	High Frequency GaAs/SiGe Analog IC Design	Analog and Mixed Signals	
665	Integrated CMOS RF Circuits and Systems	Analog and Mixed Signals	
698	Analog To Digital Converters	Analog and Mixed Signals	
704	VLSI Circuit Design	Analog and Mixed Signals	stacked with 474
720	High-Speed Links Circuits and Systems	Analog and Mixed Signals	
617	Advanced Signal Processing for Medical Imaging	Biomedical Imaging & Genomic Signal Proc	
634	Morphological Methods in Image and Signal Processing	Biomedical Imaging & Genomic Signal Proc	
648	Principles of Magnetic Resonance Imaging	Biomedical Imaging & Genomic Signal Proc	
660	BioMems and Lab-on-a-Chip	Biomedical Imaging & Genomic Signal Proc	
669	Engineering Applications in Genomics	Biomedical Imaging & Genomic Signal Proc	
760	Introduction to Probabilistic Graphical Models	Biomedical Imaging & Genomic Signal Proc	
761	Biosensors Lab	Biomedical Imaging & Genomic Signal Proc	stacked with 414
762	Advanced Ultrasound Imaging Techniques	Biomedical Imaging & Genomic Signal Proc	
763	Magnetic Resonance Engineering	Biomedical Imaging & Genomic Signal Proc	
764	Medical Imaging	Biomedical Imaging & Genomic Signal Proc	
765	Machine Learning with Networks	Biomedical Imaging & Genomic Signal Proc	
766	Algorithms in Structural Bioinformatics	Biomedical Imaging & Genomic Signal Proc	
752	Advances in VLSI Circuit Design	Computer Engineering and Systems	
602	Computer Communication and Networking	Computer Engineering and Systems	
619	Internet Protocols and Modeling	Computer Engineering and Systems	
621	Mobile Wireless Networks	Computer Engineering and Systems	
623	Parallel Geometric Computing	Computer Engineering and Systems	
624	IC Design Tools	Computer Engineering and Systems	
627	Multimedia Systems and Networks	Computer Engineering and Systems	
651	Microprogrammed Controls of Digital Systems	Computer Engineering and Systems	
652	Switching Theory	Computer Engineering and Systems	
653	Compute Arithmetic Unit Design	Computer Engineering and Systems	
654	Very Large Scale Integrated Systems Design	Computer Engineering and Systems	
659	Parallel/Distributed Numerical Algorithms	Computer Engineering and Systems	
670	Fiber Optic Networks	Computer Engineering and Systems	
676	Advanced Computer Architecture	Computer Engineering and Systems	
680	Testing and Diagnosis of Digital Systems	Computer Engineering and Systems	
687	Introduction to VLSI Design Automation	Computer Engineering and Systems	
699	Advances in VLSI Logic Synthesis	Computer Engineering and Systems	

714	Digital Integrated Circuit Design	Computer Engineering and Systems	stacked with 454
749	Microprocessor Systems Design	Computer Engineering and Systems	stacked with 449
750	Design and Analysis of Communication Networks	Computer Engineering and Systems	
751	Computational Methods for Integrated Systems Design	Computer Engineering and Systems	
753	Theory and Applications of Network Coding	Computer Engineering and Systems	
754	Optimization for Electrical and Computer Engineering Applications	Computer Engineering and Systems	
755	Stochastic Systems	Computer Engineering and Systems	
756	Game Theory	Computer Engineering and Systems	
757	Distributed Systems and Cloud Computing	Computer Engineering and Systems	Cross listed CSCE 678
758	Data Mining and Analysis	Computer Engineering and Systems	Cross listed CSCE 676, STAT 639
759	Hardware Security	Computer Engineering and Systems	Cross listed CYBR 630
600	Experimental Optics	Device Science and Nanotechnology	
631	Fiber Optic Devices	Device Science and Nanotechnology	
640	Thin Film Science and Technology	Device Science and Nanotechnology	
656	Physical Electronics	Device Science and Nanotechnology	
657	Quantum Electronics	Device Science and Nanotechnology	
658	Low-Noise Electronic Design	Device Science and Nanotechnology	
664	Nanotechnology Fabrication	Device Science and Nanotechnology	
671	Solid State Devices	Device Science and Nanotechnology	
672	Semiconductor Lasers and Photodetectors	Device Science and Nanotechnology	
673	Fundamentals of Microelectronics	Device Science and Nanotechnology	
674	Introduction to Quantum Computing	Device Science and Nanotechnology	
675	Integrated Optoelectronics	Device Science and Nanotechnology	
678	Statistical Optics	Device Science and Nanotechnology	
688	IC MEMS and Sensor Fabrication	Device Science and Nanotechnology	
694	Nanobiotechnology	Device Science and Nanotechnology	
696	Erbium-Doped Amplifier: Technology and Applications	Device Science and Nanotechnology	
767	Harnessing Solar Energy: Optics, Photovoltaics and Thermal Systems	Device Science and Nanotechnology	stacked with 467
770	Organic Semiconductor	Device Science and Nanotechnology	
771	Fluctuations & Noise Electronics	Device Science and Nanotechnology	
772	Introduction to Microelectromechanical Devices and Systems	Device Science and Nanotechnology	
773	Introduction to Nanophotonics	Device Science and Nanotechnology	
777	Photonics: Fiber and Integrated Optics	Device Science and Nanotechnology	stacked with 477
611	General Theory of Electromechanical Motion Devices	Energy and Power	
612	Computer Aided Design of Electromechanical Motion Devices	Energy and Power	
613	Rectifier and Inverter Circuits	Energy and Power	
614	Power Systems State Estimation	Energy and Power	
615	Methods of Electric Power Systems Analysis	Energy and Power	
616	Power System Electromagnetic Transients	Energy and Power	

630	Analysis of Power Electronic Systems	Energy and Power	
632	Motor Drive Dynamics	Energy and Power	
643	Electric Power System Reliability	Energy and Power	
666	Power System Faults and Protective Relaying	Energy and Power	
667	Power System Stability	Energy and Power	
668	High Voltage Direct Current (HVDC) Transmission	Energy and Power	
677	Control of Electric Power Systems	Energy and Power	
679	Computer Relays for Electric Power Systems	Energy and Power	
686	Electric and Hybrid Vehicles	Energy and Power	
710	Switching Power Supplies	Energy and Power	
710	Switching Power Supplies	Energy and Power	
711	Sustainable Energy & Vehicle Engineering	Energy and Power	
712	Power Electronics for Photovoltaic Energy Systems	Energy and Power	
715	Physical and Economical Operations of Sustainable Energy Systems	Energy and Power	
738	Power Electronics for Photovoltaic Energy Systems	Energy and Power	stacked with 438
741	Electronic Motor Drives	Energy and Power	stacked with 441
742	DSP Based Electromechanical Motion Control	Energy and Power	stacked with 442
626	Antenna Theory and Technique	Electromagnetics and Microwaves	
635	Electromagnetic Theory	Electromagnetics and Microwaves	
636	Phase Arrays	Electromagnetics and Microwaves	
637	Numerical Methods in Electromagnetics	Electromagnetics and Microwaves	
638	Antennas and Propagation	Electromagnetics and Microwaves	
639	Microwave Circuits	Electromagnetics and Microwaves	
641	Microwave Solid State Integrated Circuits	Electromagnetics and Microwaves	
730	CMOS RFIC Engineering	Electromagnetics and Microwaves	
735	Electromagnetic Field Theory	Electromagnetics and Microwaves	
601	Mathematical Methods in Signal Processing	Information Science and Systems	name change
603	Time Frequency Analysis and Multirate Signal Processing	Information Science and Systems	
604	Channel Coding for Communications Systems	Information Science and Systems	
605	Linear Multivariable Systems	Information Science and Systems	name change
606	Nonlinear Control Systems	Information Science and Systems	
608	Modern Control	Information Science and Systems	
609	Adaptive Control	Information Science and Systems	
628	Robust and Optimal Control	Information Science and Systems	name change
629	Applied Convex Optimization	Information Science and Systems	name change
633	Optimum Control Systems	Information Science and Systems	
642	Digital Image Processing	Information Science and Systems	
644	Discrete-Time Systems	Information Science and Systems	
645	Pattern Recognition by Neural Networks	Information Science and Systems	
646	Statistical Communication Theory (Probability and Random Processes for Information Science)	Information Science and Systems	name change
647	Information Theory	Information Science and Systems	
649	Pattern Recognition	Information Science and Systems	
655	Advanced Topic in Channel Coding	Information Science and Systems	

661	Modulation Theory (Advanced Digital Communications)	Information Science and Systems	name change
662	Estimation and Detection Theory	Information Science and Systems	
663	Data Compression with Applications to Speech and Video	Information Science and Systems	
682	Spread Spectrum and CDMA	Information Science and Systems	
683	Wireless Communication Systems	Information Science and Systems	

## Graduate Course Descriptions

For current graduate course listings, please visit  
<http://catalog.tamu.edu/graduate/course-descriptions/ecen/>

## Undergraduate Course Descriptions

For current undergraduate course listings, please visit  
<http://catalog.tamu.edu/undergraduate/course-descriptions/ecen/>