PEOPLE TO CONTACT

Dr. M. Begovic                   Department Head
Dr. S. Wright                   Associate Dept. Head
Dr. J. Silva-Martinez           Director of ECE Graduate Programs
Ms. Tammy Carda                 Senior Academic Advisor II
Ms. Melissa Sheldon             Program Coordinator
Ms. Anni Brunker                Payroll Administration
Ms. Yolanda Veals               Scholarship/Fellowship Administration

Graduate Student Representatives:

Priyadharshini Sundararajan Venkatasubramani  priya26@email.tamu.edu
Ahmad Al Kawam                   ahmad.alkawam@ece.tamu.edu
Graduate Studies Committee

Dr. J. Silva-Martinez: Director of ECE Graduate Program
(Analog & Mixed Signals)

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

Dr. R. Nevels:
(Electromagnetics & Microwave)

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

Dr. X. Qian:
(Bio Medical Imaging and Genomic Signal Processing)

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

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

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

Dr. T. Liu:
(Information Science and Systems)
Specific Area Home Websites

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

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

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

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

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

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

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

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

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

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

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

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

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

Master of Engineering Degree

1. Total Number of Hours (30)

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

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

4. Undergraduate hours allowed (9)
   • Only 400 level undergraduate courses can be included on degree plan.

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

6. Final examination may be waived for any MEN student maintaining a GPR of at least 3.0. A petition to waive the final exam must be submitted through the Graduate Office.

7. A final project report is required to be submitted to the Graduate Office. A graded project from any ECEN graduate course can be used to fulfill this requirement.

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

Master of Science Degree

1. Total Number of Hours (32)

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

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

4. Transfer hours allowed from another institution (6-8)
   • Transfer hours must be from a “peer institution.”
   • Transfer hours are subject to the approval of the GSC.

5. Undergraduate hours allowed (9)
   • Only 400 level undergraduate courses can be included on degree plan.

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

7. Final defense of thesis is required for all MS students.
   • A proposal must be filed.
   • A thesis proposal must be approved by the supervisory committee and submitted to the Graduate Office prior to the defense.
   • Date and location of the thesis defense must be scheduled through the Graduate Office so that official notification can be provided to OGAPS.
   • Thesis must be submitted to committee members at least two weeks before defense.

8. 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.
Requirements for Graduate Electrical Engineering Degrees
in the Department of Electrical and Computer Engineering

Doctor of Philosophy Degree

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

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

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

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

5. No more than 3 credit hours of Internship (684) are allowed.

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

7. All PhD students are required to pass the Departmental Qualifying Examination
   - Incoming 64 hour PHD students are required to take the exam within one year of starting the program.
   - Students entering the program with a previous degree outside of Electrical or Computer Engineering or a 96 hour PHD are allowed, with the approval of their advisor, an extra year and will be required to take the exam by the end of the second year.
   - Those students that fail the examination are given a second opportunity to retake the exam which must be taken at the next opportunity in which the exam is offered.
   - Those that fail the examination twice will be removed from the PHD program.
   - More details of the Qualifying Exam are given later in this handbook.
   - Degree Plans are to be filed after passing the Qualifier.
8. All PhD students are required to pass a preliminary examination.
   • 64 hours PhD students are required to schedule their prelim exam by the end of their 4th semester (excluding summers) and 6th semester for those with previous degree outside of Electrical or Computer Engineering and 96 hour PhD’s.
   • Students who have not scheduled their prelim by the appointed time will be blocked from further registration until they do so.
   • OGAPS must be officially notified of the exam schedule at least 2 weeks prior to the exam. This should be done through the Graduate Office.
   • Student must download the checklist and signature page from the OGAPS web site. The checklist must be signed by your advisor and Graduate Coordinator prior to the exam.
   • The prelim exam consists of a written and an oral examination.
   • For students who have passed the departmental Qualifying Exam, the written portion of the prelim exam can be waived subject to the approval of the student’s supervisory committee.
   • Students who fail the prelim exam will have one opportunity to retake the exam within 6 months of the original exam date.

   • A dissertation proposal must be approved by the supervisory committee and submitted to the Graduate Office prior to the defense. Typically this proposal is submitted in conjunction with the preliminary exam, submitted one (1) week after the prelim.
   • Date and location of the final defense must be scheduled through the Graduate Office so that official notification can be provided to OGAPS.
   • Dissertation must be submitted to committee members at least two weeks before defense.

10. Composition of supervisory committee
    • At least two members from within the ECEN Department and within the student’s focus area.
    • At least one member from within the ECEN Department but outside the student’s focus area.
    • At least one member from outside the ECEN Department.
Degree Plans
Degree Plans

Degree plans consist 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 plans must be submitted during (excluding summers).
- MEN/MS students should file a degree plan prior to the pre-registration period, starting your second (2nd) semester.
- 64 hour PhD students should file a degree plan within one year from the date they started the program or one semester after passing the PhD qualifier. For those with a previous degree outside of Electrical or Computer Engineering and 96 hour PhD’s should file a degree plan two years from the date they started the program or one semester after passing the PhD qualifier.
- Students who have not filed a degree plan by the deadlines indicated above will be blocked from registering for future semesters.
- The block will not be removed until the degree plan has been submitted.

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

Office of Graduate and Professional Studies (OGAPS):
The degree plan and petition can be found on the OGAPS website:
http://ogs.tamu.edu/incoming-students/student-forms-and-information/
Miscellaneous Requirements
Miscellaneous Requirements

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

<table>
<thead>
<tr>
<th>Electrical Engineering Foundation Courses</th>
<th>Computer Engineering Foundation Courses</th>
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</thead>
<tbody>
<tr>
<td>ECEN 214, Electrical Circuit Theory</td>
<td>CSCE 211 Data Structures &amp; Implementations</td>
</tr>
<tr>
<td>ECEN 248 Intro to Digital Systems Design</td>
<td>CSCE 311 Analysis of Algorithms</td>
</tr>
<tr>
<td>ECEN 314 Signals and Systems</td>
<td></td>
</tr>
<tr>
<td>ECEN 325 Electronics</td>
<td>ECEN 350 (or CSCE 321) Computer Architecture</td>
</tr>
<tr>
<td>ECEN 322 Electric and Magnetic Fields</td>
<td></td>
</tr>
<tr>
<td>Two additional courses from one of the following areas of specialization:</td>
<td></td>
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<tr>
<td>• Electronics</td>
<td></td>
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<tr>
<td>• Power</td>
<td></td>
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<tr>
<td>• Electro-physics, electro-optics, microwaves</td>
<td></td>
</tr>
<tr>
<td>• Communications, Control, Signal Processing</td>
<td></td>
</tr>
</tbody>
</table>

- Preregistration - All students currently enrolled MUST pre-register for future semesters during the pre-registration periods (in order to ensure sufficient enrollment).

Restricted Courses
- STAT 651 and STAT 652 (statistics courses) are for non-science majors and are not allowed on EE or CE degree plans.
- Business courses will not be allowed on ECEN or CEEN degree plans (exception: MEN students in CEEN can include one course from the ISYS department).
- ELI registration does not count towards A&M hours.
- Traditionally no courses from Engineering Technology will be allowed because of the non-calculus based curriculum.

- Additional restrictions which apply to CE majors:
  - CSCE 601 and 602 may not be taken for credit.
  - Credit for both CSCE 614 and ECEN 651 is not allowed. CSCE 614 is only allowed in special circumstances with the advisor’s approval.
  - Credit for CSCE 619 and CSCE 612 may not be allowed in addition to EEN 602. Please check with your advisor.

No credit will be given for the following foundation courses ECEN 214, ECEN 248, ECEN 314, ECEN 325, ECEN 350, CSCE 321, CSCE 211 and CSCE 311.
**Internships**
The internship should be undertaken after the student has had the opportunity to establish a solid theoretical base for the internship experience; e.g. after two semesters or 18 credit hours. If an internship is taken, you will receive graduate credit for 684 hours which needs to be on your degree plan and approved by your advisor.
- A report of your activities and an evaluation by your supervisor must be submitted before a course grade will be submitted.

**Directed Studies**
- Enrollment in directed studies (685) requires approval of the instructor in whose section you are enrolling.
- A 685 request form 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 grade will be assigned. It must be signed by both the student and the instructor.

**Change of Degree Programs**
- If you have received financial support from the department (through either an RA, TA, GANT, fellowship or scholarship), you may not switch to the MEN program from the MS or PHD program.
- If you are in the MEN program you may switch to the MS or PHD program with the approval of a supervising professor. Also, a transfer to the PHD program requires a minimum GPR of 3.6.

**Change of Focus Area**
- You may not change your focus area during your first semester.
- After your first semester, you may change focus areas with the approval of both groups.
Financial Aid
Financial Aid

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

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

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

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

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

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

- A student who is on probation will not be allowed to hold any type of departmental financial support.
English Language Proficiency
AN INTERNATIONAL GRADUATE STUDENT WHOSE NATIVE LANGUAGE IS NOT ENGLISH MUST FULFILL AN ENGLISH PROFICIENCY REQUIREMENT THROUGH EITHER ENGLISH PROFICIENCY VERIFICATION OR ENGLISH LANGUAGE CERTIFICATION. THIS PROFICIENCY REQUIREMENT SHOULD BE MET EARLY IN A STUDENT’S PROGRAM, AND IT MUST BE COMPLETED BEFORE SCHEDULING EITHER THE FINAL EXAMINATION FOR THE MASTER’S DEGREE OR THE PRELIMINARY EXAMINATION FOR THE DOCTORAL DEGREE.

TWO LEVELS OF ENGLISH PROFICIENCY STATUS FOR A GRADUATE STUDENT INCLUDE: ENGLISH PROFICIENCY VERIFIED AND ENGLISH PROFICIENCY CERTIFIED. ENGLISH PROFICIENCY CERTIFICATION IS REQUIRED BY THE STATE OF TEXAS, BEFORE A GRADUATE STUDENT IS ELIGIBLE TO SERVE AS A GRADUATE ASSISTANT-TEACHING, OR ANY OTHER POSITION CONSIDERED TO BE A TEACHING POSITION (E.G., INSTRUCTOR, LECTURER, ETC.). ALL OTHER STUDENTS MUST BE EITHER ENGLISH PROFICIENCY VERIFIED OR ENGLISH PROFICIENCY CERTIFIED.

ENGLISH PROFICIENCY VERIFICATION CAN BE ACHIEVED BY PRESENTING:

- A TOEFL SCORE OF AT LEAST 80 ON TOEFL iBT (550 PAPER-BASED), OR
- AN IELTS SCORE OF AT LEAST 6.0, OR
- A GRE VERBAL REASONING SCORE OF AT LEAST 146 (400 ON THE OLD SCALE), OR
- GMAT VERBAL SCORE OF AT LEAST 22, OR
- A PTE ACADEMIC SCORE OF AT LEAST 53, OR
- ACQUIRING ALTERNATIVE VERIFICATION FROM THE OFFICE OF GRADUATE AND PROFESSIONAL STUDIES VIA A DEPARTMENTAL REQUEST. AN INTERNATIONAL GRADUATE STUDENT HOLDING A MASTERS DEGREE FROM AN ACCREDITED U.S. INSTITUTION QUALIFIES FOR ALTERNATIVE VERIFICATION.

INDIVIDUAL COLLEGES MAY CHOOSE TO ESTABLISH MINIMUM TOEFL STANDARDS THAT EXCEED THE UNIVERSITY MINIMUM FOR ENGLISH PROFICIENCY VERIFICATION. SCORES FROM TOEFL EXAMINATIONS ADMINISTERED MORE THAN TWO YEARS BEFORE SUBMISSION OF THE APPLICATION FOR ADMISSION SHALL NOT BE ELIGIBLE FOR ENGLISH PROFICIENCY VERIFICATION.

ENGLISH PROFICIENCY CERTIFICATION CAN BE ACHIEVED BY:

- SCORING AT LEAST 80 ON EACH OF THE SECTIONS (READING, LISTENING, WRITTEN COMPOSITION AND ORAL SKILLS) OF THE ENGLISH LANGUAGE PROFICIENCY EXAMINATION (ELPE),
- OBTAINING GRADES OF A OR B IN ENGLISH LANGUAGE INSTITUTE (ELI) COURSES (READING, LISTENING, WRITTEN COMPOSITION AND ORAL SKILLS) AT THE 300-LEVEL OR HIGHER, OR
- ACQUIRING ALTERNATIVE CERTIFICATION FROM THE OFFICE OF GRADUATE AND PROFESSIONAL STUDIES VIA A DEPARTMENTAL REQUEST.

A STUDENT WHO HAS RECEIVED A BACcalaureate DEGREE FOLLOWING FOUR YEARS OF STUDY AT AN ACCREDITED U.S. INSTITUTION OR INSTITUTIONS QUALIFIES FOR ALTERNATIVE CERTIFICATION. ALL OTHER REQUESTS FOR ALTERNATIVE CERTIFICATION REQUIRE STRONG DEPARTMENT JUSTIFICATION AND REVIEW IN COMPLIANCE WITH OFFICE OF GRADUATE AND PROFESSIONAL STUDIES POLICIES AND GUIDELINES.
An international student who has completed an equivalent English training program at an institution other than Texas A&M may request English Proficiency Verification or Certification.

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

Recommended Courses

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

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

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

**Master of Science:**

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

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

**Master of Engineering:**

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

*(Undergraduate/graduate courses)*

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

Please check the webpage bio.ece.tamu.edu.
Electromagnetics & Microwaves  
Area Leader: Dr. R. Nevels

Recommended Courses for Master of Science and Master of Engineering  
(Undergraduate courses)

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

(Graduate courses)

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

Recommended Courses

Master of Science:

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

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

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

Recommended Courses

Master of Science:

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

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

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

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

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

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

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

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

Master of Engineering – Electro-optics:

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

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

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

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

Recommended first-level graduate courses
ECEN (undergraduate courses)
   410, 412, 419, 420, 421, 444, 447, 448, 455, 478
ECEN (graduate courses)
   601, 604, 605, 629, 642, 644, 646, 647, 649, 655, 661, 662, 663, 683

Foundation Courses (no graduate credit)
ECEN 214 Electrical Circuit Theory
ECEN 248 Introduction to Digital Systems Design
ECEN 303 Random Signals & Systems
ECEN 314 Signals and Systems
ECEN 325 Electronics
ENGL 301 Technical Writing

Tentative List of Courses for Graduate ISS Students

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

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

Genomics:
ECEN 669 Engineering Applications in Genomics

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

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

Hardware/VLSI:
ECEN 449 Microprocessor System Design
ECEN 454 Digital Integrated Circuit Design
ECEN 468 Advanced Logic Design
You may want to talk to professors in the Computer Engineering department about courses that will suit your background and interests
Graduate Degrees
Computer Engineering and Systems
Requirements for Graduate Computer Engineering Degrees
in the Department of Electrical & Computer Engineering

A. MASTER OF SCIENCE IN COMPUTER ENGINEERING (Thesis Option)

1. Total number of hours (32)
   A minimum of 24 classroom hours (Excludes 681, 684, 685, & 691).
   A minimum of 21 classroom hours from the College of Engineering and
   College of Science
2. Transfer hours allowed from another institution (6)
   Transfer hours must be from a peer institution
   Transfer hours are subject to approval of the Graduate Studies Committee
3. Max undergraduate hours (6 hours/400 only)
4. Special problems, seminar, and research (681, 685, & 691)
   8 hours maximum of these courses
   4 hours minimum of 691
   1 hour of seminar (ECEN/CSCE 681) is required
   No more than 3 hours (in combination) of ECEN 681, 684, and 685.
5. Composition of committee (at least 3)
   At least 2 within Computer Engineering Group from ECEN
   At least 1 not in the student's department
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 ECEN Graduate Office prior to the defense.
   Date and location of the thesis defense must be scheduled through the
   ECEN Graduate Office so that official notification can be provided to OGS.
   Thesis must be submitted to committee members at least two weeks before
   defense.
7. Additional course requirements are listed in D.
B. MASTER OF ENGINEERING IN COMPUTER ENGINEERING (Non-Thesis Option)

1. Total number of hours (30)
   A minimum of 27 classroom hours (Excludes 681, 684, & 685) from
   College of Engineering
   College of Science
   College of Business (at most one course, and only from the ISYS Dept.)
   A minimum of 24 classroom hours from the
   Departments of Computer Science and Engineering and
   Electrical and Computer Engineering
   At least 13 of these 24 hours must be in Electrical & Computer Engineering
   Department.
   At least 6 courses from the CE ME student course list.

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

3. Max undergraduate hours (6 hours/400 only)

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

5. No more than 3 hours (in combination) of ECEN 681, 684, and 685.

6. A report is required in at least one of the ECE or CSE courses.**

7. Students may petition for exemption from the final examination, maintain a
   GPR of at least 3.0, through the ECEN graduate office.

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

9. Additional course requirements are listed in D.

**A final project is required and to be submitted to the ECEN graduate office. A graded
project from any ECEN and CSCE graduate course can be used to fulfill this requirement.
The project requires a grade and the professor’s signature.
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.
   - A minimum of 18 (or 42) classroom hours (excludes 681,684,685,691).
   - 18 hours required for students with a previous Master’s Degree and 42 for direct PhD students.
   - Classroom hours must be taken from courses within the College of Engineering and College of Science.

2. **Max undergraduate hours (8 hours / 2 courses 400 only)**

3. **Three hours of seminar (ECEN/CSCE 681) are required.**
   - At most 3 hours of ECEN 684
   - No more than 2 credit hours of Directed Studies (685) are allowed.
   - Students working on a research project should enroll in Research (691) hours.

4. **A maximum of 6 transfer hours allowed from another institution.**
   - Transfer hours must be from a “peer institution”.
   - Transfer hours are subject to the approval of the Graduate Studies Committee

5. **Composition of committee (at least 4)**
   - At least 2 within Computer Engineering Group from ECEN
   - At least 1 not in the student’s department
   - At least 1 not in CE Group, but in ECEN department

6. **All PHD students are required to pass the Departmental Qualifying Examination**
   - Incoming PHD students are required to take the exam within one year of starting the program.
   - Students entering the program with a previous degree outside of Electrical or Computer Engineering are allowed, with the approval of their advisor, an extra year and will be required to take the exam by the end of the second year.
   - Those students that fail the examination are given a second opportunity to retake the exam which must be taken at the next opportunity in which the exam is offered.
   - Those that fail the examination twice will be removed from the PHD program.

7. **All PHD students are required to pass a preliminary examination.**
   - PHD students are required to schedule their prelim exam by the end of their 4th semester (excluding summers) or 6th semester for direct PHDs. Students who have not scheduled their prelim by the appointed time will be blocked from further registration until they do so.
   - OGS must be officially notified of the exam schedule at least 2 weeks prior to the exam. This should be done through the graduate office.
o Student must download the checklist and signature page from the OGS website. The checklist must be signed by your advisor and Graduate Coordinator prior to the exam.

• The prelim exam consists of a written and an oral examination.

• For students who have passed the departmental Qualifying Exam, the written portion of the prelim exam can be waived subject to the approval of the student's supervisory committee.

• Students who fail the prelim exam will have one opportunity to retake the exam within 6 months of the original exam date.

8. Final defense of dissertation is required for all PHD students.

• A dissertation proposal must be approved by the supervisory committee and submitted to the Graduate Office prior to the defense. Typically this proposal is submitted in conjunction with the preliminary exam, but it can be submitted afterwards.

• Date and location of the final defense must be scheduled through the Graduate Office so that official notification can be provided to OGS.

• Dissertation must be submitted to committee members at least two weeks before defense.

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

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

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

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

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

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

REVISED 9/3/15/caw
Computer Engineering and Systems Courses
Recommended first-level graduate courses

ECEN (undergraduate courses)
   468

CSCE (undergraduate courses)
   410

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

CSCE (graduate courses)
   614, 629, 662

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

6/9/16

Hardware/VLSI:
ECEN 454/14 Digital Integrated Circuit Design
ECEN 468 Advanced Digital System Design
ECEN 749 Microprocessor System Design
ECEN 624 IC Design Tools
ECEN 654 VLSI Systems Design
ECEN 680 Test and Diagnosis of Digital Systems
ECEN 687 Introduction to VLSI Design Automation
ECEN 699 Advances in VLSI Logic Synthesis
ECEN 751 Advanced Computational Methods for Integrated System Design
ECEN 752 Advances in VLSI Circuit Design
CSCE 661 Integrated Systems Design Automation

Networks:
ECEN 602 Computer Comm. and Networking
ECEN 619 Internet Protocols and Modeling
ECEN 621 Mobile Wireless Networks
ECEN 627 Multimedia Systems and Networks
CSCE 663 Real-time Systems
CSCE 665 Advanced Networking and Security
CSCE 664 Wireless and Mobile Systems
ECEN 689 Special Topics Courses
Communication Networks

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

Systems and Software:
CSCE 410 Operating Systems
CSCE 606 Software Engineering
CSCE 629 Analysis of Algorithms
CSCE 662 Distributed Processing Systems
CSCE 670 Information Retrieval and Storage
Tentative List of Courses for CE ME Students

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

9/3/15

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

Networks:
ECEN 602 Computer Comm. and Networking
ECEN 619 Internet Protocols and Modeling
ECEN 621 Mobile Wireless Networks
ECEN 627 Multimedia Systems and Networks
CSCE 663 Real-time Systems
CSCE 665 Advanced Networking and Security
CSCE 664 Wireless and Mobile Systems
ECEN 689 Special Topics Courses
  Communication Networks

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

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

Networking & Systems Theory:
ECEN 434/734 Optimization for Electrical & Computer Engineering Applications
ECEN 663 Data Compression with Applications to Speech and Video
ECEN 750 Design and Analysis of Communication Networks
ECEN 753 Theory and Applications of Network Coding
ECEN 755 Stochastic Systems
ECEN 689 Special Topics Courses
  Game Theory
  Queueing Theory
PHD Qualifiers
Department of Electrical and Computer Engineering
PhD Qualifying Examination

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

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

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

Exam Format: The exam will consist of two questions from each of the areas listed above. Each question should be designed to be completed in 20-25 minutes. Each student will be required to answer any 6 of the 18 questions on the exam. This would insure 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 will be closed book, in-class, and time limited to 3 hours.

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 will be 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 would be about one month after the end of finals. This would tend to encourage students not to spend more than one month preparing for the exam. Incoming PHD students would be required to take the exam within one year of starting the program. Students entering the program with a previous degree outside of Electrical or Computer Engineering will be allowed, with the approval of their advisor, an extra year and will be required to take the exam by the end of the second year. Those students that fail the examination will be given a second opportunity to retake the exam which must be taken at the next opportunity in which the exam is offered. Those that fail the examination twice will be removed from the PHD program.

Grading: The faculty who composed each problem will grade their perspective problems in the written exams. Once grading is completed, the GSC will meet to determine passing thresholds for the examination. The GSC may elect to normalize grades from each problem in order to maintain fairness across the various problems. Results of the exam will be
available within four weeks of the date of the exam. Appeals regarding the results of the exam by either students or faculty must be submitted in writing to the Graduate Office and will be handled by the GSC.
PhD Qualifying Examination
Electric Circuit Analysis – ECEN 214

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

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

3. DC Transient Circuit Analysis
   a. Natural response of an RL circuit
   b. Natural response of an RC circuit
   c. Step response of an RL circuit
   d. Step response of an RC circuit
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 – CSE 221

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

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

3. Complexity Analysis  
   a. Asymptotic notations: the “big-Oh” notation  
   b. Asymptotic analysis using the big-Oh notation
1. **Discrete Probability**
   a. Joint/Conditional probabilities
   b. Independence
   c. Bayes’ theorem
   d. Discrete random variables

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

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

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

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

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

5. Continuous-time and discrete-time Fourier transform
   a. Development of the Fourier transform of an aperiodic signal
   b. Dirichlet conditions, convergence of the Fourier transform
   c. Computing the Fourier transform from the definition
   d. Memorize Fourier transform of basic signals such as rectangular signal, sinc, delta, exponential signal
   e. Properties of the Fourier transform – linearity, time shift, frequency shift, scaling of the time axis and frequency axis, conjugation and symmetry, time reversal, differentiation and integration, duality, Parseval’s relation. Be conversant in using the properties of Fourier transforms to compute the FT of signals that can be obtained from simpler signals through a series of the above operations.
   f. Convolution and multiplication property
   g. Inverse Fourier transform – be able to compute this from definition as well as from looking up the transform for elementary signals. Be able to use partial fraction expansions to compute the Inverse Fourier transform.
6. Applications of the Frequency domain analysis of signals and systems
   b. Sampling – Nyquist theorem, effects of aliasing, ideal reconstruction of the signal from its samples
   c. Modulation – Amplitude modulation, Hilbert transform, DSB and SSB carrier modulation

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

8. Z-transforms
   a. Definition of direct z-transform, region of convergence (ROC), inverse z-transform using partial fraction expansion
   b. Pole-zero plot
   c. Properties of Z-transform – linearity, time shift, z-scaling, time reversal, conjugation, z-differentiation, convolution, stability and its relation to causality and ROC
   d. Transfer function of discrete-time systems and analysis of systems described by constant coefficient difference equations
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
1. **Linear circuit analysis**
   a. Magnitude and phase bode plots
   b. Phase and magnitude margin
   c. Root locus and stability
   d. Basics on feedback theory and properties

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Scheduling the Exam: Unlike the qualifying exam, the PhD prelim exam must be scheduled individually by each student through the Graduate Office.

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. This exam will be held at the time of the prelim exam. Each student is expected to submit a written thesis proposal to the thesis committee before the prelim exam.

The PhD thesis proposal should be approved by the student’s thesis committee within one week of the prelim exam. It is the student’s responsibility to turn in an approved copy of the Ph.D. thesis proposal to the Graduate Office.

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

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

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

Note: The PhD prelim exam is similar to what is called the proposal exam in some universities.
Graduate Courses by Area
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Graduate Course Descriptions

600. Experimental Optics. (3-2). Credit 4.
Hardware, electronic interfaces, and experimental techniques for optics including optical mechanics, component mounting techniques, passive optical components, interferometers and precision alignment, basic electronics including op amps, active optical elements such as acousto-optics, servos in optics, laser intensity stabilization, lock-in amplifier and frequency stabilization. Prerequisite: Approval of instructor.

601. Linear Network Analysis. (3-0). Credit 3.
Signal theory treatment of continuous and discrete signals and systems; vector spaces, projection and sampling theories, Fourier, Laplace and Z Transforms.

Computer communication and computer networks; use of the International Standards Organization (ISO) seven-layer Open Systems Interconnection model as basis for systematic approach; operational networks to be included in the study of each layer; homework assignments to make use of a campus computer network. Prerequisite: ECEN 646 or equivalent probability background.

Basic functions; short-time Fourier transform; Gabor transform; linear time-scale/time-frequency analysis; time-frequency resolution; Wigner-Ville distribution; Ambiguity function; wavelet series; multi-rate filter bank; orthogonality and biorthogonality; subband coding and pattern recognition.

604. Channel Coding for Communications Systems. (3-0). Credit 3.
Channel coding for error control, finite field algebra, block codes, cyclic codes; BCH codes; and convolutional codes; Trellis coded modulation, including ungerboeck codes and coset codes; performance on gaussian and rayleigh channels; applications to communications systems. Prerequisites: Approval of instructor and graduate classification.

605. Linear Control Systems. (3-3). Credit 4.
Application of state variable and complex frequency domain techniques to analysis and synthesis of multivariable control systems. Prerequisite: ECEN 420 or equivalent.

Techniques available to analyze and synthesize nonlinear and discontinuous control systems. Modern stability theory, time-varying systems, DF, DIDF, Lyapunov Theory, adaptive control, identification and design principles for using these concepts; examples from a variety of electronic and electromechanical systems. Prerequisite: ECEN 605.

Design of analog circuits using conventional and non-conventional voltage techniques, including floating gate, bulk driven and enhanced wide swing structures. Prerequisite: ECEN 474 or approval of instructor.

608. Modern Control. (3-0). Credit 3.

Vector Norms; Induced Operator Norms; Lp stability; the small gain theorem; performance/robustness trade-offs; L1 and Hoo optimal P control as operator norm minimization; H2 optimal control. Prerequisite: ECEN 605 or equivalent. Cross-listed with MEEN 674.


Basic principles of parameter identification and parameter adaptive control; robustness and examples of instability; development of a unified approach to the design of robust adaptive schemes. Prerequisite: ECEN 605 or approval of instructor. Cross-listed with MEEN 675.


Analog-to-digital and digital-to-analog converter architectures including Nyquist rate and oversampled converters; definition of basic data converter specifications and figures of metric; background and foreground calibration techniques to improve performance of data converters; low-power (green topologies) data converters design; state of the art mixed-signal interfaces such as transmitters and receivers front-ends in wireless and wireline communications transceivers; introduction to calibration techniques for digitally-assisted transceivers. Prerequisite: ECEN 474 or approval of instructor.

611. General Theory of Electromechanical Motion Devices. (3-0). Credit 3.

Winding function theory; inductances of an ideal doubly cylindrical machine; inductances of salient-pole machines, reference frame and transformation theory; dynamic equations of electric machines; steady-state behavior of electric machines. Prerequisite: Approval of instructor or graduate classification.


Magnetic circuits and field distribution of electric machines; main flux path calculation; calculation of magnetizing and leakage inductance; calculation of electric machine losses; principle of design of various electric machines; finite element design of electromechanical motion devices. Prerequisite: Approval of instructor or graduate classification.


Analysis/design of single phase, three phase rectifiers; phase control and PWM rectifiers; line harmonics; power factor; harmonic standards; passive and active correction methods; inverters; PWM methods; effect of blanking time; zero voltage switching and multilevel inverter; application of these systems in UPS and AC motor drives. Prerequisite: ECEN 438 or approval of instructor.

The large electric power system state estimation problem; issues of network observability; bad measurements detection/identification; sparse matrix vector techniques for computational efficiency. Prerequisite: ECEN 460.


Digital computer methods for solution of the load flow problem; load flow approximations; equivalents; optimal load flow. Prerequisite: ECEN 460 or approval of instructor.


Modeling of power system components for electromagnetic transient studies; digital computer methods for computation of transients. Prerequisites: ECEN 459 and ECEN 460.

617. Advanced Signal Processing for Medical Imaging. (3-0). Credit 3.

This is a graduate-level course covering several advanced signal processing topics in medical imaging: multi-dimensional signal sampling and reconstruction, bio-signal generation and optimal detection, Fourier imaging, Radon transform-based tomographic imaging, multi-channel signal processing, as well as constrained reconstruction, rapid imaging, image segmentation, registration and analysis. Prerequisite: Approval of the instructor.


Impact of reliability on computer and network systems design; stochastic models of reliability and availability in fault-tolerant systems; hardware, software and system interaction, system design for testability, isolation and recovery. Prerequisite: ECEN 350 or CSCE 410.


Wide spectrum of Internet protocols that make it work; analytical capabilities to evaluate the performance of complex Internet protocols; aspects of the Internet protocols, including principles, design and implementation, and performance modeling and analysis; core components of Internet protocols such as transport (TCP, UDP), network and routing (IP, RIP, OSPF, EGP, BGP-4, etc.) Prerequisite: Approval of instructor.


Development and application of advanced topics in circuit analysis and synthesis in both the continuous and discrete time and frequency domains. Prerequisite: ECEN 326 or equivalent.

621. Mobile Wireless Networks. (3-0). Credit 3.

Foundations of advanced mobile wireless networks, how they are designed, and how well they perform. Topics include fundamentals on mobile wireless networks, TCP/IP over wireless links, fading-channel modeling, CDMA, OFDM, MIMO, error control, IEEE 802.11 protocols, cross-layer optimization, wireless QoS, mobile multicast, VANETs, wireless-
sensor networks, wireless networks security. Prerequisites: Basic-level "Computer Networks" class or consent of instructor.

622. Active Network Synthesis. (3-0). Credit 3.

Methods of analyzing and synthesizing active networks; sensitivity analysis, methods of rational fraction approximation, OP AMP modeling and stability. Prerequisite: ECEN 457 or equivalent.


Parallel computer architectures and algorithms for solving geometric problems raised in VLSI design, pattern recognition and graphics; advanced research results in computational geometry including convexity, proximity, intersection, geometric searching and optimization problems. Prerequisite: CSCE 311 or ECEN 350.

624. IC Design Tools. (3-0). Credit 3.

Use of several CAD tools, not covered in other classes, oriented towards the solution of more advanced IC design task; the underlying theoretical principles, problem solved and basic solution methods. Prerequisite: Approval of instructor.

Course Descriptions/Electrical and Computer Engineering 401


Applications of millimeter-wave integrated circuits for wireless transceiver; principles of operation, modeling, design and fabrication of the most common millimeter-wave CMOS, SiGe and RF MEMS circuits. Prerequisite: Graduate classification; approval of instructor.


Applied electromagnetics and physical layer concepts for modern communication systems; topics include: advanced antenna theory and analytical techniques (e.g., variational and perturbational); full-wave tools for complex radiating structures and fading environments; reconfigurable antennas and device integration; multiple antenna techniques; and fabrication, measurement, and calibration methods. Prerequisite: Approval of instructor.

627. Multimedia Systems and Networks. (3-0). Credit 3.

Research topics in multimedia storage and delivery; real-time scheduling (processor, disk, network); guaranteed service, statistical guarantees, best-effort, IP-Multicast audio/video compression standard, multicast applications, congestion control. Prerequisite: ECEN 602 or CSCE 619.

628. Linear System Theory. (3-0). Credit 3.

Application of functional analysis and geometric concepts to the analysis and synthesis of control systems. Prerequisite: ECEN 605.

Introduction of convex optimization including convex set, convex functions, convex optimization problems, KKT conditions and duality, unconstrained optimization, and interior-point methods for constrained optimization; specific application examples in communication/information theory, signal processing, circuit design, and networking, which are based on state-of-art research papers. Prerequisites: Linear Algebra (familiar with operations over vectors and matrices).


Analysis and control of semiconductor switching power converters using specialized methods such as Fourier series, state-space averaging, time domain transfer functions, sliding mode, quadrometrics and other discontinuous orthogonal functions; application of the above techniques in practice; selected research publications. Prerequisite: Approval of instructor.


Fiber optic waveguides; directional couplers; polarization; poincare sphere fractional wave devices; PM fiber; interferometric devices and sensors fiber gyroscope; faraday effect devices; multiplexing techniques. Prerequisite: Approval of instructor.

632. Motor Drive Dynamics. (3-0). Credit 3.

Mathematical analysis of adjustable speed motor drive dynamics; direct torque control in dc and ac machines; the theory of field orientation and vector control in high performance ac motor drives; motion control strategies based on the above theories; microcomputer, signal and power circuit implementation concepts. Prerequisite: Approval of instructor.


Variational approach to the development of algorithms for the solution of optimum control problems; necessary and sufficient conditions, numerical methods, and analysis and comparison of optimal control results to classical theory. Prerequisite: ECEN 605.


Image analysis and signal processing; feature extraction based upon geometrical shape; morphological filtering for image analysis; computer simulation of filter types. Prerequisites: ECEN 447 and ECEN 601.

635. Electromagnetic Theory. (3-0). Credit 3.

Maxwell's equations, boundary conditions, Poynting's theorem, electromagnetic potentials, Green's functions, Helmholtz's equation, field equivalence theorems; applications to problems involving transmission scattering and diffraction of electromagnetic waves. Prerequisites: ECEN 322; ECEN 351 or equivalent.
636. Phased Arrays. (3-0). Credit 3.

Theory and application of phased array antennas, radiators and sensors; spatial and spectral domain analysis of phased arrays including element-by-element, infinite array and Fourier methods; applications will include phased arrays, adaptive arrays, and synthesis array antennas; for use in radar, imaging and biomedical treatment and diagnosis. Prerequisite: ECEN 322 or equivalent.


Numerical techniques for solving antenna, scattering and microwave circuits problems; finite difference and finite element differential equation methods with emphasis on the method of moments integral equation technique. Prerequisites: ECEN 351 or ECEN 635; CSCE 203 or equivalent.


Application of Maxwell's equations to determine electromagnetic fields of antennas; radiation, directional arrays, impedance characteristics, aperture antennas. Prerequisite: ECEN 351.

639. Microwave Circuits. (3-0). Credit 3.

Introduction to high frequency systems and circuits; provides background information needed to understand fundamentals of microwave integrated circuits; includes usage of S-parameters, Smith Charts, stability considerations in designing microwave circuits; utilizes CAD program "Super Compact" demonstrating design synthesis optimization and analysis of monolithic devices and circuits. Prerequisite: Graduate classification.

640. Thin Film Science and Technology. (3-0). Credit 3.

The course focuses on the thin film technology in semiconductor industry. Topics include the basic growth mechanisms for thin films (growth models, lattice matching epitaxy and domain matching epitaxy), the instrumental aspects of different growth techniques and advanced topics related to various applications. Prerequisites: Graduate standing.


Microwave two-terminal and three-terminal solid-state devices; waveguide and microstrip solid-state circuits; theory and design of microwave mixers, detectors, modulators, switches, phase shifters, oscillators and amplifiers. Prerequisite: ECEN 351.


Digital Image Processing techniques; stresses filtering, transmission and coding; fast transform techniques; convolution and deconvolution of model noise. Prerequisites: ECEN 447 and ECEN 601.

Design and application of mathematical models for estimating various measures of reliability in electric power systems. Prerequisite: ECEN 460 or approval of instructor.


Linear discrete time systems analysis using time domain and transform approaches; digital filter design techniques with digital computer implementations. Prerequisite: ECEN 601.

645. Pattern Recognition by Neural Networks. (3-0). Credit 3.

Feedforward and feedback paradigms; training algorithms; supervised and unsupervised learning; associative networks; self-clustering networks; stability and convergence; comparison with statistical pattern recognition. Prerequisite: ECEN 649 or approval of instructor.

646. Statistical Communication Theory. (3-0). Credit 3.

Concepts of probability and random process theory necessary for advanced study of communications, stochastic control and other electrical engineering problems involving uncertainty; applications to elementary detection and estimation problems. Prerequisite: Registration in ECEN 601 or approval of instructor.

647. Information Theory. (3-0). Credit 3.

Definition of information; coding of information for transmission over a noisy channel including additive gaussian noise channels and waveform channels; minimum rates at which sources can be encoded; maximum rates at which information can be transmitted over noisy channels. Prerequisite: ECEN 646 or equivalent probability background.


Introduction to the theory and design of magnetic resonance imaging systems; fundamental physical and mathematical introduction to image acquisition and reconstruction using magnetic resonance; overview of imaging system design, including magnets, imaging gradients and radio-frequency systems, contrast mechanisms, resolution. Prerequisite: ECEN 314 or ECEN 322 or approval of instructor.


Introduction to the underlying principles of classification, and computer recognition of imagery and robotic applications. Prerequisites: MATH 601 and/or STAT 601 and approval of instructor.

650. High Frequency GaAs/SiGe Analog IC Design. (3-0). Credit 4.

High frequency integrated circuit design using non-conventional technologies such as GaAs and SiGe, with the emphasis on wireless and broadband communication circuits. Device
operation, basic building blocks and typical applications. Prerequisite: ECEN 474 or approval of instructor.


Hardware and software concepts involved in the design and construction of microprocessor-based digital systems; microprocessor architecture; bussing; interfacing; data input/output; memories; and software development for operation and testing; design projects with microprocessors and related components. Prerequisites: ECEN 350 and ECEN 449 or approval of instructor.

652. Switching Theory. (3-0). Credit 3.

Digital systems design; introduction to switching algebras, overview of integrated circuit technologies, analysis and synthesis of combinational circuits, special properties of selected switching functions, sequential circuits, fundamental mode analysis, pulse mode analysis, and sequential credit synthesis. Prerequisite: Graduate classification.


Digital computer arithmetic unit design, control and memory; microprocessor arithmetic logic unit (ALU) design. High-speed addition, subtraction, multiplication and division algorithms and implementations; design and simulation with integrated circuit components and VLSI circuits. Prerequisite: ECEN 651.


Design and fabrication of microelectronic circuits such as registers, selectors, PLAs, sequential and micoprogrammed machines via large scale integrated circuitry with emphasis on high-level, structured design methods for VLSI systems. Students design small to medium scale integrated circuits for fabrication by industry. Prerequisites: ECEN 454 or equivalent undergraduate VLSI course.

655. Advanced Topics in Channel Coding. (3-0). Credit 3.

Advanced topics in Channel Coding including turbo codes, low density parity check codes, iterative decoding and applications of iterative decoding principles. Prerequisite: ECEN 604 or graduate classification.

656. Physical Electronics. (3-0). Credit 3.

Elementary quantum theory; statistical mechanics; Lattice dynamics; semiconductor theory; dielectrics; magnetic materials; quantum electronics; introduction to quantum devices, such as the laser. Prerequisite: Graduate classification or approval of instructor.

657. Quantum Electronics. (3-0). Credit 3.

Application of principles of quantum mechanics to problems in optics including emission, absorption and amplification of light; optical resonators and lasers; optical modulation; nonlinear optics; photodetectors and optical receivers. Prerequisites: PHYS 412 and PHYS 606 or approval of instructor.

Low-noise design; surveying the subject of handling electronic noise from theory to measurement, design, research and developments. Prerequisite: Approval of instructor.


A unified treatment of parallel and distributed numerical algorithms; parallel and distributed computation models, parallel computation or arithmetic expressions; fast algorithms for numerical linear algebra, partial differential equations and nonlinear optimization. Prerequisite: MATH 304 or equivalent. Cross-listed with CSCE 659.


Introduction to lab-on-a-chip technology; microfabrication techniques commonly used in BioMems device fabrication; microfluidics miniaturized systems for chemical and biomedical applications such as separation, diagnosis tools, implantable devices, drug delivery, and microsystems for cellular studies and tissue engineering; will gain a broad perspective in the area of miniaturized systems for biomedical and chemical applications. Prerequisite: Approval of instructor.


Optimum receiver principles and signal selection for communication systems with and without coding; system implementation, and waveform communication using realistic channel models. Prerequisite: ECEN 646.


Probabilistic signal detection theory and parameter estimation theory; Neyman-Pearson, UMP, and locally optimal tests; discrete time Markov processes and the Kalman and Wiener filters; bayesian, maximum likelihood and conditional mean estimation methods. Prerequisite: ECEN 646.

663. Data Compression with Applications to Speech and Video. (3-0). Credit 3.

Characterization and representation of waveforms; digital coding of waveforms including PCM, delta modulation, DPCM, tree/trellis coding, runlength coding, sub-band coding and transform coding; rate distortion theoretic performance bounds. Prerequisites: ECEN 601 and ECEN 646.

664. Nanotechnology Fabrication. (3-0). Credit 3.

Cutting edge nanostructure fabrication techniques for both top-down and bottom up approaches. Prerequisite: Instructor approval.


Introduction to wireless communication systems at the theoretical, algorithmic and circuit levels; emphasis on simulation at the architecture, transistor levels of the communication
systems; focus on circuits implementable on CMOS and BiCMOS technologies. Prerequisites: ECEN 453, ECEN 456, ECEN 474.


Calculation of power system currents and voltages during faults; protective relaying principles, application and response to system faults. Prerequisite: ECEN 460 or approval of instructor.


Steady-state, dynamic and transient stability of power systems; solution techniques; effect of generator control systems. Prerequisite: ECEN 460 or approval of instructor.


Overview of HVDC systems; comparison of AC and DC power transmission; study of six-pulse and twelve-pulse power converters; analysis and control of HVDC systems; harmonics and power factor effects; system faults and misoperations; state of the art and future developments in HVDC technology; inspection trips. Prerequisite: Approval of instructor.

669. Engineering Applications in Genomics. (3-0). Credit 3.

Tutorial introduction to the current engineering research in genomics. The necessary Molecular Biology background is presented and techniques from signal processing and control are used to (i) unearth intergene relationships (ii) model genetic regulatory networks and (iii) alter their dynamic behavior. Prerequisite: ECEN 605 or approval of instructor.

670. Fiber Optic Networks. (3-0). Credit 3.

Components, topologies and architecture for communication networks based on the optical fiber transmission medium; examples based on recent publications in technical literature. Prerequisite: Graduate classification.


Development of mathematical analysis and systematic modeling of solid state devices; relationships of measurable electrical characteristics to morphology and material properties of solid state devices, p-n junction, bipolar and unipolar transistors. Prerequisite: ECEN 656 or approval of instructor.

672. Semiconductor Lasers and Photodetectors. (3-0). Credit 3.

III-V compound semiconductor material, spontaneous and stimulated emission in lasers; optical wave guiding, rate equation solutions, quantum noise and spectral linewidth properties of lasers; principle and structure of photodetectors; III-V compound material technology. Prerequisite: ECEN 370.

Microelectronic systems and fabrication technologies; methods of engineering analysis and device characterization. Junction diodes, Schottky diodes, bipolar transistors, junction and MOS field-effect devices, solar cells, light emitting diodes, charge coupled devices, magnetic bubbles, liquid crystal displays and other newly developed devices and circuits. Prerequisite: Graduate classification or approval of instructor.

674. Introduction to Quantum Computing. (3-0). Credit 3.

Introduces the quantum mechanics, quantum gates, quantum circuits and quantum hardware of potential quantum computers; algorithms, potential uses, complexity classes, and evaluation of coherence of these devices. Prerequisites: MATH 304, PHYS 208. Cross-listed with PHYS 674.

675. Integrated Optoelectronics. (3-0). Credit 3.

Light propagation and interactions in anisotropic media; electrooptic and acoustooptic effects; passive and active guided-wave devices; fabrication and characterization. Prerequisite: ECEN 464 or equivalent.


Design of advanced computers for parallel processing; emphasis on the overall structure; interconnection networks; including single-stage and multi-stage structures; shared memory and message passing architectures; control-flow and demand-driven programming; multithreaded architectures; fine-grain and coarse-grain parallelism; SIMD and MIMD; processor designs for parallel operation. Prerequisite: ECEN 651 or CSCE 614 or approval of instructor. Cross-listed with CSCE 676.


Modeling, analysis and real-time control of electric power systems to meet the requirements of economic dispatch of voltage and power. Prerequisite: Approval of instructor.

678. Statistical Optics. (3-0). Credit 3.

Statistics of laser and thermal light; partial polarization; Jones and coherency matrices; Temporal coherence; spatial coherence; mutual coherence; optical noise; detection noise. Prerequisite: ECEN 464.


Real-time digital computer application to protective relaying; extensive overview of digital protection algorithms; latest technological advancements as microprocessor-based relays, fiber-optic communication systems, unconventional instrument transformers, dynamic testing tools and methodologies. Prerequisite: Approval of instructor.

The theory and techniques of testing VLSI-based circuits and systems, and design for testability. Prerequisites: ECEN 220 or ECEN 248 or equivalent; ECEN 350 or CSCE 321 or equivalent. Cross-listed with CSCE 680.


Reports and discussion of current research and of selected published technical articles. May not be taken for credit more than once in master's degree program or twice in PhD program. Prerequisite: Graduate classification in electrical engineering.

682. Spread Spectrum and CDMA. (3-0). Credit 3.

Spread spectrum communication systems including direct-sequence; multicarrier, and frequency hopped spread spectrum, pseudo-random sequences, code acquisition and tracking; CDMA, multi-user detection; RAKE receivers, and CDMA standards. Prerequisite: ECEN 646, ECEN 661 or approval of instructor.


Wireless applications, modulation formats, wireless channel models and simulation techniques, digital communication over wireless channels, multiple access techniques, wireless standards. Prerequisite: ECEN 646 or approval of instructor.

684. Professional Internship. Credit 1 to 4.

Engineering research and design experience at industrial facilities away from the Texas A&M campus; design projects supervised by faculty coordinators and personnel at these locations; projects selected to match student's area of specialization. Prerequisites: Graduate classification and one semester of coursework completed.

685. Directed Studies. Credit 1 to 12 each semester.

Research problems of limited scope designed primarily to develop research technique.

686. Electric and Hybrid Vehicles. (3-0). Credit 3.

Fundamental concepts of electric and hybrid-electric vehicles introduced, component requirements and system design methodologies discussed; vehicle system analysis and simulation methods presented. Prerequisite: Graduate classification or approval of instructor.

687. VLSI Physical Design Automation. (3-0). Credit 3.

The course is on algorithms for VLSI physical design automation, which include partitioning, floor planning, placement, and routing. Technical papers on the above topics will be chosen from premier CAD, conference proceedings, journals and presented in class. Prerequisite: ECEN 248, CSCE 311 knowledge in logic design and computer algorithms.
688. IC MEMS and Sensor Fabrication. (3-3). Credit 4.

Fundamental unit processes for the fabrication of silicon IC's and extension of these processes to the specialized micro-machining operations used for MEMS and sensor fabrication; basic process operations used in the laboratory to build simple IC structures; devices then characterized. Prerequisite: ECEN 325, ECEN 370, or approval of instructor.

689. Special Topics in... Credit 1 to 4.

Advanced topics of current interest in electrical engineering. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester.

Research for thesis or dissertation.


Introduction to advances in nanobiotechnology; includes fabrication of micro or nano structures, molecular manipulation, medical diagnostic and treatment options, nano scale machines such as molecular motors for drug delivery. Prerequisite: Graduate classification; approval of instructor.


Rate equations and modeling of rare-earth transitions. Spontaneous stimulated emission. Pump requirement for erbium-doped fiber. Erbium-doped fiber design and simulation using commercial dispersion compensation issues, polarization effects, self-phase modulation, cross-phase modulation. Raman and Brillouin effects in optical fibers. Prerequisite: ECEN 370 or approval of instructor.


The data conversion metrics to evaluate performance is presented, the design and classification of data converters are introduced, discussion on practical applications are given. Prerequisite: Advanced analog or approval of instructor.


Logic representation, manipulation, and optimization; combinational and sequential logic; Boolean function representation schemes; exact and heuristic two-level logic minimization; multi-valued logic representation and manipulation; multi-level logic representation and minimization; testing; technology mapping. Prerequisites: Approval of instructor and graduate classification.

710. Switching Power Supplies. (3-0). Credit 3.

This course deals with operating principles of switching power supplies. Analysis and in-depth design of several types of switching regulators including buck, boost, forward, flyback,
half and full bridge switching regulator analysis will be examined. Elements of transformer
and magnetic design will be introduced. State space analysis and feedback loop stabilization
principles will be explored. Application of these in the industry will be explained.
Prerequisites: ECEN 438 or equivalent, approval of instructor.

Forms of sustainable and unsustainable energy resources and the basic system engineering
limits of each; specific problems of sustainable transportation energy on the bases of vehicle
and power engineering; issues related to energy efficiency, life cycle analysis, global
warming, pollution, economic and social considerations. Prerequisite: Graduate classification
in engineering.

Sustainable energy sources such as photovoltaic, fuel cell, wind, and others require power
electronics to perform energy conversion and conditioning in order to convert their native
form of electrical generation to a format compatible with the ac utility grid; exploration of
the salient electrical characteristics of solar photovoltaic sources, the requirements for grid-
connection and the power electronic circuits and controls needed to perform the
interconnection and control. Prerequisite: ECEN 438 or instructor approval.

System and circuit design of high-speed electrical and optical link systems; includes channel
properties, communication techniques, and circuit design of drivers, receivers, equalizers,
and synchronization systems; project consists of link design with a statistical bit error rate
simulator and interface circuit design. Prerequisite: ECEN 474.

730. CMOS RFIC Engineering. (3-0). Credit 3.
Introduction to CMOS radio-frequency integrated circuits (RFICs) and wireless systems and
networks; theory, analysis and design of RFICs using CMOS technologies; CMOS
fundamentals (device, principle, models); scattering parameters, transmission lines,
distributed structures, lumped elements, impedance matching, RFIC layout, processing, test,
amplifiers, oscillators, mixers; CAD programs for CMOS RFIC design. Prerequisites: ECEN
322 and graduate classification.

750. Design and Analysis of Communication Networks. (3-0). Credit 3.
Analytical approach to understanding resource allocation on the Internet; study the system in
a global sense, and use a deterministic approach to study congestion control protocols; study
individual queues and routers, and use a stochastic approach to understanding system
performance. Prerequisite: ECEN 646 or some probability background.

751. Computational Methods for Integrated System Design. (3-0). Credit 3
Integrated circuit design in a computational standpoint; VLSI circuit simulation, interconnect
modeling and analysis, design and analysis of IC subsystems, parallel computing techniques
for complex system design. Prerequisite(s): ECEN 454, ECEN 474 or equivalent.
752. Advances in VLSI Circuit Design. (3-0). Credit 3

Gate and wire delays, CMOS transistors, DC and AC characteristics, VLSI fabrication, Static, Dynamic, Pass-gate and PLA implementation styles, SOI and GaAs technology, DRAM, SRAM and FLASH memory design, leakage and dynamic power, sub-threshold computation, clocking, transmission lines, packaging, off-chip IO, process variation and compensation, radiation tolerance. Prerequisite(s): Graduate classification or Instructor approval.

753. Theory and Applications of Network Coding


760. Introduction to Probabilistic Graphical Models. (3-0).

Credit 3. Broad overview of various probabilistic graphical models, including Bayesian networks, Markov networks, conditional random fields, and factor graphs; relevant inference and learning algorithms, as well as their application in various science and engineering problems will be introduced throughout the course. Prerequisites: Undergraduate level probability theory; basic programming skill in any programming language (C, C++, Python, Matlab, etc.).


Biosensors Lab is a hands on experience in basic concepts of biosensing and how to make miniaturized biosensors; various application examples associated with these sensing principles. Prerequisite: Approval of instructor.

762. Ultrasound Imaging. (3-0). Credit 3.

Covers mathematical analysis of wave propagation, scattering of ultrasound in biological tissues, electronic transducer arrays for the beam forming, models of the received signals and signal processing methods for medical ultrasound imaging of tissues. Research papers related to fundamental ultrasound imaging concepts are discussed throughout the course. Prerequisite: Approval of instructor.


Design, construction and application of instrumentation for MR Imaging; fundamentals of the architecture if an MR spectrometer and the gradient subsystem used for image localization; emphasis on the radiofrequency sensors and systems used for signal generation and reception. Prerequisite(s): ECEN 410, or ECEN 411, BMEN 420, or equivalent, or approval of instructor. Cross-listed with BMEN 627.


Organic semiconductors are new semiconducting materials with huge application potentials; designed to help students understand the material properties of organic semiconductors and the operation principles of organic electronic devices; gain broad knowledge in organic
semiconductors, from the structure-property relationship to the design and optimization of organic devices and systems. Prerequisite: Approval of instructor.

771. Fluctuations and Noise Electronics. (3-0). Credit 3.

This course is introducing the students to the research of Noise and Fluctuations. Noise and Fluctuations in electronics and other systems include virtually all scientific fields, including secure and non-secure communications, microprocessors, quantum information, mesoscopic systems, chemical sensing, corrosion diagnostics, neuro- and membrane-biology, biomedicine, etc. Prerequisite: Approval of Instructor.

772. Introduction to Microelectromechanical Devices and Systems. (3-0). Credit 3.

The goal of this course is to provide the students with a broad overview of the past and current developments in the emerging area of MEMS (microelectromechanical systems). The first part of this course will discuss the fundamental working principles, designs and fabrication techniques. The second part will consist of several special topics, discussing the latest important applications in different fields. Prerequisite: Consent of instructor.

773. Introduction to Nanophotonics. (3-0). Credit 3.

Photonic bandgap optical circuitry, photonic crystal fiber; Visible to infrared semiconductor quantum lasers; Semiconductor quantum dots. Plasmonic field enhancement, plasmonic optical circuitry, sub-wavelength optical lithography, negative refractive index and sub-wavelength optical imaging. Nano-structure characterization techniques, atomic force microscopy, near-field optical microscopy, scanning and transmission electron microscopy. Prerequisite: Basic Physics, ECEN 370 or equivalent, ECEN 322 or equivalent.

ECEN 777 Photonics: Fiber and Integrated Optics Credits 4. 3 Lecture Hours. 3 Lab Hours.

Optical power and spectral measurements of singlemode and multimode optical fibers, hands-on arc fusion splicing, lasers, amplifiers, interferometers, photodetectors, integrated optics, fiber-optics, fiber-optic devices, optical modulators. Prerequisites: Equivalent of ECEN 322 and ECEN 370 or approval of instructor.
Undergraduate Courses
Undergraduate Course Descriptions

Discussion of some well-known and major contributions that electrical and computer engineers have made to society; development of the integrated circuit, advanced vehicle research, magnetic resonance imaging, communication and others.

Resistive circuits: circuit laws, network reduction, nodal analysis, mesh analysis; energy storage elements; sinusoidal steady state; AC energy systems; magnetically coupled circuits; the ideal transformer; resonance; introduction to computer applications in circuit analysis. Prerequisites: PHYS 208; MATH 308 or registration therein; admission to upper level in an engineering major.

Fundamentals of electric circuit analysis and introduction to electronics for engineering majors other than electrical and computer engineering. Prerequisites: PHYS 208; admission to upper level in an engineering major. Corequisite: MATH 308.

Combinational and sequential digital system design techniques; design of practical digital systems. Prerequisite: CSCE 110 or equivalent. For students other than electrical engineering majors.

Provide mathematical foundations from discrete mathematics for analyzing computer algorithms, for both correctness and performance; introduction to models of computation, including finite state machines and Turing machines. Prerequisite: MATH 151. Cross-listed with CSCE 222.

Combinational and sequential digital system design techniques; design of practical digital systems. Prerequisite: Admission to upper level in an engineering major.

Problems of limited scope approved on an individual basis intended to promote independent study. Prerequisite: Approval of department head.

289. Special Topics in... Credit 1 to 4.
Selected topics in an identified area of electrical engineering. May be repeated for credit. Prerequisite: Approval of instructor.

Research conducted under the direction of faculty member in electrical engineering. May be repeated 3 times for credit. Prerequisites: Freshman or sophomore classification and approval of instructor.


Concepts of probability and random variables necessary for study of signals and systems involving uncertainty; applications to elementary problems in detection, signal processing and communication. Prerequisites: MATH 308; junior or senior classification.

314. Signals and Systems. (3-0). Credit 3.

Introduction to the continuous-time and discrete-time signals and systems; time domain characterization of linear time-invariant systems; Fourier analysis; filtering; sampling; modulation techniques for communication systems. Prerequisites: ECEN 214; MATH 308.

322. Electric and Magnetic Fields. (3-1). Credit 3.

Vector analysis, Maxwell’s equations, wave propagation in unbounded regions, reflection and refraction of waves, transmission line theory; introduction to waveguides and antennas. Prerequisites: ECEN 214; PHYS 208; junior or senior classification.


Introduction to electronic systems; linear circuits; operational amplifiers and applications; diodes, field effect transistors, bipolar transistors; amplifiers and nonlinear circuits. Prerequisite: ECEN 314 or registration therein.


Basic circuits used in electronic systems; differential and multistage amplifiers; output stages and power amplifiers; frequency response, feedback circuits, stability and oscillators, analog integrated circuits, active filters. Prerequisites: ECEN 314 and 325.


Introduction to magnetic circuits, transformers, electromechanical energy conversion devices such as dc, induction and synchronous motors; equivalent circuits, performance characteristics and power electronic control. Prerequisite: ECEN 214.


Computer architecture and design; use of register transfer languages and simulation tools to describe and simulate computer operation; central processing unit organization,
microprogramming, input/output and memory system architectures. Prerequisite: ECEN 248. Cross-listed with CSCE 350.


Guided waves; applications of Maxwell’s equations and electromagnetic wave phenomena to radiation, antenna design and optics; numerical techniques in electromagnetics. Prerequisite: ECEN 322.


Introduction to basic physical properties of solid materials; some solid state physics employed, but major emphasis is on engineering applications based on semiconducting, magnetic, dielectric and superconducting phenomena. Prerequisite: PHYS 222.

403. Electrical Design Laboratory I. (2-2). Credit 3.

Application of design process and project engineering as practiced in industry; team approach to the design process; development of a project proposal; proposed project implemented in ECEN 404. Prerequisites: ECEN 214, ECEN 314, ECEN 325; ENGL 210, ENGL 241 or ENGL 301 or COMM 203 or COMM 205; senior classification.

404. Electrical Design Laboratory II. (2-3). Credit 3.

Continuation of ECEN 403; application of the design process and project engineering as practiced in industry; team approach to the design process; completion of project based on proposal from ECEN 403; includes testing, evaluation and report writing. Prerequisites: ECEN 403, senior classification and approval of project.

405. Electrical Design Laboratory. (1-6). Credit 3.

Introduction to the design process and project engineering as practiced in industry; student teams apply the design process by developing a project from proposal through test and evaluation. Prerequisites: ENGL 210 or 301, completion of selected major field courses, senior classification and project approval.

410. Introduction to Medical Imaging. (3-0). Credit 3.

Introduction to the physics and the engineering principles of medical imaging systems; focus on magnetic resonance imaging, x-ray computer tomography, ultrasonography, optical imaging and nuclear medicine; includes system structure, source generation, energy tissue interaction, image formation and clinical examples. Prerequisites: MATH 222 or MATH 251 or MATH 253; junior or senior classification.

411. Introduction to Magnetic Resonance Imaging and Magnetic Resonance Spectroscopy. (2-3). Credit 3. Introduction to the basic physics of magnetic resonance, the principles of MR imaging and spectroscopy, the major contrast mechanisms in MRI and MR imaging system hardware; development of pulse sequences for different imaging methods, including flow and spectroscopic imaging; will build RF coils. Prerequisites: Junior or senior classification; MATH 251, PHYS 208.
412. Ultrasound Imaging. (3-0). Credit 3.

Mathematical analysis of wave propagation, scattering of ultrasound in biological tissues, electronic transducer arrays for the beam forming, models of the received signals and signal processing methods for medical ultrasound imaging of tissues; includes discussions of research related to fundamental ultrasound imaging concepts. Prerequisites: ECEN 314 or approval of instructor; junior or senior classification.


Hands-on lab experience in the development of miniaturized biosensors; includes microfluidic devices for biosensing. Prerequisite: Senior classification or approval of instructor.


Fundamentals of molecular biology; application of engineering principles to systems biology; topics include unearthing intergene relationships, carrying out gene-based classification of disease, modeling genetic regulatory networks, and altering their dynamic behavior. Prerequisite: ECEN 314, junior or senior classification or approval of instructor.

420. Linear Control Systems. (3-0). Credit 3.

Application of state variable and frequency domain techniques to modeling, analysis and synthesis of single input, single output linear control systems. Prerequisites: ECEN 314; MATH 308.


Feedback systems in which a digital computer is used to implement the control law; Z-transform and time domain methods serve as a basis for control systems design. Effects of computer word length and sampling rate. Prerequisite: ECEN 420 or equivalent.

422. Control Engineering and Design Methodology. (2-3). Credit 3.

Modeling, specifications, rating and operating principles of sensors, actuators and other control system components; experiments on conceptual design, simulation and physical implementation of control systems. Prerequisite: ECEN 420 or equivalent.


Electric power conditioning and control; characteristics of solid state power switches; analysis and experiments with AC power controllers, controlled rectifiers, DC choppers and DC-AC converters; applications to power supplies, airborne and spaceborne power systems. Prerequisite: Junior or senior classification in electrical engineering or approval of instructor.

440. Introduction to Thin Film Science and Technology. (3-0). Credit 3.

The course focuses on the thin film technology in semiconductor industry; topics include the basic growth mechanisms for thin films (growth models, lattice matching epitaxy and domain matching epitaxy), the instrumental aspects of different growth techniques and advanced
topics related to various applications. Prerequisites: Junior or senior classification; admission to upper level in College of Engineering.


Application of semiconductor switching power converters to adjustable speed DC and AC motor drives; steady state theory and analysis of electric motion control in industrial, robotic and traction systems; laboratory experiments in power electronic motor drives and their control. Prerequisite: Junior or senior classification in electrical engineering.

442. DSP Based Electromechanical Motion Control. (2-3). Credit 3.

Overview of energy conversion and basic concepts on electromechanical motion devices; different control strategies including the solid-state drive topologies; for every electromechanical motion device, its DSP control implementation discussed and implemented in the lab. Prerequisites: ECEN 314 or approval of instructor; junior or senior classification.


Digital signal processing; discrete-time signals and systems, linear shift-invariant systems, the discrete Fourier transform and fast Fourier transform algorithm, and design of finite impulse response and infinite impulse response digital filters. Prerequisite: ECEN 314.


Improvement of pictorial information using spatial and frequency domain techniques; two-dimensional discrete Fourier transform; image filtering, enhancement, restoration, compression; image processing project. Prerequisites: ECEN 314; junior or senior classification.


Features and architectures of digital signal processing (DSP) chips; fundamental compromises amongst computational accuracy, speed and cost; real-time implementation of filtering, audio, image and video processing algorithms; rapid prototyping via MATLAB/Simulink. Prerequisites: ECEN 444; junior or senior classification.


Introduction to microprocessors; 16/32 bit single board computer hardware and software designs; chip select equations for memory board design, serial and parallel I/O interfacing; ROM, static and dynamic RAM circuits for no wait-state design; assembly language programming, stack models, subroutines and I/O processing. Prerequisite: ECEN 248.


Hardware and software aspects of interfacing microcomputers and minicomputers to memory; peripheral and communication devices. Prerequisites: ECEN 248 and ECEN 449.

Introduction to antenna theory and design; includes antenna performance parameters, analysis of radiation from sources using Maxwell’s equations, theory and design of wire antennas, arrays and frequency independent antennas; computer methods for antenna design. Prerequisite: ECEN 322.


Introduction to theory and practice of ultra high frequency radio wave generation, transmission and radiation; application of Maxwell’s equations to transmission of electrical energy in wave guides. Prerequisites: ECEN 322; ECEN 351 or registration therein.


Microwave solid-state devices and circuits; theory and design of various types of active circuits; applications of these devices and circuits in radar, communication and surveillance systems. Prerequisite: ECEN 322.


Analysis and design of digital devices and integrated circuits using MOS and bipolar technologies and computer aided simulation. Prerequisites: ECEN 214 and ECEN 248.


Digital transmission of information through stochastic channels; analog-to-digital conversion, entropy and information, Huffman coding; signal detection, the matched-filter receiver, probability of error; baseband and passband modulation, signal space representation of signals, PAM, QAM, PSK, FSK; block coding, convolutional coding; synchronization; communication through fading channels; spread-spectrum signaling; simulation of digital communication systems. Prerequisite: ECEN 314.


Frequency domain and time domain response of linear systems; analog modulation methods including amplitude modulation, frequency modulation and phase modulation; signal and noise modeling using probabilistic descriptions; narrowband random processes and the performance of analog modulation techniques in the presence of noise; design of communication links. Prerequisite: ECEN 314.


Analysis of basic operational amplifier and operational transconductance amplifier (OTA) circuits; noise analysis in Op amp and OTA circuits; nonlinear OTA and Op amp circuits; instrumentation amplifiers; transducer circuits; function generators; oscillators and D/A converters and basics of switched-capacitor circuits. Prerequisite: ECEN 326.


Systematic analysis and design for active RC filters; continuous-time; switched-capacitor circuits; filter approximations; synthesis techniques; sensitivity; practical considerations for
monolithic integrated filters; experimental and computer-simulation verification. Prerequisite: ECEN 325.


General considerations in transmission and distribution of electrical energy as related to power systems; calculation of electric transmission line constants; general theory of symmetrical components and application to analysis of power systems during fault conditions. Prerequisite: ECEN 215 or ECEN 314.


Load flow studies; power system transient stability studies; economic system loading and automatic load flow control. Prerequisite: ECEN 215 or ECEN 314.


Principles of optical communication systems; characteristics of optical fibers, lasers and photodetectors for use in communication systems; design of fiber-optic digital systems and other optical communication systems. Prerequisites: ECEN 322 and ECEN 370.


Design, construction and application of instrumentation for MR imaging; fundamentals of the architecture of an MR spectrometer and the gradient subsystem used for image localization; emphasis on the radiofrequency sensors and systems used for signal generation and reception. Prerequisites: BMEN 420, ECEN 410, ECEN 411, or approval of instructor; junior or senior classification. Cross-listed with BMEN 427.


Ray optics; wave optics; propagation, reflection, refraction and diffraction of light; passive optical components, polarization, optical modulators, interferometers and lasers. Prerequisites: ECEN 322 and ECEN 370.


In-depth study of experimental optic techniques; opto-mechanical assemblies; passive optics; interferometers; opto-electronics; basic op-amp circuits; feedback and control of optics with electronics. Prerequisite: Junior or senior classification or approval of instructor.


Introduction to the design, modeling and verification of complex digital systems; modern design methodologies for logic design; development of tools for the design and testing of digital systems. Prerequisite: ECEN 248.

Introduction to advanced computer architectures including memory designs, pipeline techniques, and parallel structures such as vector computers and multiprocessors. Prerequisite: ECEN 350 or CSCE 321. Cross-listed with CSCE 469.


Fundamentals of MOS and bipolar microelectronic circuit fabrication; theory and practice of diffusion, oxidation, ion implantation, photolithography, etch; yield and reliability considerations; statistical process control; integrated process design, simulation and characterization. Prerequisites: ECEN 325 and ECEN 370.


General processes for the fabrication of microelectronic devices and integrated circuits; a review of the electronic properties of semiconductors and carrier transport and recombination; analysis and characterization of p-n junctions, bipolar transistors, and MOS capacitors and transistors; design considerations for achieving optimum performance and practical structures are discussed. Prerequisites: ECEN 325, ECEN 370.

474. VLSI Circuit Design. (3-3). Credit 4.

Analysis and design of monolithic analog and digital integrated circuits using NMOS, CMOS and bipolar technologies; device modeling; CAD tools and computer-aided design; design methodologies for LSI and VLSI scale circuits; yield and economics; test and evaluation of integrated circuits. Prerequisite: ECEN 326.


Introduction to design and fabrication of microelectronic circuits; emphasis on very large scale integration (VLSI) digital systems; use of state-of-the art design methodologies and tools; design of small to medium scale integrated circuits for fabrication. Prerequisites: ECEN 248 and ECEN 325.

476. Neural Networks and Implementations. (3-3). Credit 4.

Analysis of neural network architectures; underlying principles, circuit implementations, and the application of neural networks to practical problems. Prerequisite: Senior classification.

478. Wireless Communications. (3-0). Credit 3.

Overview of wireless applications, models for wireless communication channels, modulation formats for wireless communications, multiple access techniques, wireless standards. Prerequisites: ECEN 455; junior or senior classification.

480. RF and Microwave Wireless Systems. (3-0). Credit 3.

Introduction to various RF and microwave system parameters, architectures and applications; theory, implementation, and design of RF and microwave systems for communications, radar, sensor, surveillance, navigation, medical and optical applications. Prerequisite: ECEN 322.
485. Directed Studies. Credit 1 to 6 each semester.
Problems of limited scope approved on an individual basis intended to promote independent study. Prerequisites: Senior classification; approval of department head.

489. Special Topics in... Credit 1 to 4.
Selected topics in an identified area of electrical engineering. May be repeated for credit. Prerequisite: Approval of instructor.

491. Research. Credit 1 to 4.
Research conducted under the direction of faculty member in electrical engineering. May be repeated 3 times for credit. Registration in multiple sections of this course is possible within a given semester provided that the per semester credit hour limit is not exceeded. Prerequisites: Junior or senior classification and approval of instructor.