ELECTRICAL & COMPUTER ENGINEERING

THE UNIVERSITY OF NEW MEXICO

Electrical & Computer Engineering
Graduate Handbook

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www.ece.unm.edu

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1. Introduction

1.1 Degrees Offered

The Electrical and Computer Engineering Department offers graduate study leading to the following M.S. and Ph.D. degrees:

- Master of Science (M.S.) in Electrical Engineering
- Master of Science (M.S.) in Computer Engineering
- Master of Science (M.S.) in Optical Science and Engineering
- Doctor of Philosophy (Ph.D.) in Engineering with concentration in
  - Electrical Engineering
  - Computer Engineering
- Doctor of Philosophy (Ph.D.) in Optical Science and Engineering

The master's degree program requires 31 semester credit hours for both the thesis option and for the non-thesis option (including mandatory 1 credit hour of ECE590). The Ph.D. program requires a minimum of 48 credit hours of coursework and 18 hours of dissertation hours. A minimum of 24 hours of coursework credit must be completed at the University of New Mexico. Additional coursework and research leading to the dissertation are geared to the individual student's needs and interests. As a potential candidate for the Ph.D. program, each student must pass the Ph.D. qualifying examination to establish levels and areas of scholastic capabilities.

Albuquerque, with a metropolitan population exceeding 600,000 is the largest city in New Mexico. With an unusual blend of three cultures—Native American (Indian), Spanish-American, and Western—it is able to offer a wide variety of cultural, artistic, and aesthetic events. Several of these take place on campus, others are in the city and neighboring pueblos. The All-Pueblo Indian Art Center, the Atomic Museum, and the Maxwell Museum of Anthropology on campus offer facilities of particular interest. The city lies between the lowland of the Rio Grande and the towering, 11,000-foot Sandia mountains. In this *Land of Enchantment* environment, the sun shines every day, and warm days are followed by cool nights. Hunting, fishing, ballooning, mountain climbing, and skiing are only a few of the recreational activities available.

The University of New Mexico is the largest university in the state, with more than 30,000 students. It was established in 1889 and is situated on 600 acres in the center of metropolitan Albuquerque. The resources of the University and its proximity to Sandia National Laboratories, the Air Force Research Laboratory, and Los Alamos National Laboratory provide an excellent environment for advanced studies and research.

1.2 Graduate Program

The Electrical & Computer Engineering Graduate Program specializes in a broad range of state-of-the-art research emphases:

- **Computer Engineering**
  - Bioengineering
  - Computer Architecture & VLSI Design
  - Computer Systems and Networks
  - Computer Vision and Image Processing
  - Information Systems
- **Electrical Engineering**
  - Applied Electromagnetics
  - Bioengineering
  - Communications
  - Image Processing
  - Microelectronics
  - Optoelectronics
  - Power and Energy
  - Signal Processing
  - Systems and Controls
- **Optical Science and Engineering**

  Refer to http://www.optics.unm.edu/ for details.

ECE Graduate Office. The Graduate Committee consists of the Director of Graduate Program and faculty members elected by each research area. The Director of Graduate Program who reports to the Department Chair, coordinates all activities of the Graduate Committee and is responsible for all aspects of the graduate program, including:

- Overseeing all correspondence with applicants seeking admission, including final notification of acceptance/denial,
- Interaction with the Office of Graduate Studies (OGS), Office of International Admissions (OIA), and Office of International Programs (OIP), and
- Probation/enrollment matters and exit requirements.

The UNM catalog and ECE graduate handbook. The Office of Graduate Studies (OGS) at UNM is responsible for upholding the academic standards of all graduate programs at the University of New Mexico. To this end, it establishes and enforces certain rules that must be satisfied by all graduate students and the faculty. This handbook only includes the additional policies and procedures that apply specifically to the ECE graduate program. Graduate students are ultimately responsible for understanding and meeting the requirements described in UNM Catalog and this handbook. This edition of the handbook supersedes any

previous editions of the ECE Graduate Handbook. Students entering the graduate program in Fall 2013 or later must follow this edition of the handbook until further notice.

Grandfather clause. Students are required to meet the program requirements as described in the UNM Catalog and the ECE Graduate Handbook in effect at the time of admission. Should the requirements in the handbook change during their program, students may move to the new requirements with approval of their advisor.

2. Admissions

Admission requirements. Acceptance as a regular graduate student in the ECE Department will normally require a bachelor's degree in Computer Engineering, Computer Science, Electrical Engineering, or a related field, from an ABET accredited program in United States or its equivalent in another country. Admission into the ECE Graduate Program for both M.S. and Ph.D. degrees is decided on a case-by-case basis. Many factors are taken into account for admission decisions, including, but not limited to, previous academic degree(s) and coursework, GRE scores, letters of recommendation, etc. and TOEFL (for international students, check UNM Catalog).

Applicants	GRE Verbal	GRE Quantitative	GPA
M.S.	400(old)/146(new)	650(old)/151(new)	3.0
Ph.D.	450(old)/150(new)	690(old)/154(new)	3.5

Financial aid. The ECE graduate program has two types of assistantships: Graduate Assistantships (GA) and Research Assistantships (RA). The GAs are awarded by the ECE department for exceptional students. On the other hand, RAs are chosen and administered completely by faculty, with their own research grants. In addition to the GA and RA assistantships there are many fellowships available to graduate students.

Application procedures. Prospective graduate students will find UNM application materials and ECE required materials online at http://grad.unm.edu/. Please note that incomplete applications will not be processed by the UNM Admissions Office (domestic) or the International Admissions Office, and therefore will not be forwarded to the ECE department.

The ECE departmental requirements include GRE scores, three letters of recommendations and a Statement of Purpose. The letters of recommendation and the Statement of Purpose should be submitted through the online application system while Please GRE scores should be sent directly to UNM using the University code #4845.

Application deadlines. All application materials must be received by the established deadlines for timely consideration. The ECE Department reviews graduate applications twice a year, corresponding to the Fall and Spring semesters.

Application Type	Fall Semester	Spring Semester
All applicants requesting financial aid	February 15	July 15
International applications	February 15	July 15
Domestic applications without financial aid	July 15	November 1

Course articulation. A student whose previous educational background is not in Computer Engineering, Computer Science, or Electrical Engineering, may have to make up certain courses at the undergraduate level. Determination of these courses will be in accordance with the UNM requirement of 12 semester hours of upper division coursework (300 level or higher) in the major field or in cognate areas and will be decided upon by an advisor and approved by the ECE Graduate Office at the time of admission. If any articulated courses at the undergraduate level are identified, the student may fulfill the requirement by taking the prescribed course at UNM, or by taking an equivalent course at another university. Normally, the student is not admitted to the graduate program until all identified articulated courses are completed with a B grade or better.

Exceptions. For students wishing to enter the graduate program who have fulfilled all other admission requirements, but whose GPA is slightly less than 3.0 for M.S. degree or 3.5 for Ph.D. degree, the ECE Graduate Office may recommend the student completing further requirements, which usually consist of a list of 1 to 4 undergraduate courses that are important to the student's proposed graduate work and in which the student received a low grade in his/her undergraduate program. Upon successful completion of these courses (i.e. receiving at least a grade point average of 3.0 for M.S. or 3.5 for Ph.D.), the student will be placed in regular status in the M.S. or Ph.D. program.

Students who are admitted on probation, with certain course requirements, will be given a limited time (no more than 2 semesters) to complete those courses. The objective is to ensure that these courses are expeditiously completed and that they are taken before other courses that may have them as a prerequisite. If the time limit is not met, the student may be dis-enrolled.

Non-degree courses. Domestic students may enroll as non-degree status before admission (this option is unavailable for International students). A student in non-degree status who desires to receive graduate credit for an approved 400-level course must obtain signatures from the course instructor and the Office of Graduate Studies on a Graduate Credit Authorization card. Moreover, only 9 credits are acceptable for transfer from non-degree to degree status.

3. General Information

Advisement hold. Each ECE graduate student must meet with her/his advisor on a regular basis, since this is an important part of the educational process. Therefore, each student will have a HOLD placed on her/his registration. Students must obtain academic advisement each semester before the hold is removed. After advisement, the advisor will sign the advisement form so the hold can be removed.

Guidelines for courses outside ECE. All courses taken for the M.S. and Ph.D. degrees in ECE must be approved by both the ECE department, and the Office of Graduate Studies. Before selecting any course at the 400-level, check to see that graduate credit is granted by the department.

Any elective courses taken outside the department for the satisfaction of degree requirements, must be of a technical nature. Courses from the following departments are usually acceptable: Computer Science, Mathematics, Physics, or another department in the School of Engineering. Some courses from the Anderson School of Management are acceptable; however, approval should be sought from the Director of Graduate Program before registering for the course. If the course is not from one of these departments or the course might be questionable, you should first obtain the approval of the Director of Graduate Program

ECE 590 Seminar. All M.S. students are required to complete at least one credit hour of ECE 590 Seminar, and all Ph.D. students are required to complete two credit hours of ECE 590. The grading will be CR/NC based and the credits will not apply toward the required number of degree hours in the program.

ECE 551/651 Problems courses. The ECE Department has a policy that requires that each student taking ECE 551 or ECE 651 Problems course submit a final report for the student's record. A copy of the report should be sent to the ECE Graduate Office for insertion into the student's file. This requirement will be checked once the student submits the Application for Candidacy or the Program of Studies, and before the student graduates. Failure to submit the report may result in a delay in graduation. Plan II (non-thesis) M.S. students should take 3 credits of ECE 551 associated with their M.S. project.

Time limit for completion of degree. All work used to meet degree requirements for an M.S. degree, including transfer credit, must be completed within a seven-year period immediately preceding the granting of the degree. Course work older than seven years cannot be used to meet requirements for the master's degree. Note that international students on student Visa must make progress towards their degree, and are therefore expected to graduate within 2 years from starting their M.S. studies.

Doctoral candidates have five (5) calendar years from the semester in which they pass their doctoral comprehensive examination to complete the degree requirements. The final requirement is generally the acceptance of the student's dissertation by the Dean of Graduate Studies.

Notification of Intent to Graduate. A student must inform the ECE Graduate Office, in writing, of the Intent to Graduate no later than 11:00am on the last day of the semester immediately preceding the semester of graduation. Degrees are awarded three times during the year, while commencement exercises are only held in May and December. Graduation is dependent upon the completion of all degree requirements for graduation by November 15 for Fall, April 15 for Spring, or July 15 for Summer. If a student does not complete all degree requirements for graduation in a particular semester, the student must submit a new Intent to Graduate form for graduation in a subsequent semester. Only students who have completed all degree requirements may participate in commencement exercises.

Graduating GPA requirements. A student may not graduate if his/her program of study includes more than 6 hours of coursework graded C, C+, or CR (ECE590 is excluded from this limitation). A student's cumulative GPA cannot be below 3.0. In addition, the GPA for courses presented in his/her program of studies cannot be below 3.0.

4. Research Emphases and Core Courses

A graduate student in ECE department is required to choose a research emphasis. Each emphasis is associated with three core courses which are required for students to take. Students are requested to identify his/her choice of emphases in the application to ECE department. During the initial stage of the program study, a student may reselect his/her research emphases. Switching of research emphases after one year from the enrollment either as a MS student or as a PhD student is not encouraged. Table 1 lists all major core courses for different emphases in ECE Department.

Table 1: ECE Research Emphases and Core Courses.

	Emphases	**Major Core Courses**
Computer Engineering	Bioengineering with CompE	List A: Select at-least two core courses from: ECE 520, ECE 533, ECE 536, ECE 537, ECE 538, ECE 540, ECE 549. List B: Select at-most one core course from: ECE 506, ECE 510, ECE 512, ECE 516, ECE 517, ECE 522, ECE 539, ECE 541, ECE 542, ECE 633. On the Qualifying exam, students will be tested on the 3 major core courses. Additionally, students can select any ECE core course as the 4th minor core course, including courses on Lists A or B above.
	Computer Architecture & VLSI Design	
	Computer Systems and Networks	
	Computer Vision and Image Processing	
	Information Systems	
Electrical Engineering	Applied Electromagnetics	ECE560 Intro. to Microwave Engineering (Fall), ECE561 Electrodynamics (Spring), Either: 1) ECE534 Plasma Physics I (Fall, Plasma Science track), OR 2) ECE569 Antennas (Spring, Antennas track). 4th course required for Ph.D.: ECE 563 Computational Methods for Electromagnetics
	Bioengineering with EE	ECE510 Medical Imaging (Fall), ECE533 Digital Image Processing (Spring) And one of: ECE561 Electrodynamics (Spring, Applied EM track) ECE539 Digital Signal Processing (Spring, Signal Processing track) ECE500 Theory of Linear Systems (Fall, Systems & Controls track)
	Communications	ECE500 Theory of Linear Systems (Fall), ECE541 Probability Theory & Stochastic Processes (Fall), ECE542 Digital Communications Theory (Spring)
	Image Processing	ECE533 Digital Image Processing (Spring), ECE541 Probability Theory & Stochastic Processes (Fall), ECE539 Digital Signal Processing (Spring)
	Microelectronics	ECE520 VLSI Design (Spring), ECE523 Analog Electronics (Fall), ECE576 Modern VLSI Devices (Spring)
	Optoelectronics	ECE561 Electrodynamics (Spring), ECE570 Optoelectronic Semiconductor Materials & Devices, ECE572 Physics of Semiconductors (Spring)
	Power and Energy	ECE583 Power Electronics (Fall), ECE584 Photovoltaics (Spring), ECE588 Smart Grid Technologies (Spring)
	Signal Processing	ECE500 Theory of Linear Systems (Fall), ECE541 Probability Theory & Stochastic Processes (Fall), ECE539 Digital Signal Processing (Spring)
	Systems & Controls	ECE500 Theory of Linear Systems (Fall), ECE541 Probability Theory & Stochastic Processes (Fall), ECE546 Multivariable Control Theory (Spring)

5. M.S. Program

5.1 Degree Requirements

The M.S. (in Electrical Engineering or Computer Engineering) program is offered under Plan I (Thesis) and Plan II (Non-Thesis) as shown in Table 2. Plan I requires 24 hours of coursework, 6 hours of Thesis, and 1 hour of ECE590 (Graduate Seminars). Plan II requires 31 hours of coursework including at least 1 hour of ECE590. Both plans require at least 12 credit hours of ECE core courses, among which 9 hours are required by the chosen research emphasis as 3 major core courses, and the other 3 hours are selected from another emphasis as a minor core course. The minor core course must be selected from one of the core courses listed in Table 1, outside of the student's major core (emphasis). The remaining courses are free electives.

Table 2: Master Degree Requirements.

Plan I (thesis option):	**Plan II (non-thesis option):**
1. A minimum of 24 hours of coursework (not including ECE590 and thesis hours), with a minimum of 15 hours in ECE. 2. At least 12 credit hours must be ECE core courses of which 9 hours are required by the emphasis area as 3 major core courses. The other 3 hours can be selected from core courses of another emphasis area as a minor core course. 3. A maximum of 6 hours of 400-level ECE courses, and no more than 6 ECE courses, and no more than 6 hours of 400-level Non-ECE courses (400-level courses must be approved for graduate credit. ECE 495 cannot be used for graduate credit). 4. A maximum of 3 hours in "problems" courses (ECE551 or ECE651). 5. At least 50% of required coursework must be completed after admission to the graduate program, unless further limited by the graduate program. 6. One credit hour of graduate seminar (ECE 590). 7. No more than half of the minimum required coursework hours, exclusive of Thesis, may be taken with a single faculty member.	1. A minimum of 31 hours of coursework (including ECE590), with a minimum of 18 hours in ECE. 2. At least 12 credit hours must be ECE core courses of which 9 hours are required by the emphasis area as 3 major core courses. The other 3 hours can be selected from core courses of another emphasis area as a minor core course. 3. A maximum of 6 hours of 400-level ECE courses, and no more than 6 hours of 400-level Non-ECE courses (400-level courses must be approved for graduate credit. ECE 495 cannot be used for graduate credit). 4. A maximum of 6 hours in "problems" courses (ECE551 or ECE651). 5. At least 50% of required coursework must be completed after admission to the graduate program, unless further limited by the graduate program. 6. At least one credit hour, but not more than two credit hours, of graduate seminar (ECE 590). 7. No more than half of the minimum required coursework hours may be taken with a single faculty member.

8. No more than 6 credit hours of coursework can have a grade of C (2.0), C+ (2.33) or CR (grading option selected by student). ECE 590 is excluded from this limitation.	8. No more than 6 credit hours of coursework can have a grade of C (2.0), C+ (2.33) or CR (grading option selected by student). ECE 590 is excluded from this limitation.
9. A student's cumulative GPA cannot be below 3.0. In addition, the GPA for courses presented in his/her program of studies cannot be below 3.0	9. A student's cumulative GPA cannot be below 3.0. In addition, the GPA for courses presented in his/her program of studies cannot be below 3.0
10. Six hours of Thesis (ECE599) credit and completion and successful defense of a Master's thesis.	10. Three credit hours of ECE 551 (problems) associated with the M.S. project, and successful completion of the M.S. exit exam (Technical report and its presentation).

5.2 Program of Studies

Each student should choose an academic adviser as soon as possible, and must have an adviser at the time the Program of Studies (POS) is submitted. On admission into the department, students will be assigned an academic adviser if they have not already arranged for advisement with a regular faculty member. An M.S. student should file a Program of Studies (POS) with the Office of Graduate Studies as soon as she/he has planned a program of studies for the degree in consultation with the major advisor.

The Program of Studies must be approved by the ECE Graduate Office and be submitted to the Office of Graduate Studies by the following deadlines: October 1st for Spring Graduation, March 1st for Summer Graduation and July 1st for Fall Graduation. Each Program of Studies must be approved by the UNM Dean of Graduate Studies before a student may take the master's exit examination.

In the Program of Studies, no more than half the graduate program's minimum required course work hours, exclusive of Thesis, may be taken with a single faculty member. After a Program of Studies has been filed, a student may switch between Plans I and II only with the approval of the ECE Graduate Office and the Dean of Graduate Studies and must submit a new Program of Studies.

Transfer of graduate credit. The applied or transfer of graduate credit to a Program of Studies is never automatic. With the approval of the ECE Graduate Office, a maximum of 50% of the course work requirements for the M.S. degree may consist of a combination of applied/transfer credits, assuming they meet the restrictions specified in the UNM catalog. Note that course work that has been counted toward a previous degree may not be counted again in the Program of Studies for a master's degree. All applied/transfer credit must meet the following criteria:

1. The course work was taken at an accredited institution and is approved by both the ECE Graduate Office and the UNM Dean of Graduate Studies.
2. The course work is graded at least a B and was completed within the required seven-year period; and
3. The courses are submitted to the ECE graduate office for approval. This usually requires a course syllabus and a consultation of the Director of Graduate Program with the appropriate faculty members.

5.3 Master's Examination

All M.S. students are required to pass a final master's exit examination. The student will have at most two opportunities to pass this exam.

- **MS Plan I Exit Examination (Thesis defense):** Final master's exam for Plan 1 is the thesis defense. Plan I students will be examined over the thesis material by the thesis committee.
- **MS Plan II Exit Examination (Technical report-based MS Exit Exam):** Final master's examination for Plan II is an exit exam based on a technical report. Plan II students will be examined in their selected emphasis area based on a technical report plus its presentation to the examination committee (see below for more details).

Advisor and Examination committee. When the student is ready to schedule the M.S. Exit exam (thesis defense - Plan I, or M.S. project presentation - Plan II), he or she, in cooperation with the academic advisor, will form an examination committee that includes three members, two of whom must be UNM faculty holding tenure-track appointments. The examination committee must be chaired by an ECE tenure-track faculty member who works in the emphasis area of the student as listed by the ECE Graduate Office (e.g., systems & controls, optoelectronics, etc.).

Technical report-based MS Exit Examination (Plan-II). MS Plan II students should register for 3 credit hours of ECE 551 (problems) associated with an MS Plan II project. The exit exam consists of two components: i) an original technical report on a topic approved by the advisor; and ii) an oral presentation of the technical report in front of the examination committee. The student must work with his/her advisor for the report no later than the submission of the student's POS. Students may not re-use reports produced for any other UNM course (including special-topics courses) as a technical report for the MS Plan-II Exit Exam. The report should be typed, using 12-point font, single space with a 1-inch margin on all sides. Typical length is between 12 and 15 pages excluding references. Details of the report content and length should be agreed upon by the student and his or her advisor. Students are reminded that verbatim copying of text and illustrations without proper citation of the source, paraphrasing and other forms of plagiarism are unacceptable and will result in failing the exam.

At least three weeks before the graduation deadline, the student must sign up for the MS Plan-II Exit Exam with the ECE Graduate Office. At least two weeks before the exam, the Plan-II MS Exam announcement form must be filled and the technical report must be submitted to the committee. The results of the MS Plan-II Exit Exam (pass or fail) must be reported to the Office of Graduate Studies by November 15th for fall graduation and by April 15th for spring graduation and July 15th for summer graduation. If a student fails the exam, she/he may re-take the exam within one calendar year from the date of the first exam. The Plan-II MS exam may be taken only twice. A second failure will result in the student's termination from the program.

Announcement of master's examination. At least two weeks before the final examination is held, and no later than November 1st for Fall, April 1st for Spring or July 1st for summer, the ECE Graduate Office must notify the Office of Graduate Studies of the student's scheduled date by submitting the appropriate announcement form.

6. Ph.D. Program

6.1 Degree Requirements

A minimum of 48 coursework hours (excluding the 18 hours of dissertation and 2 hours of ECE590) beyond the bachelor's degree is required, which may include a maximum of 6 hours of master's thesis. A maximum of 30 hours can be transferred from another accredited graduate school, under certain conditions (refer to the graduate program section of the UNM Catalog). A minimum of 24 hours must be completed at UNM, of which 18 hours must be at the 500 level or above. The Ph.D degree requires at least 12 hours of ECE core courses, among which 9 hours are required by the emphasis as 3 major core courses, and the other 3 hours are required as a minor core course to be chosen from any ECE emphasis outside the major emphasis. Note that in addition to the three major core courses some emphases (e.g. Applied EM) may require another course, as listed in Table 1. The remaining courses are free electives.

Table 3: Doctoral Degree Requirements.

1. A minimum of 48 hours of coursework credits (not including ECE590 and ECE699 dissertation hours).
    - At least 24 hours of coursework graduate credit must be completed at UNM.
    - At least 18 hours of graduate credit coursework must be completed at UNM after admission to the doctoral program.
    - A minimum of 18 hours of graduate credit coursework earned at UNM must be courses numbered 500 or above.
2. Two credit hours of ECE 590 (Graduate Seminar).
3. A minimum of 18 hours of dissertation credits (ECE 699).
4. No more than 6 credit hours of coursework can have a grade of C (2.0), C+ (2.33) or CR (grading option selected by student). ECE 590 is excluded from this limitation.
5. A student's cumulative GPA cannot be below 3.0. In addition, the GPA for courses presented in his/her Application of Candidacy cannot be below 3.0
6. No more than 50% of the required coursework credits at UNM may be taken with a single faculty member. (Course work that has been completed for an M.S. degree is included in this limit).
7. Must be enrolled in at least one graduate credit in the semester in which the doctoral comprehensive examination is taken and in the semester in which the degree requirements are completed, including the summer session.

6.2 Qualifying Exam

All Ph.D. candidates are expected to take this exam. A graduate student can take the Qualifying exam no more than twice in his/her Ph.D. program. The passing levels will be determined by the ECE faculty,

according to the recommendations of the corresponding research emphases group and the ECE graduate committee.

The qualifying exam must be attempted within one year of admission to the PhD program, unless otherwise determined by the academic adviser and the Director of Graduate Program. Failure to take the exam at the prescribed time will be equivalent to failing the exam. The exam date will be set so that the student will have ample time (2 semesters) to complete required course work and to study for the exam. Only in extraordinary circumstances students will be allowed to petition for a later test date. All petitions must be approved by the ECE Graduate Office.

Qualifying exam schedule. The qualifying exam is given twice a year: In January and in August, the week before the first day of the Spring or Fall semesters. Students must sign up for this exam four weeks in advance through the ECE Graduate Office. If, after signing up, a student determines that he/she will not be able to sit for the exam, the student must submit a written request at least two weeks in advance of the scheduled exam date, with advisor approval, to withdraw from the exam.

During the two weeks following the written exam, students must be able to be physically present to attend an oral exam if necessary. Students will be notified of the need to conduct an oral exam within one week of the written exam. The results of the Qualifying Exam will be made available to students within three weeks of the written exam.

Qualifying exam information. The written exam is a 4-hour long, closed book/notes test. Personal items, such as laptops, PDAs, calculators, cell phones or any other type of electronic device will not be allowed to be brought into the testing site. A basic calculator will be provided for students to use. Students are required to PASS the exam in three major core subject areas (a subject area corresponds to a core course) based on their chosen research emphasis. See Table 1 for major core courses corresponding to different research emphases.

Four weeks before the Qualifying Exam, students are required to sign up for their major emphasis (three major core courses). For the test, students are required to complete all questions from the three major core courses. Table 1 lists all major core courses for different emphases in ECE Department. Students taking Qualifying Exam should check the latest list from the ECE Graduate Office before signing up for the exam. Students are also expected to know the material in courses prerequisite to those listed in Table 1.

Evaluation of Qualifying exam. The progressive rule allows for passing at the subject level. Students will have 2 consecutive opportunities to pass the three subject areas. Students will be evaluated as having passed or failed in the individual subject areas.

- After a Ph.D. student's 1st written exam, the outcome may be
  - Pass, or
  - Partial pass in certain individual subject areas
- After a PhD student's 2nd written exam, the outcome may be
  - Pass
  - Fail

6.3 Application to Ph.D. Candidacy

Doctoral Committee on Studies. Each Ph.D. student is required to have a Committee on Studies consisting of at least four members. A minimum of two members must be regular University faculty members from the ECE Department. One of the committee members must be tenured or tenure-track faculty from outside the ECE department or at other institutions. All committee members (both internal and external to UNM) must be approved for graduate instruction (check with the Graduate Office for information). Students should form this committee early in their Ph.D. program in cooperation with their dissertation advisor who will be the Chair of this committee.

The Committee on Studies must approve all courses taken by the student via a form called the Ph.D. Candidacy form, which is a list of all courses counted toward the degree, including any transfer hours. The Application to Candidacy enables the student to formally summarize his/her program of studies. The application form will be submitted in the same semester during which the Comprehensive Exam is passed.

Comprehensive exam (Dissertation proposal). Before a student may complete this requirement, he/she must have passed the Qualifying Exam. The Comprehensive Exam must be administered and passed in the same semester the Ph. D. Candidacy form is submitted to the UNM Office of Graduate Studies. The focus of the Comprehensive Exam is on a dissertation topic, in which the student demonstrates to the Committee on Studies that he/she is capable of carrying out the proposed research. The Chair of the Committee on Studies will advise the student on preparing for this exam, which must be scheduled through the ECE Graduate Office. The Office of Graduate Studies must be notified of the Comprehensive Exam at least two weeks before the exam through the completion of the appropriate Comprehensive Exam announcement form, available from the ECE Graduate Office.

6.4 Dissertation and the Final Examination.

Dissertation Committee. The Committee on Studies usually becomes the Dissertation Committee (with appropriate members added or deleted), after the Comprehensive Exam is passed. The composition of the dissertation committee is exactly the same as that of the Committee on Studies. The duties of the Dissertation Committee are stated in the graduate program section of the UNM Catalog. The dissertation topic and committee's membership must be recorded by completing the Appointment of Dissertation Committee form, available in the ECE Graduate Office

Outside expert as dissertation advisor. An outside expert, who has a Ph.D., may serve as a member of the Dissertation Committee, with special permission of the UNM Dean of Graduate Studies. The chair of the committee must be a regular university faculty member in the ECE Department.

Dissertation defense. All candidates must pass a final exam (dissertation defense). The Dissertation Committee conducts the defense of the dissertation. The candidate must contact the ECE Graduate Office early enough so that all necessary arrangements can be made. See the latest UNM Catalog for pertinent deadlines. It is the responsibility of the student to meet the deadlines printed in the UNM Catalog. The examination must be scheduled through the ECE Graduate Office at least two weeks in advance of the exam. Before the exam is scheduled, the student must 1) present an abstract of the dissertation to the ECE Graduate Office, and 2) submit a draft of the dissertation to each committee member.

Please refer to the UNM Catalog for details on dissertation hours, format, submission, approval, and fees.

Required paper submission. As part of the departmental requirement for the Ph.D. dissertation, the student must submit a paper, based on the dissertation, to the dissertation committee. This paper must have been submitted for publication in a professional journal and an acknowledgment of submission received prior to the dissertation defense.

A. ECE Faculty and Research Interests

Chaouki T. Abdallah Gardner-Zemke Professor and Provost, Ph.D., Georgia Institute of Technology, Interests: Control systems, communications and computing.

Ganesh Balakrishnan Associate Professor; Associate Chair; Director of Undergraduate Program; PhD, University of New Mexico, Interests: Semiconductor device development including epitaxy and characterization, high power vertical external cavity surface emitting lasers and novel semiconductor material development for Mid-Infrared lasers.

Vince D. Calhoun Distinguished Professor; Director, Image Analysis and MRI Research, The MIND Research Network, Ph.D., University of Maryland, Interests: Biomedical engineering, psychiatric neuroimaging, functional and structural magnetic resonance imaging (MRI), multimodal data fusion, and medical image analysis.

Francesca Cavallo Assistant Professor; Ph.D., TU-Chemnitz (Germany), Interests: Fundamental and applied aspects of nanoscale-thin films (i.e., nanomembranes) with emphasis on bio-integrated systems, integration of inorganic nanomembranes (e.g., semiconductor, dielectric, and metal thin films) with biological cells with an emphasis on their mechnanical and chemical capability, integration of inorganic this films with conventionally soft materials, strain engineering in thin films, Graphene photonics and electronics, fabrication and characterization of strain-driven nanostructures for highly integrative applications, mechanical, optical, and electronic properties of stacked nanomembranes and 3D device architectures, flexible electronics and optoelectronics, optomechanics and non-linear optics and Aton-scale mechanisms of film growth.

Thomas P. Caudell Emeriti Professor; Ph.D., University of Arizona, Interests: Neural networks, virtual reality, machine vision, robotics and genetic algorithms.

Christos G. Christodoulou Distinguished Professor; Associate Dean for Research, School of Engineering, Ph.D., North Carolina State University, Interests: Modeling of electromagnetic systems, phased array antennas, antennas for wireless communications, microwave systems and applications of neural networks in electromagnetics.

Michael Devetsikiotis Professor; ECE Department Chair; PhD., North Carolina State, Interests: Efficient simulation and rare event modeling techniques, and in analyzing complex systems, ranging from high-speed networks to wireless resource allocation, to collaboration technologies, to smart grid infrastructure, and to intelligent buildings and electric vehicles.

Daniel Feezell Assistant Professor; Ph.D., University of California, Santa Barbara, Interests: Epitaxial growth, fabrication, and characterization of group III-nitride materials and devices, including nonpolar/semipolar orientations, solid-state lighting and high-efficiency LEDs, visible edge-emitting and vertical-cavity surface-emitting lasers and applications of group III-nitrides to energy efficiency and renewable energy

Rafael Fierro Professor, Ph.D., University of Texas at Arlington, Interests: Cooperative control of multi-agent systems, cyber-physical systems, mobile sensor and robotic networks, motion planning under sensing/communication constraints, optimization-based multivehicle coordination.

Charles B. Fleddermann Gardner-Zemke Professor; Associate Dean for Academic Affairs, School of Engineering, Ph.D., University of Illinois at Urbana-Champaign, Interests: Plasma processing, physical electronics, photovoltaics.

Mark A. Gilmore Associate Professor, Ph.D., University of California at Los Angeles, Interests: Plasma physics, plasma diagnostics, fusion energy, pulsed power, microwave engineering.

Majeed M. Hayat Professor; General Chair, Optical Science and Engineering; Associate Director of the Center for High Technology Materials, Ph.D., University of Wisconsin at Madison, Interests: Statistical communication theory, signal and image processing, algorithms for infrared spectral sensors and images, novel avalanche photodiodes, optical communication, cooperative distributed sensing and computing, applied probability and stochastic processes.

Gregory L. Heileman Professor; Associate Provost, Ph.D. University of Central Florida, Interests: Data structures and algorithmic analysis, security in cloud computing, theory of information and computing, machine learning and pattern recognition.

Mani Hossein-Zadeh Associate Professor, PhD, University of Southern California-Los Angeles, Interests: Electrooptics, microwave-photonic devices and systems, ultra high-Q optical microresonators, optomechnical interaction in UH-Q optical resonators, optical communication, photonic sensors, optofluidics and plasmonics.

Ravinder K. Jain Professor, Ph.D., University of California at Berkeley, Interests: Quantum electronics, opto-electronics, electro-optics, experimental solid-state physics.

Sudharman K. Jayaweera Associate Professor; Associate Chair; Director of Graduate Program, Ph.D., Princeton University, Interests: Cognitive and cooperative communications, machine learning, inference, network information theory, control and optimization in smart-grids, networked control systems, wireless communications, statistical signal processing.

Ramiro Jordan Associate Professor; Associate Dean for International Programs, School of Engineering, VP of Technology, ISTEC,, Ph.D., Kansas State University, Interests: Data communications, multidimensional signal processors, software engineering.

Sanjay Krishna Professor; Director-Center for High Technology Materials, Ph.D., University of Michigan at Ann Arbor, Interests: Investigation of nanostructured semiconductor materials for mid-infrared lasers, detectors and thermophotovoltaic cells. The nanoscale materials consist of self-assembled quantum dots, strain layer superlattices and quantum wells grown on metamorphic buffers.

Olga Lavrova Assistant Professor, Ph.D. University of California at Santa Barbara, Interests: photovoltaics and nano-scale semiconductor structures for photovoltaic applications, renewable energy, smart grids, as well as emerging power, energy, distribution and storage technologies.

Jane Lehr Professor; Ph.D. Polytechnic Institute of New York University, Interests: pulsed power, electromagnetics, high-power microwave sources and effects, exploding wires, electrical breakdown physics.

Manel Martinez-Ramon Professor; Prince of Asturias Endowed Chair, Universidad Carlos III de Madrid, Interests: Machine Learning with applications to Magnetic Resonance Imaging, Signal Processing, Antenna Array Processing, Smart Grid Technologies.

Meeko Oishi Assistant Professor, Ph.D. Stanford University, Interests: Hybrid systems and control, cyber-physical systems, nonlinear systems, reachability analysis and controller synthesis, modeling and control of Parkinson's disease, flight management systems, collaborative control, assistive technologies.

Marek Osinski Professor, Ph.D., Polish Academy of Sciences, Poland, Interests: Semiconductor lasers, optoelectronic devices and materials, group-III nitrides, degradation mechanisms and reliability, computer simulation.

Marios S. Pattichis Professor, Ph.D., University of Texas at Austin, Interests: Digital image and video processing and communication, medical imaging and statistical methods for image processing, reconfigurable image processing systems.

Zhen Peng, Assistant Professor, Ph.D., Chinese Academy of Sciences, Interests: simulation-based engineering, computational electromagnetics and multi-physics analysis, Power integrity and signal integrity analyses of integrated circuits, multi-scale metamaterials and reconfigurable antennas.

James F. Plusquellic Professor, PhD, University of Pittsburgh, Interests: IC Trust, design for manufacturability, defect-based and data-driven VLSI test, small delay faulty test model-to-hardware correlation and IC fabrication process monitors.

L. Howard Pollard Assistant Professor, Ph.D., University of Illinois at Urbana-Champaign, Interests: Computer architecture, digital design, fault tolerance, microprocessors.

Balu Santhanam Associate Professor, Ph.D., Georgia Institute of Technology, Interests: Statistical signal processing, statistical communications, digital signal processing, time-frequency analysis, adaptive signal processing, and general signal processing.

Edl Schamiloglu Distinguished Professor, and Gardner-Zemke Professor, Ph.D., Cornell University, Interests: Physics and technology of charged particle beam generation and propagation, high-power microwave sources and effects, pulsed power science and technologies, plasma physics and diagnostics, electromagnetics and wave propagation, infrastructure surety and complex systems.

Wei Wennie Shu Associate Professor; Associate Dean for Graduate Recruitment, Ph.D., University of Illinois at Urbana-Champaign, Interests: Distributed and parallel systems, system support for GPGPU and multicore machines, multimedia networking, mobile ad-hoc and sensor networks, vehicle network, biomedical modeling and simulation.

Yin Yang Assistant Professor, Ph.D., University of Texas at Dallas, Interests: Computer Graphics, Physics-based simulation, Animation, Visualization, Biomechanical modeling.

Payman Zarkesh-Ha Associate Professor, Ph.D. Georgia Institute of Technology, Interests: Statistical modeling of VLSI systems, design for manufacturability, low-power and high-performance VLSI design.