ELECTRICAL & COMPUTER ENGINEERING

THE UNIVERSITY OF NEW MEXICO

# Electrical & Computer Engineering
# Graduate Handbook

**Spring 2021 Edition**

**Companion with UNM Catalog 2020-2021**

ELECTRICAL & COMPUTER ENGINEERING

www.ece.unm.edu

Department of Electrical & Computer Engineering,
University of New Mexico, Albuquerque, NM, 87131, USA,
Telephone: 1-505-277-2600, http://www.ece.unm.edu

# Contents

**1. Introduction** ..... **2**

1.1 Degrees Offered ..... 2

1.2 Graduate Program ..... 3

**2. Admissions** ..... **4**

**3. General Information** ..... **5**

**4. Research Emphases and Core Courses** ..... **7**

**5. M.S. Program** ..... **8**

5.1 Degree Requirements ..... 8

5.2 Program of Studies ..... 9

5.3 Master's Examination ..... 10

**6. Ph.D. Program** ..... **10**

6.1 Degree Requirements ..... 10

6.2 Qualifying Exam ..... 11

6.3 Application to Ph.D. Candidacy ..... 12

6.4 Dissertation and Final Examination ..... 13

**A. ECE Regular Faculty and Research Interests** ..... **14**

# 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
- Master of Science (M.S.) in Electrical Engineering or Computer Engineering with concentration in Entrepreneurship and Technology Management
- Master of Science (M.S.) in Computer Engineering with concentration in Quantum Information Systems
- Master of Science (M.S.) in Electrical Engineering with concentration in Space Systems Engineering - *Accelerated Online Program*
- Master of Science (M.S.) in Computer Engineering with concentration in Internet of Things - *Accelerated Online Program*
- 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 the thesis option (Plan I), this 31 hours includes 6 credit hours of M.S. thesis research (ECE 599). For the coursework-only option (Plan III), this 6 credit hours of thesis research is replaced by coursework hours. Both Plan I and Plan III include a mandatory one credit hour of ECE 590 Graduate Seminar. The Plan II M.S. (M.S. project) is no longer offered by the ECE department, except to students with a concentration in Entrepreneurship and Technology Management (ETM).

The Ph.D. program requires a minimum of 50 credit hours of coursework and 18 credit hours of dissertation. Of the 50 coursework credits, at least 2 credits must be ECE 590 Graduate Seminar. 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.

## 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
  - Internet of Things
  - Quantum Information Systems
- **Electrical Engineering**
  - Applied Electromagnetics
  - Bioengineering
  - Communications
  - Image Processing
  - Microelectronics
  - Optoelectronics
  - Power
  - 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 Graduate Program Director and faculty members elected by each research area. The Graduate Program Director, 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 Graduate Studies (GS) and the Global Education Office (GEO), and
- Probation/enrollment matters and exit requirements.

**The UNM catalog and ECE graduate handbook.** Graduate Studies (GS) 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 Spring 2021 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 online at www.unm.edu/apply. ECE required materials can be found online at http://ece.unm.edu/. Please note that incomplete applications will not be processed by the UNM Admissions Office (domestic) or Global Education Office (international), 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 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. Accelerated Online Program (AOP) applications are also reviewed for admission to the Summer semester.

| Application Type | Fall Semester | Spring Semester |
|---|---|---|
| All applicants requesting financial aid | January 31 | June 30 |
| International applications | March 31 | August 31 |
| Domestic applications without financial aid | July 15 | November 15 |

**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 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 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, Chemistry, Biology, 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 Graduate Program Director 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 Graduate Program Director.

**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.

**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 to the instructor. The instructor should keep a copy of the report on file for at least five years.

**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.

**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.

**Distinction Honors.** MS Thesis and Ph.D. students are eligible to receive distinction honors. This recognition is determined by the examining committee members at the time of the thesis/dissertation defense, with final approval given by the Graduate Program Director. A unanimous vote is required by the committee members. This honor is documented on the transcript as "Passed with Distinction."

# 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 524, ECE 525, ECE 533, ECE 537, ECE 538, ECE 540, ECE 549.<br><br>List B: Select at-most one core course from: ECE 506, ECE 510, ECE 516, ECE 517, ECE 522, ECE 539, ECE 541, ECE 542, ECE 633.<br><br>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 | |
| | Internet of Things | |
| | Quantum Information Systems | Required: ECE 537, 545, 547, and at least one from: CHEM 587, PHYC 566, 571, 572, 581 |
| 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)<br>And one of:<br>ECE561 Electrodynamics (Spring, Applied EM track)<br>ECE539 Digital Signal Processing (Spring, Signal Processing track)<br>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), ECE 514 Nonlinear Control (Spring), ECE541 Probability Theory & Stochastic Processes (Fall) |

# 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 III (Coursework only) as shown in Table 2. Plan I requires 24 hours of coursework, 6 hours of Thesis, and 1 hour of ECE590 (Graduate Seminar). Plan III 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. The M.S. Plan II (M.S. Project) option is no longer offered by the ECE Dept except to students with a concentration in Entrepreneurship and Technology Management (ETM).

**Table 2: Masters Degree Requirements.**

| **Plan I (thesis option):** | **Plan III (coursework only option):** |
|---|---|
| 1. A minimum of 24 hours of coursework (not including ECE590 and thesis hours), with a minimum of 15 hours in ECE.<br>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.<br>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).<br>4. A maximum of 3 hours in "problems" courses (ECE551 or ECE651).<br>5. At least 50% of required coursework must be completed after admission to the graduate program, unless further limited by the graduate program.<br>6. One credit hour of graduate seminar (ECE 590). | 1. A minimum of 31 hours of coursework (including ECE590), with a minimum of 18 hours in ECE.<br>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.<br>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).<br>4. A maximum of 6 hours in "problems" courses (ECE551 or ECE651). The maximum allowed to Shared Credit 4+1 students is 3 credit hours.<br>5. At least 50% of required coursework must be completed after admission to the graduate program, unless further limited by the graduate program.<br>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, exclusive of Thesis, may be taken with a single faculty member.<br><br>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.<br><br>9. The CR grading option is not allowed for ECE Core or minor courses.<br><br>10. 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<br><br>11. Six hours of Thesis (ECE599) credit and completion and successful defense of a master's thesis. | 7. No more than half of the minimum required coursework hours may be taken with a single faculty member.<br><br>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.<br><br>9. The CR grading option is not allowed for ECE Core or minor courses.<br><br>10. 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 |

## 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 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 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 III 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 consultation with the Graduate Program Director and appropriate faculty members.

### 5.3 Master's Examination

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

**Advisor and Examination committee.** When the student is ready to schedule the Plan I (thesis) M.S. Exit exam, he or she, in cooperation with the academic advisor, will form an examination committee that includes three members, two of whom must be ECE faculty. The examination committee should generally be chaired by an ECE tenure-track faculty member. See Graduate Studies website for further committee formation guidelines.

**Announcement of Plan I 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 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 50 coursework hours (excluding the 18 hours of dissertation) 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 50 hours of coursework credits (not including ECE 699 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. These two credit hours are part of the required 50 hours of coursework.
3. A minimum of 18 hours of dissertation credits (ECE 699). These 18 dissertation hours are *in addition to* the required 50 hours of coursework.
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. CR/NC grading is not allowed for ECE core or minor courses.
6. 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
7. 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).
8. A maximum of 9 hours in "problems" courses (ECE551 or ECE651).
9. Must be enrolled 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 required 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 exam committee and the ECE Graduate Committee.

The qualifying exam must be attempted within four semesters of admission to the PhD program, unless otherwise determined by the academic adviser and the Graduate Program Director. 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 core course work and to prepare 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 scheduled on an individual basis throughout the semester, in coordination with the exam committee. The exam consists of a written submission and oral presentation,

followed by an oral question and answer session. The presentation is to be based on the reading of research literature in the student's Emphasis area and a short proposal for how the research could be expanded. The exam committee will consist of at least three regular ECE faculty members, and cannot be chaired by the student's academic advisor.

The student, in coordination with his or her academic advisor and Emphasis Area chair, should begin the process of scheduling the exam the semester prior to the semester in which the exam will be taken (the Qualifying Exam semester). Students must file a *Qualifying Exam Proposal Form* four weeks before the end of the semester prior to the Ph.D. Qualifying Exam semester. No later than four weeks before the assigned examination day, the student will be given the shortlist of papers and will be asked to choose one paper from that list for the exam. The student must email the Ph. D. Qualifying Exam Committee members his/her written report at least one week prior to the exam date. On the day of the examination, each student will be examined by the Ph. D. Qualifying Exam Committee.

Students will be given feedback by the exam committee on his or her exam performance, and notified of the need to repeat the exam within one week of the exam day. The results of the Qualifying Exam will be finalized by the full ECE faculty and made available to students by the end of the semester in which the exam is taken.

**Qualifying exam information.** Further information, including a detailed timeline and the required forms, can be found on the ECE PhD Qualifying Exam page**.**

**Evaluation of Qualifying exam.** On the first attempt, the outcome will be either Pass or Fail. In the event of a Fail, the student will be given detailed feedback on areas of needed improvement by the exam committee, and will have an opportunity to retake the exam for a second time. In the event of a Fail on the second attempt, the student will not be allowed to continue in the ECE Ph.D. program.

## 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 should 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 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. 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 on the Graduate Studies website.

### 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 UNM 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.

## A. ECE Regular Faculty and Research Interests

**Tameem Albash** Assistant Professor; Ph.D. University of Southern California, Interests: Quantum computing, quantum simulation, open quantum systems, and computational methods

**Viktoriia Babicheva** Assistant Professor; Ph.D., Technical University of Denmark, Denmark, Interests: Nanophotonics, nano-optics, photonic materials, plasmonics, metasurfaces, metamaterials, transdimensional nanostructures

**Ganesh Balakrishnan** Professor; 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

**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 mechanical 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** Professor Emeritus; Ph.D., University of Arizona, Interests: Neural networks, virtual reality, machine vision, robotics and genetic algorithms

**Christos G. Christodoulou** Distinguished Professor; Dean, 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; Ph.D., 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

**Tarief M. Elshafiey** Lecturer III, PhD Arizona State University, 1996; Microwave circuit and devices, Antenna analysis and Design, Numerical techniques in Electromagnetic, Interaction of electromagnetic with materials. Teaches more than 25 courses in Electrical Engineering

**Daniel Feezell** Associate 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, Ph.D., University of Illinois at Urbana-Champaign, Interests: Plasma processing, physical electronics, photovoltaics

**Mark A. Gilmore** Professor, Ph.D., University of California at Los Angeles, Interests: Plasma physics, high-energy-density physics, fusion energy, plasma diagnostics, microwave engineering

**Eric Ehrhardt Hamke** Lecturer II, MSc Electrical Engineering University of New Mexico, Control Systems, Communication Systems, Signal Processing, and Machine Learning

**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** Professor, Ph.D., Princeton University, Interests: Cognitive and cooperative communications, machine learning, deep learning, cognitive GPS, UAV/drone communications, Beyond 5G, inference, network information theory, control and optimization in smart-grids, networked control systems, wireless communications, statistical signal processing

**Ramiro Jordan** 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

**Jane M. Lehr** Professor, Ph.D. New York University, Interests: physics and applications of pulsed power and high voltage engineering, power and energy system components, wide bandgap semiconductors, high power transient electromagnetics, generation and applications of nonthermal plasmas, exploding wires, electrical breakdown physics and mitigation

**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

**Milad Marvian** Assistant Professor, PhD, University of Southern California, Interests: Quantum computing, Quantum information, Quantum error correction, Open quantum systems

**David Modisette** Sr Engineering Laboratories Coordinator, BSEE, MEE, Rice University, 30+ Years as Practicing Engineer in Industry including Bell Telephone Laboratories, Bio-Rad Semiconductor Division, Geosource Geophysical Survey Division, Ford Motor Contractor. Areas of expertise include: Analog and Digital Design, Firmware and Software Design, Project Management. 10+ years teaching and assisting student

**Edward J. Nava** Lecturer III, PhD, University of New Mexico, Interests: Security of computer-based systems, embedded systems, computer architecture, software engineering, computer networks

**Meeko Oishi** Professor, and Gardner-Zemke Professor, Ph.D., Stanford University. Interests: Autonomous systems, learning and control, human cyber-physical systems, stochastic optimal control, hybrid systems, stochastic reachability analysis

**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

**José Luis Palacios** Lecturer III, Ph.D. University of California at Berkeley. Assoc. Editor of Methodology and Computing in Applied Probability, and MATCH Communications in Mathematical and in Computer Chemistry. Interests: Markov chains, Mathematical Chemistry

**Marios S. Pattichis** Professor; ECE Associate Chair, Ph.D., University of Texas at Austin, Interests: Digital image and video processing and communications, video analysis, biomedical image analysis and communications, reconfigurable image processing systems

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

**Balu Santhanam** Professor, Ph.D., Georgia Institute of Technology, Interests: Statistical signal pro-cessing, 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: High energy density science, pulsed power science and technologies, plasma physics and diagnostics, physics and technology of charged particle beam generation and propagation, high power microwave sources and effects, neurosystems engineering

**Ashwani Sharma** Lecturer III, PhD, University of New Mexico, Interests: Low dimensional materials with unique physical, chemical, electromagnetic and thermodynamic properties aimed for development of devices with new functionalities and capabilities to operate in a variety of extreme conditions

**Xiang Sun** Assistant Professor, Ph.D., New Jersey Institute of Technology, Interests: wireless networks, free space optical communications, Internet of Things, edge computing, drone assisted mobile networks, and green computing, communications and networking

**Eirini Eleni Tsiropoulou** Assistant Professor, Ph.D., National Technical University of Athens,, Interests: Computer networks, wireless communications, network economics, network modeling and optimization, internet of things, cyber-physical systems

**Lei Yang** Assistant Professor, Ph.D., Chongqing University, Interests: Hybrid computing and communication systems, hardware/software co-exploration for neural architectures, machine learning for emerging applications, optimization

**Payman Zarkesh-Ha** Professor, Ph.D. Georgia Institute of Technology, Interests: analog and digital VLSI circuit designs, high-performance and low-power VLSI designs, statistical modeling of VLSI systems, fault tolerance and yield enhancement design techniques, novel nano-electronic devices such CNFETs, and novel opto-electronic devices