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I. GENERAL INFORMATION

A. INTRODUCTION

The Department of Electrical Engineering (EE) at the University of California, Riverside (UCR) offers advanced study in specialized areas of electrical engineering. The information contained in this manual is intended to help graduate students in this Department and particularly students new to the UCR campus. Other sources of information include:

- UCR General Catalog
  [www.students.ucr.edu/catalog](http://www.students.ucr.edu/catalog)

- Graduate Student Handbook, Graduate Division
  [www.graddiv.ucr.edu/studafftoc.html](http://www.graddiv.ucr.edu/studafftoc.html)

- Thesis and Dissertation Format Guide, Graduate Division
  [www.graduate.ucr.edu/ESforms.html](http://www.graduate.ucr.edu/ESforms.html)

- Policies & Regulations Governing Graduate Student Employment, Graduate Division
  [www.graduate.ucr.edu/ESforms.html](http://www.graduate.ucr.edu/ESforms.html)

- Financial Support Regulations, Graduate Division
  [www.graduate.ucr.edu/ESforms.html](http://www.graduate.ucr.edu/ESforms.html)

- UCR Graduate Division Website
  [www.graddiv.ucr.edu](http://www.graddiv.ucr.edu)

- Academic Dishonesty

The Department may specify more rigorous requirements for the degree than listed in the other sources. Therefore, when there appears to be a conflict in requirements for the degree, the more rigorous requirements must be satisfied. In addition to degree requirements, this manual also summarizes EE policies and procedures. The Department reserves the right to modify the departmental procedures and requirements outlined in this manual. Such modifications generally will not be considered retroactive.

B. ADMISSION

All applicants for admission to the EE graduate program must be approved first by the EE Graduate Advisor then by the Dean of Graduate Division (Graduate Dean). To be approved by the EE Graduate Advisor, an applicant should have a B.S. degree in engineering with a grade point average above 3.0 (based on a 4.0 point system) in the last two years of undergraduate work, a combined (verbal and quantitative) GRE score above 1100 and 3 good
supporting reference letters. Students from non-English speaking countries also must have a minimum TOEFL score of 550 on the paper-based test, 213 on the computer-based test, or 80 in the internet-based test. Typical scores are normally higher for admitted students. Students with undergraduate degrees outside engineering, who meet the above criteria, may be required to complete remedial undergraduate course work before being granted official admission into the EE graduate program. This remedial work may not be used to satisfy graduate degree requirements.

C. FINANCIAL ASSISTANCE

Financial awards include: research or teaching assistantships, and fellowships. Typically, teaching and research assistantships are awarded annually, on a competitive basis, and include:

- full or part-time salary, up to $15,000 per academic year and, in addition,
- payment of the Graduate Student Health Insurance Plan (GSHIP) fee and a Partial Fee Remission (PFR).
  Non-resident students receiving an assistantship may also receive a partial or full non-resident tuition (NRT) remission.

Applicants and enrolled students may apply for fellowships, which provide a stipend up to $16,000 and include full or partial payment of tuition and fees.

Assistants are expected to aid faculty members in the instructional or research programs. A 50% appointment requires an average of 20 hours per week. Administration and selection of teaching assistants (TAs) is done through the EE department. Research assistantships (Graduate Student Researchers, GSRs) are selected by the faculty members directing the project and not by the department and are supported by research contracts and/or grants. However, faculty members consult with the Graduate Advisor and Academic Program Assistant concerning the availability of qualified students seeking support.

Any EE Ph.D. graduate student whose native language is not English (in particular, international students) must pass the TOEFL Academic Speaking Test (TAST) or the SPEAK test. The purpose of both tests is to evaluate English proficiency and comprehensibility. The TAST is administered by EST and the ratings based on TAST scores are as follows:

- 23 – 30: Clear Pass
- 17 – 22: Conditional Pass
- 16 or below: No Pass

Ratings based on SPEAK test scores are as follows:

- 50 – 60: Clear Pass
- 40 – 45: Conditional Pass
- 20 - 35: Fail
Any EE Ph.D. student who has not received a “clear pass” must participate in the English
language classes offered at the UCR Extension Center until a “clear pass” is obtained.
Students are provided with one quarter of free instruction at UCR Extension Center.
However, if students do not pass the exam after one quarter, they are responsible for paying
for the instruction until a “clear pass” is obtained on the TAST/SPEAK test. The estimated
cost per quarter is $380. A student with a “conditional pass” can be appointed as a TA.
However, these appointments will only be approved for one quarter at a time. Every quarter,
a student with conditional pass can continue serving as TAs only if approved by the Graduate
Dean. This decision is made on the basis of:

- Departmental recommendation, including an assessment of the student's academic
  ability;
- Student teaching evaluations;
- Other evidence of commitment to/performance in teaching (e.g., faculty evaluations
  or statements of support, videotapes);
- Evidence of a good-faith effort to improve English skills; and
- Relative proximity to the level of competence represented by a clear pass.

All TAs are required to take the TADP workshop series offered by the Learning Center in the
beginning of every quarter. The TA training should be completed in the first two quarters a
TA begins teaching. Students sign up for the workshop series online at
http://www.tadp.ucr.edu/.

D. ADVISEMENT

Upon admission to the EE graduate program by the Graduate Division, each student is
assigned a preliminary faculty Advisor (generally by the Graduate Advisor) to assist with
course selection and general curriculum guidance. New graduate students are required to
consult with their Advisor before registering for classes. During the first or second quarter of
graduate studies, students must select a Faculty Advisor. This Advisor becomes, in effect,
the chairperson of the student’s M.S. or Ph.D. committee(s). These committees are described
in the Degree Requirements section of this manual.

The Ph.D. program is qualitatively different from the undergraduate or Master’s program.
The Ph.D. program prepares a student for a career in research. The core component of the
Ph.D. program is the independent research culminating in a Ph.D. thesis. Ph.D. students
admitted with a UCR Fellowship have been chosen and sponsored by a specific Professor
based on the student’s previous experience and stated interests. The sponsoring Professor
will be the Fellowship student’s Ph.D. advisor. Upon arrival at UCR, the Fellowship student
is expected to join the sponsoring Professor’s laboratory and begin participating in research
activities under the Professor’s direction.
Graduate study is individual in nature and requires frequent interaction between the student and Advisor. The Faculty Advisor must be consulted in the planning of programs of study for each quarter and the preparation of the Statement of Program (Study Plan). Other consultations should be arranged with the Advisor as needed. The Graduate Advisor or Academic Program Assistant may also be of assistance and provide counsel in non-degree related matters such as health services, housing, communication deficiencies, and career development.

It is the responsibility of the student to register and submit forms by the deadlines specified in the quarterly Schedule of Classes. Therefore, advisement meetings with the degree Advisor should be scheduled in anticipation of these deadlines.

E. COLLOQUIA/SEMINARS

Students are expected to register for three quarters of EE 259 Colloquium in Electrical Engineering course. Colloquia announcements will be posted on Department bulletin boards, on the EE website, and via email. It is the student’s responsibility to watch for the announcements and attend all Department colloquia. If a course/TA/Lab assignment conflicts with the scheduled seminar a student must notify the Academic Program Assistant via email prior to the start of the seminar. Only 2 unexcused absences are allowed for this course.

F. KEY PERSONNEL AND POINTS OF CONTACT

The administrative suite is located in Room 343 at the Engineering Building 2 (EBU2.) A listing of key contact personnel in the EE Department and the College of Engineering with whom graduate students may interact is given below. The complete directory for the Department of Electrical Engineering is available at www.ee.ucr.edu.

Vanda Yamaguchi, Graduate Program Assistant, Room 343 EBU2, 827-2484, vanda@ee.ucr.edu

Alexander Balandin, Professor & Graduate Advisor, Room 435 EBU2, 827-2351, alexb@ee.ucr.edu

Roger Lake, Professor & Chair, Room 437 EBU2, 827-2122, rlake@ee.ucr.edu

Bill Bingham, Department Manager, Room 343 EBU2, 827-2397, bill@ee.ucr.edu

Mark Bourbonnais, Academic Personnel Assistant, Room 343 EBU@, 827-2475, mark@ee.ucr.edu

Trudi Loder, Accounting, Payroll/Personnel & Purchasing Assistant, Room 343 EBU2, 827-2727, trudi@ee.ucr.edu

Steven Haughton, Computer Systems Administrator, Room 109 EBU2, 827-2452, systems@ee.ucr.edu
Dan Giles, Asc. Development Engineer, Room 137 EBU2, 827-2220, dgiles@ee.ucr.edu

Center for Research in Intelligent Systems (CRIS), Dr. Bir Bhanu, Director, Room 219 EBU2, 827-3954

College of Engineering-Center for Environmental Research Technology (CE-CERT), 1200 Columbia Avenue, Dr. Matt Barth, Interim Director, (951) 781-5791
II. AREAS OF STUDY AND DEGREE REQUIREMENTS

A. AREAS OF STUDY

The Department of Electrical Engineering offers advanced study and research designed to educate students in a range of technical areas within electrical engineering. Current areas of specialization offered in the EE graduate program are:

- Computer Engineering
- Control and Robotics
- Intelligent Systems
- Nano- materials, devices, and circuits (NMDC)
- Signal Processing and Communication

Individual programs of study can be designed to specialize in one of these areas, or in two related areas, or in other newly evolving areas of electrical engineering. The student and the student’s advisor make the choice. Proposed M.S. and Ph.D. programs for other emphases must be approved by the EE Graduate Committee and must include applicable basic core courses prescribed by the EE Department.

B. RECOMMENDED COURSES

To insure that EE graduate students have advanced knowledge in engineering principles, an EE recommended course program has been implemented. All M.S. students must participate in the EE recommended course program. Ph.D. students are not required to take these courses; however, they are expected to have knowledge of the material covered in these classes. Competency will be tested as part of the Comprehensive exam for M.S. students and the Preliminary exam for Ph.D. students. The current EE recommended courses are listed below. In the academic year 2006-2007, students must choose at least three out of the following five courses:

- EE 203 – Solid State Devices and Circuits
- EE 204 – Advanced Electromagnetics
- EE 210 – Advanced Digital Signal Processing
- EE 215 – Stochastic Processes
- EE 235 – Linear System Theory
- EE 242 – Intelligent Systems

C. INFORMAL AND INTERDISCIPLINARY COURSES

In addition to the courses given on the regular basis, faculty Advisors can offer Informal Courses. These courses are:
EE 290 Directed Studies – If you will study a particular subject under direction of a faculty member, and a regular course in that subject is not offered, you may enroll in EE 290. Students are required to file a petition no later than the third week of class to enroll in EE 290 to be able to use the units earned towards degree requirement.

EE 297- Non-thesis Research – If you are doing research under advisement of a faculty and this research is not directed toward your thesis or dissertation, you may enroll in EE 297.

Informal courses require a narrative description on a request form and should be approved and signed by the instructor and Graduate Advisor. The EE 290 Petition form may be found in Room 347 EBU2. EE 297 approval should be verified on the Quarterly Advising form.

EE graduate students also take Interdisciplinary Engineering Courses. These courses improve analytical, computational, and engineering skills required for advanced studies in the EE program. This area can include courses in Mathematics, Statistics, Physics, Computer Science, and other Engineering areas. A list of Interdisciplinary courses which have proven useful to EE Graduate students is given on pp. 31-32.

Only graduate and upper-division courses (125 and above) are counted toward the Degree requirements described in the following sections. Typical sample programs and course recommendations are listed in Section III. Registration for courses is done by the Academic Program Assistant after the courses are approved by the Graduate Advisor.

D. GENERAL REQUIREMENTS

1. Full-time Enrollment

Normally, the program of course work is formulated by each student and a Faculty Advisor by the end of the second quarter after admission to the program and must be approved by the EE faculty by the end of the first year. Full-time enrollment requires at least 12 units of graduate work per quarter or 16 units of undergraduate credit. The seminar EE259 gives one extra quarter unit (not counted towards the degree requirements). Some typical combinations include: 12 (grad. units)+0 (undergrad. units), 8+5, 4+11, 0+16.

2. M.S. Program

M.S. degree can be earned by completing one of two plans:

Plan I: completion of a thesis that reports an original investigation of a defined problem, or
Plan II: passing a comprehensive examination.

No more than two attempts to pass the exam may be allowed. If a student fails the exams once and then wants to switch to the Thesis Plan, he/she should contact the EE Graduate Advisor. If a student fails twice, he/she may NOT switch to the Thesis Plan.
Course requirements:
Completion of a minimum of 36 units of approved course work including 12 units of recommended courses. Specific plan requirements are as follows:

- Plan I: 24 or more graduate-course units, maximum of 12 units in Thesis Research (299), maximum of 16 units in Research and Directed Studies: EE290, EE297, and EE299.
- Plan II: 18 or more graduate-course units, none in research (EE297 or EE299), maximum of 6 units in Directed Studies (EE290).

3. Ph.D. Program

The Ph.D. degree is conferred after a student passes the following three steps:

- Ph.D. Preliminary examination
- Ph.D. Qualifying examination (approval of a Ph.D. dissertation proposal)
- defense and approval of the Ph.D. dissertation.

These procedures are shown in the following Figure and are described in Section II G in more detail.

The main component and focus of the Ph.D. program is the independent research culminating in a Ph.D. thesis. Courses are taken as necessary to prepare the student to pass the Preliminary exam and to train the student in his or her research area. Courses are taken from the Electrical Engineering Department and other Departments as deemed necessary by the faculty advisor.

In preparation for the Preliminary exam, a Ph.D. student in Electrical Engineering is required to establish a major subject area. A coherent program of approximately 24 units of graduate course work in the major area is recommended. The EE Department also recommends that students establish a minor subject area covering approximately twelve (12) quarter units of course work.

4. Grade requirements and time limits

The M.S. Program in Electrical Engineering requires one year of academic residence. Normative (typical time) is 2 years. The Ph.D. Program requires at least 2 years of academic residence, with normative time 3.5 years for students holding an M.S. degree in Electrical Engineering and 5 years for other students. The maximum time limit for either degree is one year beyond the normative time, excluding approved leaves of absences.

In addition, M.S. and Ph.D. students must maintain a GPA (grade point average) above 3.00, with the scale of A (4.00), B (3.00), and C (2.00). Namely, the students are considered to be making unacceptable progress and become subject to dismissal when:
• the overall GPA falls below 3.00;
• the quarterly GPA falls below 3.00 for two consecutive quarters;
• they have 12 or more units of incomplete courses ("I") outstanding;
• they fail to take their oral qualifying exams within five years, if applicable;
• they fail to fulfill program requirements such as exams or research in a timely and satisfactory manner;
• they have not completed their programs within one year after reaching the normative time;
• they fail to pass comprehensive or qualifying examinations in two attempts.
Ph.D. Progress

Choose Advisor and Complete Study Plan by the end of 2nd Quarter.

Ph.D. Preliminary Exam 3rd or 4th Quarter

Pass Exam:
Continue in Ph.D. Program

Fail Exam

Take Exam second time

Nominate Qualifying Exam Committee (5 members – 1 outside of department) as soon as possible. Have them review study plan and make any revisions they suggest.

Submit Dissertation Proposal to the Qualifying Exam Committee within one year of passing the Preliminary Exam. Within a month of receiving the proposal, the Committee will schedule the Qualifying Exam (Defense of the Proposal). The Committee will then make a recommendation.

Fail Exam - Academic Dismissal

Nominate Dissertation Committee as soon as possible after advancing to candidacy. They will advise you through the rest of the process.

Advance to Ph.D. Candidacy

Modify or Enhance Proposal

Withdraw from Program

Do Research, Write Dissertation

Submit Draft Dissertation to Dissertation Committee, Pass Final Examination-Defense (open to the public), Turn Dissertation in to Graduate Division.

Forms needed by grad. division with thesis draft:
1. Acceptance and Deposit Form
3. NORC Survey Of Earned Doctorates
4. Ph.D. Form 5 (Report of Final Examination)
EE GRADUATE PROGRAM POLICIES

5. Transfer of Credits Taken at Other Universities

Units from another University of California campus may be used to satisfy one of the three quarters of the residence requirement and may be counted for up to one half of the total units required for the M.S. degree. EE Department and Graduate Division approval must be obtained before such units can be accepted for credit.

A maximum of 8 quarter units from institutions outside the University of California may be counted toward the M.S. degree at UCR. All transfer work must have been completed in graduate standing with a minimum grade of "B." EE Department and Graduate Division approval must be obtained before these units can be accepted for credit. These units cannot be used to reduce the minimum residency requirement or minimum requirement in 200 series courses taken at this University. Unit credit only is posted on the UCR transcript (grade points are not transferred).

UCR undergraduates who have no more than two courses or 8 units of course work remaining in their bachelor's programs and who have been admitted to graduate status may begin course work for their advanced degrees at the beginning of the final quarter of undergraduate study. Bringing forward units from undergraduate status requires that the students inform the EE Graduate Advisor before beginning the course work in question and that they petition the Graduate Division for credit once they are enrolled as graduate students.

Students may apply Summer Session course work from any University of California campus toward their graduate degree requirements if they have prior approval of the EE Department and of the Graduate Dean.

UCR Extension is considered an outside institution that also offers "concurrent enrollment" courses (prefix XRC) as regularly offered UCR courses. The students may transfer in up to 8 units of concurrent enrollment credit if:

- a grade of "B" or better was received;
- these units were taken prior to graduate enrollment.

Matriculated graduate students may not use the University Extension concurrent enrollment mechanism. Graduate students who withdraw before completing their program are required to wait one year before applying XRC courses to their degrees. (Please note that a student could transfer-in 8 additional units from the category 'Non-UC Campuses' described above.)

6. Undergraduate Courses

Students wishing to use an undergraduate course to partially fulfill their graduate degree requirements must submit an approval request to the Graduate Advisor before the undergraduate course is taken. Retroactive approval will not be granted. Such courses are limited to upper division courses numbered 128 and above. Approval must be noted on the Quarterly Advising form.
Remedial courses, such as those required as prerequisites to the core EE graduate classes (EE 200 level), will not be allowed to count toward the degree requirements.

7.  Deadlines

It is the responsibility of the student to meet all deadlines specified by the EE Department and the Graduate Division. Students should consult the Graduate Student Handbook of the Graduate Division and the quarterly UCR Class Schedule for deadline information.

8.  Grading

For a graduate student only the grades A, A-, B+, B, B-, C+, C and S represent satisfactory scholarship and are applied toward degree requirements. A grade of C- at UCR may be accepted in partial satisfaction of the degree requirements if the student has a GPA of at least 3.0 in all courses applicable to the degree. These include all upper division undergraduate and graduate courses in the student's program of study, and must be taken while registered in graduate status.

Individual study and research, or other individual graduate work is normally evaluated by the grades Satisfactory/No Credit. Only the grade S is credited towards degree requirements. Academic work applicable to a graduate program may be graded S/NC only if the course descriptions so indicate. Undergraduate courses that do not have any significant relationship to the graduate program are considered as pure electives. These courses may be taken S/NC with the approval of the Graduate Dean, and do not count towards the student's degree requirements.

The grade Incomplete (I) is given only when a student's work is satisfactory but is incomplete because of circumstances beyond his or her control, and the student has been excused in advance from completing the quarter's work. Although incomplete grades do not affect the student's GPA, they are an important factor in evaluating academic progress. A student with 12 units of "I" grades is deemed to be making unacceptable progress. Students may not be employed as TA's, GSR's, or Teaching Fellows if they have more than 7 units of "I" grades.

The incomplete portion of the work needed to earn a grade must be received by the instructor no later than the last day of the quarter following the assignment of the "I". If not made up within the time allowed, the "I" lapses to an F ("Fail") or NC. An advanced degree cannot be awarded if there is an Incomplete on the student's record.

9.  Student Progress

An overall written evaluation of each student's academic progress is done by the department faculty at least once each academic year. This evaluation includes a brief review of the student's work to date, with particular attention to the period since the last report. Evaluation criteria that need to be addressed are listed above in Section D. This report also addresses academic objectives for the next period. The Graduate Advisor, the Graduate Division, and the student receive copies of this report.
10. Leaves of Absence

A graduate student is expected to enroll for each regular academic session unless a formal Leave of Absence is granted. A Leave of up to one year's duration may be granted if it has been determined that the Leave is consistent with the student's academic objective. This must be approved by both the academic unit and the Graduate Dean.

Graduate students granted a Leave of Absence forfeit the use of University facilities and faculty time. The student who will be absent from the campus while continuing to pursue graduate research or scholarly activity should register (in absentia if outside the State of California). Students who must leave the academic program for more than three quarters normally should withdraw and apply for readmission at the time they expect to resume graduate study at UCR.

A Leave ordinarily may be granted when a student is to be away from the University of California for any of the following reasons:

- Serious illness or temporary disability
- An occupation not directly related to the student's academic program
- Temporary interruption of the student's academic program for other appropriate reasons, such as family responsibilities

Generally, Leaves of Absence are limited to a total of three regular academic quarters and may be granted retroactively, after the start of a quarter, under exceptional circumstances. A Leave may not be granted if a student has not completed at least one quarter's work, or has not demonstrated satisfactory academic progress. (A student who has more than eight units of "I" outstanding on their transcript is considered to be making unsatisfactory progress.)

While on a Leave of Absence, a student is not eligible for University fellowship support, University research grants, or financial aid. A graduate student on Leave may not usually work on campus and may not hold an appointment as a Graduate Student Researcher, Teaching Assistant, or similar academic employment which requires full-time registration as a graduate student.

The immigration status of foreign students might be affected by a Leave depending on circumstances and whether they are staying in the U.S., or, returning to their own country. It is imperative that foreign students considering a Leave of Absence seek counseling at the International Services Center.

Students should pick up a General Petition for a Leave of Absence from the Graduate Division or it can be downloaded from the Graduate Division's website. The petition must be signed by the Graduate Advisor, and a memo of justification from the department must be submitted with the petition.

The student is also required to secure the signatures of the Cashier and Business Office (to determine if there are any outstanding debts or loan provision that must be considered), and
International Services (if foreign) before a final decision can be made. The petition must be into the Graduate Division by the published deadline dates. While a Leave of Absence may be granted retroactively to the beginning of the current quarter, a request for Leave submitted after beginning of classes ordinarily should be accompanied by an explanation of the circumstances justifying the late request. Students should not expect an answer until two weeks after their petition has been submitted.

E. MASTER OF SCIENCE (M.S.) DEGREE PROGRAM

As indicated above, the M.S. degree in Electrical Engineering can be earned by:

**Plan I:** completion of a thesis that reports an original investigation of a defined problem, or **Plan II:** passing a comprehensive examination.

1. **Thesis Committee (Plan I)**

M.S. thesis committees consist of three members. The committee is nominated by the Graduate Advisor or Department Chair after discussion with the student and faculty Advisor. Nominations are reported to the Graduate Dean using the Advancement to Candidacy forms. The Graduate Dean reviews the nominations and appoints the Committee. The committee, once approved by the Graduate Dean, becomes fully responsible for the student's academic guidance and evaluation.

The chairman of the Committee is the director of the candidate's research and is normally a faculty member of the EE department, or a cooperating faculty member. A member may be appointed who is a researcher on campus, who is from off-campus, or who is a visiting lecturer within the department; however, a memo indicating the academic degree and affiliation of the nominated member, as well as a curriculum vitae, must accompany such a request. (Memos need not accompany the nomination of an Adjunct faculty member.) If a change in the thesis committee is made, a memo to the Graduate Dean must be submitted explaining why a change is being requested and who is being added or removed.

After the committee is formed, the subject of the thesis must be approved by the committee. A joint meeting of the committee members and the student should be held before work on the thesis is begun to ensure the topic is clear and acceptable to all. All three members of the committee must approve the thesis and sign the title page of the thesis upon completion. Normally, M.S. students conducting a thesis are required to give a seminar presentation of their thesis work.

2. **Comprehensive examination (Plan II)**

The exam is administered by the Graduate Committee and is combined with the Ph.D. Preliminary examination. The examination will normally be given twice a year on weekends during the Fall and Spring quarters, between weeks 8 and 10. It is recommended that the students take the exam prior to the end of the third or the forth quarter of their studies.
A student may take the exam twice. A student who failed in the first attempt has two options. The student may switch to Plan I, or the student must take the examination again at the time of the next immediate examination. A student who has failed the examination twice is automatically removed from the program. A student who registered for the exam but did not show up is considered to have failed.

To complete their education, the students must pass the Comprehensive exam prior to the end of the second year of their studies. Exceptions can be made for those students who were admitted to the program with substantial deficiencies in their education, and for this reason were assigned to the remedial undergraduate courses covering these deficiencies. Students for whom the above requirements present an undue hardship, may petition the Graduate Committee for an appropriate extension of time.

The Comprehensive Examination is a five-hour written, closed-book exam held on one (1) day. A total of five questions must be answered. Students will choose three (3) questions from their major area, and two (2) questions taken from two other areas. For example, a student majoring in Communication, can split 5 questions similar to one of the following formats:

- 3 - Communication  OR  3 – Communication  OR  3 – Communication
- 1 – Control  OR  1 – Control  OR  1 – NMDC
- 1 – Interdisciplinary  1 – NMDC  1 – Intelligent Systems

Test problems will draw primarily from material related to graduate courses; however, a minor portion of the test may involve problems drawn from upper division courses. The examination committee following its evaluation of the written exam may request an oral follow-up session.

If a student fails 3 or fewer questions on the first attempt, the student only needs to re-take the failed questions on the second attempt. If more than 3 questions are failed on the first attempt, the exam must be re-taken in its entirety.

To take the exam, the students must register by notifying the Academic Program Assistant at least one month prior to the exam date. Those students who wish to include Interdisciplinary question(s) in their exam, must register at least 1.5 months prior to the exam date, to allow the Graduate Committee to request an outside expertise, if necessary.

3. Advancement to Candidacy and Degree Conferral

Students must be advanced to candidacy for M.S. degree no later than the first week of the quarter in which their degree is expected to be awarded. Deadlines for submission are published each quarter in the Schedule of Classes and in the annual Graduate Division Calendar. If the application is not received by the deadline date, the degree may be deferred until the following quarter.

If the Master's degree requires a thesis (Plan I), a thesis committee should be nominated. The Student Affairs Section certifies the candidacy of the student and checks for the completion
of the University and departmental requirements. The student is sent a "Certificate of Candidacy" when certified. All requirements for the degree must be satisfied within a calendar year from the time of completion of the required course work. Should the student be unable to complete the degree requirements within this time, candidacy will lapse. The student must then file a General Graduate Student Petition requesting a reinstatement of Master's Candidacy with the Graduate Division.

The Master's degree is conferred at the end of the academic quarter in which all requirements have been satisfied (the official conferral day is the last day of the quarter). The students must have been formally advanced to candidacy during the quarter in which they finish their degree. Ordinarily, a graduate student will be registered or on Filing Fee status the quarter in which all degree requirements are completed and the degree is to be conferred. However, students may complete the requirements during the quarter break. If they were enrolled or on Filing Fee status the quarter before, they may complete degree requirements before the next quarter officially begins and not be assessed registration fees for that quarter.

If a student wishes to complete degree requirements during the Summer months, they must have had student status (be enrolled or on Filing Fee status) every quarter of the previous academic year to complete without paying additional fees. If they were withdrawn or on Leave any one of those quarters, they must use Filing Fee status or enroll in two units of Summer Session course work to complete during the Summer.

If a student does not complete the necessary courses by the end of the quarter in which degree conferral is expected, or does not attain the required level of scholarship, registration for the next regular academic session is mandatory - otherwise student status will lapse and candidacy for the degree may lapse. Once student status lapses, the degree can be conferred only after readmission of the student, followed by at least one quarter of registration or Filing Fee status.

Students are advised by mail of formal degree award at the end of the quarter in which the degree is conferred. As soon as all degree requirements are completed, the student may request a formal letter of certification of completion bearing the Graduate Dean's signature and University Seal from the Graduate Division. A formal certification of completion is the equivalent of the diploma or the official academic transcript posting for employment and career advancement purposes.

Once the diploma is ready, the Registrar will notify students by postcard that they may pick-up their diploma at that office. If they want it mailed to them they must pay the Registrar for postage. They should make these arrangements with the Registrar's Office.

A graduate student pursuing the Master's degree as a terminal degree may not continue to register as a graduate student once the degree has been awarded unless they have been formally admitted to another program.
F. DOCTOR OF PHILOSOPHY (PH.D.) DEGREE PROGRAM

The Ph.D. degree provides an opportunity for students to pursue a program of in-depth research in a specialized area. As pointed in Section II B, the procedure consists of three parts:

- passing a Ph.D. Preliminary examination
- passing a Ph.D. Qualifying examination (approval of a Ph.D. dissertation proposal)
- defense and approval of the Ph.D. dissertation.

1. Ph.D. preliminary examination

The purpose of the Ph.D. preliminary examination is to screen candidates for continuation in the doctoral program. The exam is administered by the Graduate Committee, and is combined with the M.S. Comprehensive Exam. A Ph.D. candidate is required to pass the exam at the Ph.D. level. To do this, a student must typically get a higher score than what is necessary to pass at the M.S. level. The structure of the exam and all procedures are described in Section E, page 14.

2. Ph.D. Qualifying Examination

After successful completion of the Ph.D. preliminary examination, each student, with the advisement from an Advisor, prepares a dissertation proposal. Typically, each Ph.D. student must submit a dissertation proposal to the Ph.D. Qualifying Committee within one year after successfully completing the preliminary examination. The Ph.D. Qualifying Committee chairperson will normally schedule an oral defense within one month of the written proposal submission. The presentation is given to the Ph.D. Qualifying Committee members. This presentation is not open to the general public. It is open to members of the Academic Senate.

The oral presentation/defense of the proposal focuses on the dissertation problem. Students should demonstrate considerable depth of knowledge in the student's area of specialization and a clear understanding of the research methods that are needed for successful completion of the dissertation research. The oral presentation/defense will begin with a presentation by students on their dissertation topic and will be followed by questions and suggestions from the Ph.D. Qualifying Committee.

Based on the written proposal and oral defense, a recommendation will be made by the Ph.D. Qualifying Committee that the student either 1) be advanced to Ph.D. candidacy, 2) be asked to modify and enhance the proposal, or 3) be requested to withdraw from the Ph.D. program.
3. Ph.D. Qualifying Committee

By Academic Senate Regulation and Graduate Council policy, the Qualifying Committee is comprised of five members, a majority of whom, but not all, are affiliated with the program. The Chair of the Qualifying Committee is normally the student's Ph.D. Advisor, who must be a voting member of the Academic Senate. (All committee members should normally be voting members of the UC Academic Senate.) Any exceptions must hold Ph.D.s, be qualified for a UC faculty appointment and must be supported by a memo of justification from the Graduate Advisor. A memo need not be written for those holding Adjunct faculty positions.

One member of the Qualifying Committee, designated the “outside member,” must be a voting member of the UC Academic Senate who does not hold an appointment in the EE department. This person represents the faculty at large and acts most importantly, as a "third party ensuring fairness." Special expertise in the area of the student's dissertation is not expected; this member's academic field may be unrelated to the field of study of the student and the other committee members, and this member is expected to be unaffiliated with the department. The “outside member” cannot be an EE Cooperating Faculty.

The student and his/her Advisor nominate the Committee with the concurrence of the Department Chair or Graduate Advisor. After review of the nominations, the Graduate Dean appoints the Committee. This Committee, once approved by the Graduate Dean, becomes responsible for the student's academic guidance and evaluation until advanced to candidacy.

The proposed Qualifying Committee and the date set for the exam must be submitted to the Graduate Division Office on the Ph.D. Form 2 (Nomination for Qualifying Examination for the Degree of Doctor of Philosophy) at least two weeks (preferably one month) prior to the date of the final qualifying examination date. If any nominee is not a member of the University of California Academic Senate, a curriculum vitae and a memo justifying the appointment from the Graduate Advisor or Department Chair should be submitted with the Form 2.

Once the committee has been formally appointed, the date and time of the oral proposal presentation/defense will be scheduled. Any changes in the exam date or in the composition of the Committee must be communicated in writing to the Graduate Division not less than twenty-four (24) hours before the oral examination is held.

The recommendation of the committee must be reported to the Graduate Council within forty-eight (48) hours on Ph.D. Form 3 (Report on Qualifying Examination and Nomination of Dissertation Committee) which is provided by the Graduate Division to departments on request. Each committee member must sign the form. No one can sign for them.

The Graduate Dean will accept a unanimous committee report for or against approval for the Graduate Council. If a student has failed the qualifying examination, the committee is required make a recommendation for or against a second examination, ordinarily not to be given until at least three months have elapsed. The date of the second oral examination shall be communicated to the Graduate Division in writing at least two weeks prior to its
occurrence. A third examination is not permitted. The student will be notified of the results immediately following the exam when a unanimous vote is reached.

If there is an initial divided vote, the committee will make every effort to arrive at unanimity. Failing unanimity, a committee reports which contains only one negative vote will be deemed a pass, and committee’s report containing two (or more) negative votes will be considered a failure. When the vote is split, the committee or any member of the committee can petition (in writing) the Graduate Council to consider a reversal of the judgment. In that event, the Administrative Committee of the Graduate Council will make the final determination as to whether the student has passed. In such cases no statement is made to the student regarding his/her passing or failure until the final determination has been made. The student shall be informed within forty-eight (48) hours that the vote is split and the final determination will be made by the Graduate Council.

When the Committee meets to conduct the oral Qualifying Examination, it must report the vote and/or action to the Graduate Council via the Graduate Dean. If the Committee decides to reexamine the student at a later date or does not pass the student for any reason, this must be reported. Once a committee convenes an examination, that committee must report either a pass or fail. All committee members must sign the Form 3 at the time the qualifying examination is concluded, and submitted even if the examination was failed.

4. Advancement to Candidacy

After successful completion of the qualifying examinations and completion of all University and departmental requirements, the student is eligible for formal advancement to candidacy. At that time, the EE department submits the "Report of Departmental Requirements for Ph.D. Degree" to the Graduate Division to conduct a degree check. The student will be billed the Candidacy Fee after the degree check has been completed. After a successful degree check, the student and EE department are notified of the formal advancement to candidacy.

All students who are considered nonresidents for tuition purposes and are advanced to candidacy for the Ph.D. receive a reduction of 100 percent of the non-resident tuition. Each student is eligible for a maximum of three calendar years of non-resident tuition reduction. Time spent not registered (withdrawn, on leave, or on filing fee status) will count toward the three-year total unless the Graduate Dean grants an exception. A student must be advanced by the first day of the academic term to qualify for that quarter.

Candidacy for the Ph.D. will normally lapse if the student loses graduate standing by academic disqualification or failure to comply with the University policy on continuous registration. A readmitted student who was a candidate for the Ph.D. may be required to again advance to candidacy and thereafter enroll as a candidate for at least one academic quarter before the Ph.D. will be conferred. If less than three years has passed since the student withdrew, the candidacy will normally remain in effect. If three or more years have passed since Advancement to Candidacy, candidacy status will be determined by consultation between the Graduate Dean and the department.
Following advancement to Ph.D. candidacy, students formally begin their dissertation research. The student’s Ph.D. Dissertation Committee monitors the progress of the dissertation. It is recommended that Ph.D. candidates interact frequently with members of their dissertation committee to insure that dissertation progress is acceptable.

After completion of the dissertation research, a written copy of the dissertation must be submitted to and approved for defense by the student's Ph.D. Dissertation Committee. Once a draft has been approved for defense, an oral defense of the dissertation will be scheduled. This defense consists of a seminar open to the entire academic community, followed by a question/answer period conducted by the Ph.D. Dissertation Committee.

5. **The Doctoral Dissertation Committee**

Upon recommendation of the Graduate Advisor or EE Chair, doctoral dissertation committees are appointed by and responsible to the Graduate Council through the Graduate Dean. At this stage, the Dissertation Committee becomes responsible for the student's academic guidance and evaluation for the remainder of their degree studies.

All members of the dissertation committee shall normally be faculty members in the student's department and members of the Academic Senate. These criteria assume that any nominated person will be affiliated with this campus throughout the time that the student is working on the dissertation. For any nominee who does not fit the above criteria (other than Adjunct faculty), the Graduate Division requires supporting justification from the Department for review and consideration. All committee members must have a doctoral degree.

If the Chairperson of the dissertation committee leaves the campus, he or she leaves the department as well as the Academic Senate. If the student has already completed a major portion of the dissertation research under this chairperson, the outgoing faculty member may remain on the student's committee in the capacity of Co-Chairperson, serving with a member of the student's department who does meet the above criteria appointed as Co-Chairperson. Of course, the outgoing faculty member would need to be willing to continue serving on this committee.

If a committee member other than the Chairperson leaves the campus, a faculty member meeting the above stated criteria normally replaces the outgoing member. Exceptions to this practice have been made when the student has already completed a substantial portion of the dissertation research, and the departing member is willing to continue to serve on the committee. As a safeguard for the student, *the appointment of a minimum of three UCR Academic Senate members to dissertation committees is normally required*.

Dissertation committees are charged with guiding the students in their research and passing judgment on the final merits of their dissertation. The committee arranges for such conferences with the candidate as are necessary for the development and elucidation of the research treated in the dissertation.

The dissertation committee has responsibility for both the content and the style of the dissertation. The Doctoral Committee certifies that the completed dissertation is satisfactory through the signatures of all committee members on the signature page of the completed
dissertation. After the Doctoral Committee has approved a dissertation, two copies of the dissertation must be submitted to the Graduate Division. (See Instructions for the Preparation and Submission of Theses and Dissertations for complete information about UCR dissertation requirements.) During the process of accepting the dissertation, the committee in a final oral examination normally examines the candidate.

The Doctoral Committee supervises a final examination, the focus of which is the content of the doctoral dissertation. The results of the exam are reported on Ph.D. Form 5 (Report of Final Examination). Under unusual circumstances, the exam may be waived with the unanimous consent of the committee and the approval of the Graduate Dean. The final examination may be given either just prior to the completion of the dissertation and while the student is in residence during a regular academic session or after the acceptance of the dissertation, and will be open to all members of the academic community.

Upon completion or waiver of the final examination and approval of the dissertation, the Doctoral Committee recommends, by submission of Ph.D. Form 5, that the Ph.D. be conferred. All members of the committee must sign the form. They may not have anyone else sign for them.

6. Degree Conferral

Ph.D. degrees are conferred, subject to the final approval of the Graduate Council, as of the last day of the regular academic quarter in which all requirements have been satisfied (the last day of the quarter), including the final positive recommendation of the Doctoral Committee, and the acceptance of the approved dissertation by the Graduate Division on behalf of the University. A graduate student must be registered or on Filing Fee status the quarter in which the dissertation is submitted and the degree is to be conferred. No fee for filing the manuscript itself is required.

Unless payment of a Filing Fee or a Leave of Absence is approved, all graduate students must register each regular academic quarter (excluding Summer Session) until all degree requirements are completed - otherwise, student status and candidacy for the Ph.D. will normally lapse. Once status lapses, the degree can be conferred only after readmission of the student, followed by at least one quarter of registration or Filing Fee status and possibly re-advancement to candidacy. Students are advised by mail of formal degree conferral at the end of the quarter in which the degree is completed. As soon as all degree requirements are completed, the student may request a formal letter of certification of completion bearing the Graduate Dean’s signature from the Division office. A formal certification of completion is the equivalent of formal degree conferral for faculty and postdoctoral appointments and other employment and career advancement purposes.

Once the diploma is ready, the Registrar will notify the student by postcard that they may pick-up their diploma at that office. If they want it mailed to them they must pay the Registrar for postage. They should make these arrangements with the Registrar's Office.
III. SAMPLE PROGRAMS AND COURSE DESCRIPTION

A. SAMPLE PROGRAMS
This section presents sample programs for each EE area of study. Five recommended courses are also cross-listed in the corresponding core areas. Each course is counted one time towards the degree and exam requirements. The M.S. students can choose courses from different sub-areas of their sample program to satisfy the minimum requirements described in Section II D:

| Program: Nano- materials, devices, and circuits |

**CORE AREA COURSES**

- EE 201 – Applied Quantum Mechanics
- EE 202 – Fundamentals of Semiconductors and Nanostructures
- EE 203 – Solid State Devices and Circuits
- EE 205 – Optoelectronics and Photonic Devices
- EE 206 – Nanoscale Characterization Techniques
- EE 207 – Noise in Electronic Devices
- EE 208 – Semiconductor Electron, Phonon, and Optical Properties
- EE 209 – Semiclassical Electron Transport
- EE 212 – Quantum Electron Transport
- EE 219 – Advanced Complementary Metal Oxide Semiconductor …
- EE 215 – Stochastic Processes
- EE 235 – Linear System Theory
- CEE 202 – Transport Phenomena
- Physics 221A-C – Quantum Mechanics
- Physics 240A-C – Solid State Physics
- Physics 209A – Quantum Electronics

**RECOMMENDED COURSES** (12 units)

- EE 203 – Solid State Devices and Circuits
- EE 204 – Advanced Electromagnetics
- EE 210 – Advanced Digital Signal Processing
- EE 215 – Stochastic Processes

Completion of a minimum of 36 units of approved course work including 12 units of recommended courses.

- Plan I: 24 or more graduate-course units, maximum of 12 units in thesis research (299), maximum of 16 units in Research and Directed Studies: EE290, EE297, and EE299.
- Plan II: 18 or more graduate-course units, none in research (EE 297 or EE 299), maximum of 6 units in Directed Studies (EE 290).
EE 235 – Linear System Theory
EE 242 – Intelligent Systems

***Core area and recommended courses should not overlap***

**ELECTIVE COURSES**

CS 237 – Advanced Topics in Modeling and Simulation
EE 224 – Digital Communication Theory and Systems
EE 237 – Nonlinear Systems and Control
Physics – 209B – Nonlinear Optics
Physics – 242 – Physics at Surfaces and Interfaces
Physics – 283 – Techniques of Microscopy
Physics – 278 – Surface Sciences
Physics – 281 – Theoretical Topics in Condensed Matter Physics
Physics – 284 – Optical Techniques for Measurements in Physics
EE 290 – Directed Studies

**RESEARCH/SEMINAR**

EE 259 – Colloquium in Electrical Engineering
EE 297 – Directed Research
EE 299 – Thesis or Dissertation Research

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**Program: Control and Robotics**

**CORE AREA COURSES**

EE 210 – Advanced Digital Signal Processing
EE 215 – Stochastic Processes
EE 235 – Linear System Theory
EE 236 – State and Parameter Estimation Theory
EE 237 – Nonlinear Systems and Control
EE 238 – Linear Multivariable Control
EE 239 – Optimal Control
EE 245 – Advanced Robotics
EE 2XX – Adaptive Control

**RECOMMENDED COURSES** (12 units)

EE 203 – Solid State Devices and Circuits
EE 204 – Advanced Electromagnetics
EE 210 – Advanced Digital Signal Processing
EE 215 – Stochastic Processes
EE 235 – Linear System Theory
EE 242 – Intelligent Systems

***Core area and recommended courses should not overlap***
ELECTIVE COURSES
1. Interdisciplinary Math or Statistics or CS Course
2. EE 290 – Directed Studies

RESEARCH/SEMINAR
EE 259 – Colloquium in Electrical Engineering
EE 297 – Directed Research
EE 299 – Thesis or Dissertation Research

Program: Intelligent Systems

CORE AREA COURSES
EE 210 – Advanced Digital Signal Processing
EE 215 – Stochastic Processes
EE 240 – Pattern Recognition
EE 235 – Linear System Theory
EE 236 – State and Parameter Estimation Theory
EE 241 – Advanced Digital Image Processing
EE 242 – Intelligent Systems
EE 243 – Advanced Computer Vision
EE 244 – Computational Learning
EE 247 – Current Topics in Computer Vision and Pattern Recognition

RECOMMENDED COURSES (12 units)
EE 203 – Solid State Devices and Circuits
EE 204 – Advanced Electromagnetics
EE 210 – Advanced Digital Signal Processing
EE 215 – Stochastic Processes
EE 235 – Linear System Theory
EE 242 – Intelligent Systems

***Core area and recommended courses should not overlap***

ELECTIVE COURSES
1. Interdisciplinary Math or Statistics or CS Course
2. EE 290 – Directed Studies

RESEARCH/SEMINAR
EE 259 – Colloquium in Electrical Engineering
EE 297 – Directed Research
EE 299 – Thesis or Dissertation Research

**Program: Signal Processing/Communication**

**CORE AREA COURSES**
EE 210 – Advanced Digital Signal Processing
EE 211 – Adaptive Signal Processing
EE 215 – Stochastic Processes
EE 224 – Digital Communication Theory and Systems
EE 225 – Error-Correcting Codes
EE 226 – Wireless Communications
EE 227 – Spread Spectrum Communications
EE 228 – Fundamentals of Data Compression
EE 235 – Linear System Theory
EE 236 – State and Parameter Estimation Theory
EE 250 – Information Theory
EE 251 – Algorithmic and Combinatorial Coding Theory
CS 204 – Advanced Computer Networks
CS 240 – Network Routing
CS 257 – Wireless Networks and Mobile Computing

**RECOMMENDED COURSES (12 units)**
EE 203 – Solid State Devices and Circuits
EE 204 – Advanced Electromagnetics
EE 210 – Advanced Digital Signal Processing
EE 215 – Stochastic Processes
EE 235 – Linear System Theory
EE 242 – Intelligent Systems

***Core area and recommended courses should not overlap***

**ELECTIVE COURSES**
1. Interdisciplinary Math, or Statistics, or CS Course
2. EE 290 – Directed Studies

**RESEARCH/SEMINAR**
EE 259 – Colloquium in Electrical Engineering
EE 297 – Directed Research
EE 299 – Thesis or Dissertation Research
Program: Computer Engineering

CORE AREA COURSES
EE 213 – Computer-Aided Electronic Circuit Simulation
EE 219 – Advanced Complementary Metal Oxide Semiconductor …

RECOMMENDED COURSES (12 units)
EE 203 – Solid State Devices and Circuits
EE 204 – Advanced Electromagnetics
EE 210 – Advanced Digital Signal Processing
EE 215 – Stochastic Processes
EE 235 – Linear System Theory
EE 242 – Intelligent Systems

***Core area and recommended courses should not overlap***

ELECTIVE COURSES
1. Interdisciplinary Math, or Statistics, or CS Course
2. EE 290 – Directed Studies

RESEARCH/SEMINAR
EE 259 – Colloquium in Electrical Engineering
EE 297 – Directed Research
EE 299 – Thesis or Dissertation Research

B. EE GRADUATE COURSE DESCRIPTIONS
Descriptions of EE graduate courses are listed below. Descriptions of undergraduate EE
courses, as well as those from other departments may be found in the UCR General Catalog
and on the UCR website (http://www.catalog.ucr.edu/).

EE 201. Applied Quantum Mechanics. (4) Lecture, 3 hours; outside research, 3 hours.
Prerequisite(s): PHYS 040A, MATH 046. Schrodinger equation, operator formalism,
harmonic oscillator, quantum wells, spin, bosons and fermions, solids, perturbation theory,
WKB approximation, tunneling, tight-binding model, quantum measurements, quantum
cryptography, and quantum computing.

EE 202. Fundamentals of Semiconductors and Nanostructures. (4) Lecture, 3 hours;
outside research, 3 hours. Prerequisite(s): EE 133, EE 201. Examines principles of
semiconductor materials and nanostructures. Topics include periodic structures, electron and
phonon transport, defects, optical properties, and radiative recombination. Also covers
absorption and emission of radiation in nanostructures, and nonlinear optics effects.
Emphasizes properties of semiconductor superlattices, quantum wells, wires, and dots.
EE 203. **Solid-State Devices and Circuits.** (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): EE133, EE 202. Covers electronic devices including p-n junctions, field-effect transistors, heterojunction bipolar transistors, and nanostructure devices. Explores electrical and optical properties of semiconductor heterostructures, superlattices, quantum wires and dots, as well as devices based on these structures.

EE 204. **Advanced Electromagnetics.** (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): EE 117. Presents study of selected topics in electromagnetic theory and antenna design. Topics include power transmission and attenuation in microstrip transmission lines (TL) and waveguides (WG); transient analysis and applications of TL and WG; radiation of EM waves; antenna design issues; electromagnetic interference and compatibility; numerical methods in electromagnetic theory.

EE 205. **Optoelectronic and Photonic Devices.** (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): EE 203, EE 204. Covers the physical optical and photonic devices and their use in an optical communication system: silica fibers, LEDs, heterojunction lasers, p-I-n photodiodes, and avalanche photodiodes.

EE 206. **Nanoscale Characterization Techniques / Experimental Lab.** (4) Lecture, 3 hours; laboratory, 3 hours. Prerequisite(s): EE201, EE202, EE 203. Presents in-depth study of nanoscale materials and device characterization techniques. The course has a practical laboratory component with emphasis on the atomic force microscopy (AFM) and scanning tunneling microscopy (STM). Topics include semiconductor fabrication fundamentals, metrology requirements, in-situ monitoring, interconnects and failure analysis, principles of AFM, STM, scanning electron microscopy, X-ray methods, optical and infrared techniques, and electrical characterization of materials and devices.

EE 207. **Noise in Electronic Devices** (4) Lecture, 3 hours; outside research, 3 hours. Lecture, three hours; outside research, three hours. Prerequisite(s): EE 203 or consent of instructor. A study of fluctuation processes in solids and noise in electronic devices. Topics include the theory of random processes and analysis of noise types such as generation-recombination noise, low-frequency noise, random telegraph noise, thermal noise, and short noise.

EE 208. **Semiconductor Electron, Phonon, and Optical Properties** (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 202. Topics include semiconductor electronic band structure theory and methods, phonon dispersion theory and methods, defects in semiconductors, and optical properties of semiconductors.

EE 209. **Semiclassical Electron Transport** (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 201, EE 203, EE 208. Covers the Boltzman transport equation applied to semiconductor device modeling. Topics include the physics of carrier scattering in common semiconductors, theoretical treatments of low and high field transport, balance equations, and Monte Carlo solutions.
**EE 210. Advanced Digital Signal Processing (4)** Lecture, 3 hours; discussion, 1 hour.
Prerequisite(s): EE 110B, EE 141. Provides students with an in-depth understanding of various advanced techniques for designing digital filters and power spectral estimation. Topics discussed are design of digital filters, discrete random signals, nonlinear effects of finite-wordlength implementations of digital filters, nonparametric and parametric power spectrum estimation techniques, multirate digital signal processing, least square methods of digital filter design, and applications of digital filter design.

**EE 211. Adaptive Signal Processing. (4)** Lecture, 3 hours; discussion, 1 hour.
Prerequisite(s): EE 210, EE 215, EE 236. Provides an in-depth understanding of adaptive signal processing techniques. Covers Wold decomposition, Yule-Walker equations, spectrum estimation, Weiner filters, linear prediction, Kalman filtering, time-varying system tracking, nonlinear adaptive filtering, and performance analysis of adaptive algorithms and their variations including stochastic gradient, least mean square, least squares, and recursive least squares.

**EE 212. Quantum Electron Transport (4)** Lecture, 3 hours, discussion, 1 hour.
Prerequisite(s): EE 208. Covers the theory and methods used to model quantum electron transport in ultrascaled traditional semiconductor devices such as transistors, nanoscaled research semiconductor devices such as quantum dots, and novel electronic material systems such as carbon nanotubes and molecular wires.

**EE 213. Computer-Aided Electronic Circuit Simulation (4)** Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): EE 001A, EE 001B, EE 133. Introduction to numerical algorithms and computer-aided techniques for the simulation of electronic circuits. Covers theoretical and practical aspects of important analyses. Topics include circuit formulation methods; large-signal nonlinear direct current, small-signal alternating current, and moment-matching transient; sensitivity; and noise. Also discusses recent advances in timing analysis, symbolic analysis, and radio frequency circuit analysis.

**EE 214. Single-Electronics and Quantum Computing (4)** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 201 or equivalent; graduate standing or consent of instructor. Introduces single-electron devices and their potential use in very large-scale integration applications and quantum computing. Topics include Coulomb blockade, “orthodox” theory of single-electron tunneling, single-electron transistor, shot noise theory superconducting and quantum dot single-electron devices; analog applications, single-electron memory and logic, basic principles of quantum computing and quantum cryptography, Shor’s algorithm, quantum error correction, and potential solid-state realizations of a quantum computer.

**EE 215. Stochastic Processes (4)** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor. A study of probability theory and stochastic processes, with a focus on the most fundamental aspect of modern communication, control, and signal processing systems driven by random signal inputs. Topics include random variables and stochastic processes; spectral analysis; Wiener optimum filter, matched filter, and Karhunen-Loeve expansion; mean square estimation theory including smoothing, filtering, and linear prediction; Levinson’s algorithm, lattice filters, and Kalman filters; and the Markov process.
EE 216. Nanoscale Phonon Engineering (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): EE 202. Studies acoustic and optical phonons that affect electrical, thermal, and optical properties of materials. Focuses on the confinement-induced changes of phonon properties in nanostructures and their implications for performance of electronic, thermoelectric, and optoelectronic devices. Explores phonon theory, Raman spectroscopy and other phonon characterization techniques, thermal conductivity, and related measurements.

EE 219. Advanced Complementary Metal Oxide Semiconductor (CMOS) Technology (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 203. Introduces advanced complementary metal oxide semiconductor (CMOS) technology. Topics include MOS field effect transistor (MOSFET) scaling, short and narrow channel effects, high field effects, vertical MOSFET transistors, single electron transistors, MOSFET nonvolatile memory devices, and small- and large-signal MOSFET models. Covers CMOS process integration.

EE 224. Digital Communication Theory and Systems (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 115; either the MATH 149A and MATH 149B sequence or the STAT 160A and STAT 160B sequence; or equivalents. Provides an overview of basic communication techniques and an introduction to optimum signal detection and correction. Topics include sampling and bandwidth; pulse code modulation; line coding and pulse shaping; delta modulation; stochastic approach to bandwidth and noise corruption; white Gaussian noise; matched filter; optimum signal detection; Shannon theorem; and error correction.

EE 225. Error-Correcting Codes (4) Prerequisite(s): EE 215 and 224. This course provides an overview of basic error-correcting techniques used in data transmission and storage. Topics include groups and Galois fields, error-correction capability, and code design of Hamming codes, cyclic codes, Bose-Chaudhuri-Hocquengem (BCH) codes, and Reed-Solomon codes. Concatenated design and decoding techniques are also considered.

EE 226. Wireless Communications. (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 215, EE 224. Presentation of fundamental cellular concepts and new techniques in wireless communications. Topics include cellular systems and standards, frequency reuse, system capacity, channel allocation, cellular radio propagation, fading channel modeling and equalization, spread spectrum communications and other multiple access techniques, and wireless networking.

EE 227. Spread Spectrum Communications (4) Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 115, EE 215; or consent of instructor. Provides an overview of spread spectrum communication techniques. Topics include direct sequence, frequency hopping and hybrid spread spectrum, pseudorandom sequence generation, modulation and spreading, code tracking, carrier synchronization, coherent and noncoherent data demodulation over fading channels, direct sequence multiple access, and performance evaluation of various multiuser detectors. Xu
**EE 228. Fundamentals of Data Compression (4)** Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): EE 215 (may be taken concurrently). Covers the fundamental theory and tools for designing data and signal compression systems. Topics include lossless coding, scalar quantization, predictive and transform coding techniques, vector quantization, and the general trade-off between the reproduction signal quality and the bit-rate of the digital representation. Provides a foundation for further study and research in speech, audio, image, and video compression.

**EE 229. Video Processing and Communication (4)** Lecture, 3 hours; laboratory, 1 hour; extra reading, 2 hours. Prerequisite(s): EE 150, EE 210. Covers the fundamental principles and technologies in the compression and transmission of coded video streams over wired and wireless networks, including wireless network protocols, compression standards, digital signal processor architectures, network or traffic management, quality of service, rate control schemes, and error resilience.

**EE 235. Linear System Theory (4)** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 132, Math 113. Provides a review of linear algebra. Topics include the mathematical description of linear systems; the solution of state-space equations; controllability and observability, canonical and minimal realization, and state feedback, pole placement, observer design, and compensator design.

**EE 236. State and Parameter Estimation Theory (4)** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 235 or equivalent. Covers autoregressive and moving-average models, state estimation and parameter identification (including least square and maximum likelihood formulations), observability theory, synthesis of optimum inputs, Kalman-prediction (filtering and smoothing), steady-state and frequency domain analysis, on-line estimation, colored noise, and nonlinear filtering algorithms.

**EE 237. Nonlinear Systems and Control (4)** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 235. Explores nonlinear systems and control. Topics include nonlinear differential equations, second order nonlinear systems, equilibrium and phase portrait, limit cycle, harmonic analysis and describing function, Lyapunov stability theory, absolute stability, Popov and circle criterion, input-output stability, small gain theorem, averaging methods, and feedback linearization.

**EE 238. Linear Multivariable Control (4)** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 235. Investigates multivariable feedback systems, stability, performance, uncertainty, and robustness. Topics include analysis and synthesis via matrix factorization; Q-parameterization and all stabilizing controllers; frequency domain methods, and H theta design; and structured singular value analysis.

**EE 239. Optimal Control (4)** Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 235, EE 215. Presents the theory of stochastic optimal control systems and methods for their design and analysis. Covers principles of optimization, Lagrange’s equation, linear-quadratic-Gaussian control; certainty-equivalence; the minimum principle; the Hamilton-Jacobi-Bellman equation; and the algebraic Ricatti equation.
EE 240. **Pattern Recognition (4)** Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): EE 141 or consent of instructor. Covers basics of pattern recognition techniques. Topics include hypothesis testing, parametric classifiers, parameter estimation, nonparametric density estimation, nonparametric classifiers, feature selection, discriminant analysis, and clustering.

EE 241. **Advanced Digital Image Processing (4)** Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): EE 152 or consent of instructor. Covers advanced topics in digital image processing. Examines image sampling and quantization, image transforms, stochastic image models, image filtering and restoration, and image data compression.

EE 242. **Intelligent Systems (4)** Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): Graduate standing or consent of instructor. Introduces fundamental concepts of design of intelligent systems. Topics include biological versus computational systems, knowledge representation, computational reasoning, computational learning, language and human-machine communication, expert systems, computational vision, and examples of intelligent machines.

EE 243. **Advanced Computer Vision (4)** Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): EE 146 or consent of instructor. A study of three-dimensional computer vision. Topics include projective geometry, modeling and calibrating cameras, representing geometric primitives and their uncertainty, stereo vision, motion analysis and tracking, interpolating and approximating three-dimensional data, and recognition of two-dimensional and three-dimensional objects.

EE 244. **Computational Learning (4)** Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): Graduate standing or consent of instructor. Explores fundamental computational learning techniques. Topics include elements of learning systems, inductive learning, analytic learning, case-base learning, genetic learning, connectionist learning, reinforcement learning and integrated learning techniques, and comparison of learning paradigms and applications.


EE 246. **Intelligent Transportation Systems (4)** Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): graduate standing or consent of instructor. EE 115 and EE 132 are recommended. Focuses on the control, communications, and computer aspects of intelligent transportation systems. Topics include traffic flow theory fundamentals, intelligent transportation system user services, travel and traffic management, advanced vehicle safety...
systems, intelligent transportation system applications, architectures, standards, strategic needs assessment and deployment, and evaluation.

EE 247. Current Topics in Computer Vision and Pattern Recognition (4) Lecture, 3 hours; outside research, 3 hours. Prerequisite(s): EE 240 or EE 243 or consent of instructor. Explores advanced mathematical techniques of recent research interest. Topics include particle filters, sampling techniques, stochastic optimization, stochastic approximation algorithms, independent components analysis, energy function techniques, nonlinear discriminant analysis, and support vector machines.

EE 250. Information Theory (4) Lecture, 3 hours; extra reading, 3 hours. Prerequisite(s): EE 215. An overview of fundamental limitations imposed on communication systems. Topics include Shannon's information measures, weak and strong typicality, lossless data compression, source and channel models and Shannon's coding theorems, channel capacity and the rate-distortion function, Gaussian sources and channels, and limits of communication between multiple terminals.

EE 251. Algorithmic and Combinatorial Coding Theory (4) Seminar, 2 hours; lecture, 2 hours. Prerequisite(s): EE 225 or consent of instructor. Explores combinatorial and algorithmic techniques in coding theory. Covers algebraic design of Bose-Chaudhuri-Hocquenghem (BCH) codes and Reed-Muller codes. Algorithmic topics include gradient-like decoding, split-syndrome techniques, and information-set decoding. Introduces decoding with polynomial complexity based on Bayesian estimation, iterative decoding, and codes on graphs. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

EE 259. Colloquium in Electrical Engineering (1) Colloquium, 1 hour. Prerequisite(s): Graduate standing. Lectures on current research topics in electrical engineering presented by faculty members and visiting scientists.

EE 260. Seminar in Electrical Engineering (4) Seminar, 4 hours. Prerequisite(s): Consent of instructor. Seminar on current research topics in electrical engineering, including areas such as signal processing, image processing, control, robotics, intelligent systems, computer vision, and pattern recognition.

EE 290. Directed Studies (1-6) Individual study, 3-18 hours. Prerequisite(s): Graduate standing; consent of instructor and Graduate Advisor. Individual study, directed by a faculty member, of selected topics in electrical engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 12 units.

EE 297. Directed Research (1-6) Outside research, 3-18 hours. Prerequisite(s): graduate standing; consent of instructor. Research conducted under the supervision of a faculty member on selected problems in electrical engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.
EE 298-I. Individual Internship in Electrical Engineering (1-12) Internship, 2-24 hours; written work, 1-12 hours. Prerequisite(s): graduate standing; consent of instructor. Provides the Electrical Engineering graduate student with career experience as an electrical engineer in an industry or a research unit. Includes fieldwork with an approved professional individual or organization and academic work under the direction of a faculty member. Requires a final report. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 12 units.

EE 299. Research for the Thesis or Dissertation (1-12) Outside research, 3-36 hours. Prerequisite(s): graduate standing; consent of instructor. Research in electrical engineering for the M.S. thesis or Ph.D. dissertation. Graded Satisfactory (S) or No Credit (NC). Course is repeatable.

Interdisciplinary Engineering Courses include:


Computer Science courses: Computer Networks (164), Modeling and Simulation (177), Advanced Computer Networks (204), Theory of Computation (215), Advanced Topics-Modeling and Simulation (237), Network Routing (240), Wireless Networks and Mobile Computing (257)

Chemical and Environmental Engineering: Transport Phenomena (202)

Mechanical Engineering: Nanoscale Science and Engineering (272)

Chemistry: Current Issues in Semiconductor Processing (208)

Physics: Nonlinear Optics (209B), Quantum Mechanics (221), Solid State Physics (240), Physics at Surfaces and Interfaces (242), Techniques of Microscopy (283), Surface Sciences (278), Theoretical Topics in Condensed Matter Physics (281), Optical Techniques for Measurements in Physics (284)

Interdisciplinary courses can be extended quarterly to broaden the students’ expertise and cover new emerging areas relevant to EE research.
IV. FACULTY PROFILES

This section presents information concerning the EE graduate faculty and their research interests, office numbers, phone numbers, and e-mail addresses.

A. EE DEPARTMENTAL FACULTY

Afshin Abdollahi
Assistant Professor
Ph.D., University of Southern California
Room 416 – EBU 2 827-6204
afshin@ee.ucr.edu
Quantum computation and quantum circuit synthesis, Nano-circuit fabrics and nano-technology, Logic synthesis and verification and low power design CAD methodologies.

Alexander Balandin
Professor and Graduate Advisor
Ph.D., University of Notre Dame
Room 435 - EBU2 827-2351
alexb@ee.ucr.edu
Electronic materials and devices, nanostructures and nanotechnology, nanoelectronic and quantum computer architecture, optoelectronics, noise in electronic devices, electromagnetics and antennas.

Matthew J. Barth
Professor
Ph.D., University of California, Santa Barbara
Room 342 - EBU2 827-2992
barth@ee.ucr.edu
Transportation Systems: transportation and emissions modeling, intelligent transportation systems (ITS), vehicle activity analysis, intelligent electric vehicles, intelligent sensing and control, mobile robot navigation. Robotics: active computer vision, panoramic sensing techniques, mobile robot navigation.

Gerardo Beni
Professor
Ph.D., University of California, Los Angeles
Room 321 - EBU2 827-6317
beni@ee.ucr.edu
Robotics, swarm intelligence, distributed systems, multimedia.

Bir Bhanu
Professor
Ph.D., University of Southern California
Room 219 - EBU2 827-3954
bhanu@shivish.ucr.edu
Computer vision, image processing, pattern recognition, machine learning, artificial intelligence,
robotics, multi-media databases, computer graphics and visualization, digital systems.

**Jie Chen**  
Professor  
Ph.D., University of Michigan  
Systems and control, system identification, robust control, linear multivariable systems theory, acoustic control.

**Ilya Dumer**  
Professor  
Ph.D., USSR Academy of Sciences  
Error-correcting codes, information theory, decoding algorithms.

**Jay Farrell**  
Professor and Undergraduate Advisor  
Ph.D., Notre Dame  
Adaptive and learning control, intelligent control, navigation, stability theory, autonomous systems.

**Susan Hackwood**  
Professor  
Ph.D., DeMontford  
Robotics, distributed sensing systems, color vision and integrated manufacturing.

**Yingbo Hua**  
Professor  
Ph.D., Syracuse University  
Blind channel identification, wireless communications, spectral estimation, signal processing, estimation and detection.

**Sakhrat Khizroev**  
Associate Professor  
Ph.D., Carnegie Mellon University  
Nanomagnetic Devices and Systems, Magnetic Memory, Data Storage Systems, Spintronics, NanoMagnetic Resonance Imaging (NMRI), and Focused Ion Beam Based Nanofabrication.

**Alexander Korotkov**  
Associate Professor  
Ph.D., Moscow State University
Single-electron tunneling, electron transport in semiconductors, quantum measurements.

**Roger Lake**  
Professor and Electrical Engineering Chair  
Ph.D., Purdue University  
Electron transport in nanostructures, modeling semiconductor devices, theoretical electronics and opto-electronics, ultra-scaled devices.  
Room 437 - EBU2  
827-2122  
rlake@ee.ucr.edu

**Ping Liang**  
Associate Professor  
Ph.D., University of Pittsburgh  
Image processing and analysis, medical image processing, pattern recognition, artificial neural networks, signal processing, pattern formation in distributed systems, decision support systems.  
Room 323 - EBU2  
827-2261  
liang@ee.ucr.edu

**Jianlin Liu**  
Assistant Professor  
Material growth, nano-fabrication and characterization, and device fabrication and characterization.  
Room 439 - EBU2  
827-7131  
Jianlin@ee.ucr.edu

**Ilya Lyubomirsky**  
Assistant Professor  
Fiber-optic and free-space optical communications, optical satellite systems, coherent optical receivers, optical propagation through atmospheric turbulence, and DSP-based equalization techniques.  
Room 431 - EBU2  
827-7701  
ilyubomi@ee.ucr.edu

**Mihri Ozkan**  
Associate Professor  
Ph.D., University of California, San Diego  
Bio-micromechanical-systems (Bio-MEMS) and Bio-Photonics for applications in bioengineering.  
Room 436 - EBU2  
827-2900  
mihri@ee.ucr.edu

**Amit Roy Chowdhury**  
Assistant Professor  
Computer vision and image processing, statistical pattern recognition, machine learning, video communication, imaging/non-imaging sensor networks, biological image processing.  
Room 322 - EBU2  
827-7886  
amitrc@ee.ucr.edu

**Sheldon Tan**  
Assistant Professor  
Computer-aided design for VLSI integrated circuits  
Room 424 - EBU2  
827-5143  
stan@ee.ucr.edu
with emphasis on design automation for mixed-signal/analog/RF circuits, embedded system based on FPGA platforms and signal integrity issues in deep sub-micron and nanometer VLSI designs.

**Ertem Tuncel**
Assistant Professor
Ph.D., University of California, Santa Barbara
Information theory, data compression, video coding, and content-based retrieval.

**Zhengyuan (Daniel) Xu**
Associate Professor
Ph.D., Stevens Institute of Technology
Blind system identification, spread spectrum communication, multiuser detection, and wireless communication networks.

**ADJUNCT FACULTY MEMBERS**

**Hossny El-Sherief**
Adjunct Professor
Ph.D., McMaster University
Digital signal processing, control systems, software engineering.

**Bahram Parvin**
Adjunct Professor
Ph.D., Purdue University
Computational bioimaging and informatics

**B. COOPERATING FACULTY MEMBERS**

**Guillermo Aguilar**
Assistant Professor, Mechanical Engineering
Ph.D., University of California, Irvine
Cryogen spray cooling, medical lasers and transport phenomena for biomedical applications.

**Ludwig Bartels**
Associate Professor, Chemistry
Ph.D. Freie Universität, Belin, Germany
Physical and chemical properties at the single-molecule level. Development of novel instrumentation capable of addressing and manipulating individual molecules at ever increasing resolution and reliability. Scanning Tunneling
Microscopy is the key instrument of my lab; other instrumentation includes Transmission Electron Microscopy, Femtosecond Laser Excitation and Thermally Programmed Desorption.

**Laxminarayan Bhuyan**
Professor, Mechanical Engineering  
Ph.D, Wayne State University  
Multiprocessor architecture; network processors; internet routers; web servers; parallel and distributed computing; performance evaluation.  
Room 441 - EBU2  
827-2347  
bhuyan@cs.ucr.edu

**Michalis Faloutsos**
Assistant Professor, Computer Science & Engineering  
Ph.D, University of Toronto  
Routing and QoS protocols for the Internet; multicasting; wireless-ad-hoc networks; measurement and modeling of real graphs; internet topology and power-laws.  
Room 332 - EBU2  
827-2480  
michalis@cs.ucr.edu

**Paulo Chagas**
Assistant Professor, Music  
Ph.D, University of Liège, Belgium  
Composer, theoretician and researcher in music technology.  
Room 138 – Arts Bldg.  
827-2939  
paulo.chagas@ucr.edu

**Dimitrios Gunopulos**
Assistant Professor  
Ph.D., Princeton University  
Data mining and knowledge discovery in databases; geospatial data; database indexing; design and analysis of algorithms; computational geometry.  
Room 324 - EBU2  
827-2479  
dg@cs.ucr.edu

**Robert Haddon**
Distinguished Professor, Chemistry  
Ph.D., Pennsylvania State University  
Data mining and knowledge discovery in databases; geospatial data; database indexing; design and analysis of algorithms; computational geometry.  
203 – Pierce Hall Annex  
827- 2044  
robert.haddon@ucr.edu

**Harry Hsieh**
Assistant Professor, Computer Science & Engineering  
Ph.D., University of California, Berkeley  
Automation of design technology for embedded computing systems; computer-aided formal methods for embedded system design.  
Room 339 - EBU2  
827-2030  
harry@cs.ucr.edu

**Qing Jiang**
Professor, Mechanical Engineering  
Ph.D., California Institute of Technology  
Mechanical properties of carbon nanotubes, mechanical behaviors of ferroelectric/piezoelectric materials and...
devices, acoustics and ultrasonics with applications in sensing and imaging.

**Tao Jiang**  
Professor, Computer Science & Engineering  
Ph.D., University of Minnesota  
Design and analysis of algorithms; computational molecular biology; bioinformatics; comparative genomics; approximation algorithms; average-case analysis; applications of Kolmogorov complexity.  
Room 336 - EBU2  
827-2991  
jiang@cs.ucr.edu

**Srikanth Krishnamurthy**  
Assistant Professor, Computer Science & Engineering  
Ph.D., University of California, San Diego  
Machine learning and information retrieval; techniques for solving similarity and indexing problems in time-series datasets.  
Room 334 - EBU2  
827-2348  
krish@cs.ucr.edu

**Keh-Shin Lii**  
Professor, Statistics  
Ph.D., University of California, San Diego  
Spectral analysis of spatial/temporal weather variations.  
2652 Stat Com Bldg  
827-3836  
ksl@ucrstat.ucr.edu

**Mart L. Molle**  
Professor, Computer Science & Engineering  
Ph.D., University of California Los Angeles  
Computer networking; performance evaluation; distributed algorithms; fundamental performance limits; applications of analytical modeling techniques to practical problems in computer systems.  
Room 331 - EBU2  
827-7354  
mart@cs.ucr.edu

**Walid Najjar**  
Professor, Computer Science & Engineering  
Ph.D., University of Southern California  
Computer architecture and parallel computing; compilation and code optimizations for reconfigurable computing systems; novel platforms and programming paradigms for sensor networks; low power computer architectures.  
Room 421 - EBU2  
827-4406  
najjar@cs.ucr.edu

**Cengiz Ozkan**  
Assistant Professor, Mechanical Engineering  
Ph.D., Stanford University  
Wafer fab processing, thin film mechanics and nanotechnology.  
A305 - Bourns Hall  
827-5016  
cozkan@engr.ucr.edu

**Thomas Stahovich**  
Professor, Mechanical Engineering  
Ph.D., Massachusetts Institute of Technology  
Design, Artificial Intelligence, pen-based computing, sketch-understanding, and man-computer interaction.  
A349 - EBU2  
827-7719  
stahov@engr.ucr.edu
Harry W. K. Tom  
Professor, Physics  
Ph.D., University of California, Berkeley  

Frank Vahid  
Assistant Professor, Computer Science & Engineering  
Ph.D., University of California, Irvine  
Hardware/software co-design functional partitioning, embedded systems.

Sundararajan Venkatadriagaram  
Assistant Professor, Mechanical Engineering  
Ph.D., University of California, Berkeley  
Manufacturing systems.

Junlan Wang  
Assistant Professor, Mechanical Engineering  
Ph.D., University of California, Irvine  
Nano and micromechanics of materials
V. EE FACILITIES

A. ELECTRICAL ENGINEERING TEACHING & RESEARCH LABORATORIES


Electrical Engineering Research Laboratories include: Distributed Robotics & Multimedia Lab, Communication Research Lab, Lab for Identification & Control, Laboratory for Terahertz and Terascale Electronics, Neural Networks & Pattern Recognition Lab, Nanostructure Materials and Device Research Lab, Robotics Research Lab, and the Visualization & Intelligent Systems Lab.

B. CENTER FOR RESEARCH IN INTELLIGENT SYSTEMS (CRIS)

The Center for Research in Intelligent Systems (CRIS) involves an interdisciplinary team of 18 UCR faculty members from seven departments, to promote research and development of autonomous/semiautonomous systems with sensing capabilities that are able to communicate and interact with other intelligent (biological and artificial) systems. These intelligent systems will be able to perform tasks that require understanding of the environment through knowledge, learning, reasoning and planning.

C. COLLEGE OF ENGINEERING - CENTER FOR ENVIRONMENTAL RESEARCH AND TECHNOLOGY

CE-CERT is a center for collaborative research by university, industry, and regulatory agencies on environmental problems. Founded in 1992, CE-CERT is housed in a 36,000 square-foot office and laboratory complex located two miles from the UCR campus in an industrial park. The laboratories at CE-CERT have been designed and developed to address air pollution and technology issues. Primary laboratories at CE-CERT include an atmospheric processes laboratory, vehicle emissions research laboratory, advanced vehicle engineering laboratory, environmental modeling laboratory, pollutant analysis laboratory, and stationary source evaluation laboratory. Each of these laboratories is a state-of-the-art test facility, and a number of the labs, especially the vehicle emissions research laboratory, contain equipment which is unique to a university research facility.
VI. MISCELLANEOUS INFORMATION

A. FACILITY ACCESS AND KEYS

EBU2 uses card access for most of the doors in the building. The “key” is the student ID card, “UCR Connection Card,” students receive when first registered at UCR. Card key access to general EE graduate student areas is granted to students when they first apply for a computer and e-mail account during the graduate student orientation. This access will be continuous as long as a student is in good academic standing.

Access to research laboratories must be requested on a quarterly basis by the faculty member supervising the specific research laboratory. The Department Chair grants access to instructional laboratories to TAs on a quarterly basis. If regular keys are required for a specific door, a written request, approved by the student’s Advisor and Department Chair, must be submitted to the Department Manager. A $5 deposit is required for each key, which is refunded when the key is returned. Replacement of damaged or lost cards is the responsibility of the students. Lost keys should be reported immediately to the Department Manager.

B. OFFICE AND DESK SPACE

The Academic Program Assistant assigns office and desk space, as available to full-time students. Preference is given to full-time students with teaching assistant appointments, full-time students with research assistant appointments, other full-time students, and finally part-time students, in that order. It may not be possible for every student to be assigned desk space.

C. MAIL

Incoming mail and intercampus notices may be picked up from mailboxes in the mailroom in Room 107 inside the TA room in EBU-2. Outgoing intercampus mail and official university mail can be deposited in the Departmental Suite in Room 343. Students should send and receive all personal mail (e.g. personal letters, bills, non-technical magazines) from their personal residences.

D. REMUNERATION AND DISBURSEMENT

Surepay statements or paychecks can be obtained at the reception desk in Room 343 EBU-2, usually after 10:30 a.m. on payday (the first business day of each month). Students employed by other departments should verify the disbursement location and time from the administrative office of the employing department. The Department of Electrical Engineering strongly encourages each employee to participate in the Surepay program. Should you desire a traditional paycheck, you will need to request a waiver and the paycheck
will be sent to your residence via U.S. Postal Service. It is incumbent upon the employee to ensure your local address is current in the Payroll/Personnel System (PPS).

E. TELEPHONE/FACSIMILE

Student offices and laboratories have telephone service, which is restricted either to the local calling area or to within UCR, although long distance calls can be received. If long distance calls of an official nature are required, they should be made through the Advisor’s phone and a charge slip completed.

Use of the facsimile (fax) machine is restricted to official university business only. Obtain your advisor’s consent and ask the department manager for permission to use the fax machine. You will need to complete the fax log upon completion of your transmittal.

F. PHOTOCOPYING

There is a photocopier in the mailroom in Room 343 EBU-2 that is available during regular office hours. Only graduate students copying material associated with their duties as a research or teaching assistant may use the photocopier. The copying of copyrighted material must be accomplished through the Printing & Reprographics department. This ensures prevention of infringement of intellectual property rights; royalties, patents and other commercial protection authors of various printed works are entitled.

Research or teaching assistants should submit a request to the reception desk in Room 343 EBU-2 for a copy access code. The request must first be approved by the student’s Advisor or TA faculty supervisor. Photocopy charges will be billed to the appropriate account.

PERSONAL PHOTOCOPYING, INCLUDING COPYING OF NOTES, HOMEWORK, EXAM SOLUTIONS, THESIS DRAFTS, TEXTBOOKS AND JOURNAL ARTICLES, NOT ASSOCIATED WITH RESEARCH OR TEACHING ASSISTANT DUTIES, IS NOT PERMITTED ON DEPARTMENTAL PHOTOCOPIERS. Commercial photocopy machines are located in the UCR Bookstore, Rivera Library, Science Library, and the Copy Service store in the Commons.

MACHINE SHOP

The machine shop facilities are located in the ground-floor of the laboratory wing of EBU2, Room B155. Students may borrow equipment and use certain machine tools with supervision and prior approval of Paul Stovall, ME Principal Mechanic. Such use is limited to research and is not for personal work.
G. SAFETY

Safety precautions shall be exercised, observed and complied with at all times. NO EXCEPTIONS! All employees are required to attend General Safety Orientation and may be required to attend Laboratory Safety Orientation depending upon duties and tasks performed. In addition, lab specific or task specific training may be required depending upon requirements of the laboratory assigned or employed. Students must become acquainted with all safety rules and procedures before working in the machine shop or laboratories. Dan Giles, is the department safety coordinator and can be reached at 2-2220 or dgiles@ee.ucr.edu.

H. COMPUTERS

Computers and a printer available for use by graduate students are located in the EE Computer Labs. In addition, there are a number of computer labs distributed around the UCR campus, including the Science Library. Students should register for E-mail and network accounts on the EE server when they first enroll for graduate studies. Registration forms and submittals can be obtained from the EE Program System Administrator in Room 109 at the EBU2.

Please check your email frequently, this is the primary method of information dissemination regarding deadlines, seminars, etc.

I. THESES AND DISSERTATIONS

Typing and submittal of a thesis or dissertation to the specifications of the Graduate Division is the responsibility of the student. See the Thesis & Dissertation Format Guide from the Graduate Division for specific information.

J. UNIVERSITY LETTERHEAD

The use of University letterhead is for official business only. See your advisor should you feel the use of letterhead is warranted.

K. DEADLINES

It is the responsibility of the student to submit the proper forms, paperwork, etc. on time to both the Department and the Graduate Division, and in all other respects satisfy the requirements for a degree as specified by the Department and the Graduate Division.
L. TIMETABLE TO FILE APPROPRIATE FORMS

1. M.S. Degree

- At the beginning of the quarter in which the student wants to graduate, the Application for Candidacy for Master of Science in the Field of Electrical Engineering form must be filled out and submitted to the Graduate Division. Due dates for this form are published in the quarterly Schedule of Classes. See appendix for form.

- Student should schedule the final defense of the thesis if he/she opted for Plan I. (the date does not have to be reported to Graduate Division when scheduled).

- Student should sign up to take the Comprehensive Exam if he/she opted for Plan II. If students had already taken the comprehensive exam at the time of advancement, results of the exam should be reported on the Application for Candidacy.

- Student should report the result of thesis defense immediately following the event by using the Report of Final Defense for Master’s Degree. See appendix for form.

- Students in Plan I - Thesis option should bring the draft of the thesis to Graduate Division for format review.

- Student should file final copies of thesis with Graduate Division (on or before the last day of the quarter.)

2. Ph.D. Degree

- Student must pass the Preliminary Examination to advance towards a Ph.D. degree.

- Students should nominate Oral Exam Committee by completing and submitting the Nomination for Qualifying Examination for the Degree of Doctor of Philosophy (Form 2) to Graduate Division for Dean’s approval. See Appendix for form.

- Student should take the Oral Exam and report the result to the Graduate Division for Dean’s approval. Student should also nominate the Dissertation Committee by completing the Report on Qualifying Examination for the Degree of Philosophy & Nomination of Dissertation Committee (Form 3). See appendix for form.

- The Report of Departmental Requirements for Ph.D. Degree form should be filled out and sent to the Graduate Division for students to advance to candidacy (this form should be filed before or along with form 3.) See appendix for form.

- Student should schedule the final Defense of Dissertation (date does not have to be reported to Grad Division when scheduled.)

- Student should report the result of Final Defense to Graduate Division for Dean’s approval by submitting the Report on Final Examination for the Degree of Doctor of Philosophy (Form 5). See appendix for form.

- Student should bring draft of dissertation to Graduate Division for format review.

- Student should file final copies of dissertation with Graduate Division (on or before last day of the quarter.)
VII. PROFESSIONAL SOCIETIES

Listed below are a number of professional associations related to the Electrical Engineering field. In addition, a variety of journals are listed which publish current research articles in the EE areas of study. Many of the associations or journals have student membership rates. The reduced fees provide you with an excellent opportunity to join these professional societies or to purchase the journals.

A. ASSOCIATIONS

American Physical Society (APS)
The Institute of Electrical and Electronics Engineers, IEEE
IEEE Societies & Technical Councils
IEEE Aerospace and Electronic Systems Society
IEEE Antennas and Propagation Society
IEEE Broadcast Technology Society
IEEE Circuits and Systems Society
IEEE Communications Society
IEEE Components Packaging, and Manufacturing Technology Society
IEEE Computer Society
IEEE Consumer Electronics Society
IEEE Control Systems Society
IEEE Dielectrics and Electrical Insulation Society
IEEE Education Society
IEEE Electromagnetic Compatibility Society
IEEE Electron Devices Society
IEEE Engineering Management Society
IEEE Engineering in Medicine and Biology Society
IEEE Geoscience & Remote Sensing Society
IEEE Industrial Electronics Society
IEEE Industry Applications Society
IEEE Information Theory Society
IEEE Intelligent Transportation Systems Council
IEEE Instrumentation and Measurement Society
IEEE Lasers & Electro-Optics Society
IEEE Magnetics Society
IEEE Microwave Theory and Techniques Society
IEEE Nuclear and Plasma Sciences Society
IEEE Neural Networks Council
IEEE Oceanic Engineering Society
IEEE Power Electronics Society
IEEE Power Engineering Society
IEEE Professional Communication Society
IEEE Reliability Society
IEEE Robotics & Automation Society
IEEE Signal Processing Society
IEEE Society on Social Implications of Technology
IEEE Solid - State Circuits Society
IEEE Systems, Man, and Cybernetics Society
IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society
IEEE Vehicular Technology Society
B. JOURNALS

ACM Transactions in Graphics
Advances in Artificial Intelligence Research
Advances in Computer Vision
Applied Physics Letters
Artificial Intelligence
Bulletin of Informatics and Cybernetics
Cognition and Brain Theory
Cognitive Science
Computer and Control Abstracts
Computer Vision, Graphics, and Image Processing
Current Industrial Reports, SMT, Manufacturing Technology
CVGIP, Graphical Models and Image Processing
CVGIP, Image Understanding
Cybernetics
Engineering Cybernetics
IEEE Expert
IEEE Journal of Robotics and Automation
IEEE LCS
IEEE Transactions on Acoustics, Speech, and Signal Processing
IEEE Transactions on Aerospace and Electronic Systems
IEEE Transactions on Aerospace and Navigational Electronics
IEEE Transactions on Antennas and Propagation
IEEE Transactions on Audio
IEEE Transactions on Audio and Electroacoustics
IEEE Transactions on Automatic Control
IEEE Transactions on Bio-Medical Engineering
IEEE Transactions on Broadcast and Television Receivers
IEEE Transactions on Broadcasting
IEEE Transactions on Circuit Theory
IEEE Transactions on Circuits and Systems
IEEE Transactions on Communications
IEEE Transactions on Component Parts
IEEE Transactions on Components, Hybrids, and Manufacturing Technology
IEEE Transactions on Computers
IEEE Transactions on Consumer Electronics
IEEE Transactions on Education
IEEE Transactions on Electrical Insulation
IEEE Transactions on Electromagnetic Compatibility
IEEE Transactions on Electron Devices
IEEE Transactions on Engineering Management
IEEE Transactions on Geoscience and Remote Sensing
IEEE Transactions on Geoscience Electronics
IEEE Transactions on Industrial Electronics
VIII. IMPORTANT DATES

Orientation:
Monday, September 18, 2006 (11 am)

Preliminary/Comprehensive Examinations:

Fall 2006 - December 9, 2006 (9 am)

Spring 2007 - June 9, 2007 (9 am)
IX. APPENDIX
APPLICATION FOR CANDIDACY FOR MASTER OF SCIENCE
IN THE FIELD OF ELECTRICAL ENGINEERING

Students must obtain required signatures before filing application. Candidates must be registered or using filing fee in quarter in which the degree is to be awarded.

NAME Mr./Ms. __________________________ SID __________________________

Print Name as It Appears on Official Record (First, Middle, Last)

PRESENT ADDRESS ______________________________________________________

FUTURE ADDRESS: as of: ___________________________________________________

DEGREES RECEIVED (Dates/Institutions/Locations): ______________________________

________________________________________________________________________

EXPECTED DEGREE DATE: December 20_____; March 20_____; June 20_____; August/Sept. 20_____

STUDENT SIGNATURE ______________________________________________________

By signing this application, I give UCR permission to publish my name and degree information in official campus Commencement publications. Check the box below if you do not wish to have your name published.

☐ I do not wish to have my name and degree information published in official campus Commencement publications.

Plan I (Thesis) – TITLE OF THESIS __________________________________________

________________________________________________________________________

THESIS COMMITTEE RECOMMENDATIONS (Attach memo of support for Non-Academic Senate members):

1. __________________________________ 2. __________________________________ 3. __________________________________

(Chair)

Approved for plan and title of thesis: ______________________________ Committee Chair Signature

Plan II (Comprehensive Exam)

Master’s Level Examination:

Date Taken __________________________ (_____ ) Pass (_____ ) Fail

Do Not Write Below This Line

Requirements to be completed Prior to Degree Conferral:

Residence (3qtrs) _________ GPA _______

Courses Required: 100 200 24/18 Total 36

Courses Completed: 100 200 Total

Courses in Progress: 100 200 Total

To Be Completed: 100 200 Total

Date Thesis Filed: __________________________

Final Defense Date: ____________

Advancement Date: __________________________
I. Admission Deficiencies (if any were present at time of admission, please indicate how they were met): ________________

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Units</th>
<th>Quarter Taken or to be Taken</th>
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</table>

II. List all upper division courses (125 and above) completed or to be completed which are applicable to the degree:

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TOTAL __________

III. List all graduate courses (200 series) completed or to be completed in the major which are applicable to the degree. Plan I - 24 graduate units required, no more than 12 units of 297 or 299 may be used. Plan II – 18 graduate units required (297 and 299 may not be used to fulfill this requirement), maximum of 6 units of 290 may be used.

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TOTAL __________

Graduate Advisor's Signature ________________ Date __________

8/03 (EleEng-MS)
REPORT OF FINAL DEFENSE FOR
MASTER’S DEGREE

To be presented to the Graduate Division prior to filing thesis.

Student: ____________________________  Student ID: ______________

This is to certify that the above student has completed and passed the final defense
of his/her master’s thesis _______________ on _____________.

Date

__________________________
Thesis Chairperson or Graduate Advisor
Nomination for Qualifying Examination for the Degree of Doctor of Philosophy
This form must be filed at least two weeks (preferably one month) prior to the oral examination.

NAME OF CANDIDATE _____________________________________________________________

ADDRESS ___________________________________________ SID ____________________

DEPARTMENT ___________________________ FIELD OF STUDY ___________________

To the Dean of the Graduate Division:
The student named above is ready to proceed to the Qualifying Examinations for the degree of Doctor of Philosophy. The subjects upon which the student is to be examined are: ________________

The department nominates the following persons to serve as the qualifying committee for the examination which will be held: ____________________________________________ *

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<tr>
<th>Name</th>
<th>Department Affiliation and Academic Title**</th>
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<tr>
<td>Chairperson</td>
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<td>Outside Member</td>
<td>Department</td>
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*If exact date of exam is not indicated or changes, the Graduate Division is to be informed not less than 24 hours before the oral examination is held.

**Indicate departmental affiliation if nominee is not in student’s department; indicate academic title if nominee is not an Academic Senate member.

Approved: ___________________________ Department Chairperson or Graduate Advisor ___________________________ Date

Approved: ___________________________ Dean of the Graduate Division ___________________________ Date
REPORT OF DEPARTMENTAL REQUIREMENTS FOR THE PH.D. DEGREE
IN THE FIELD OF ELECTRICAL ENGINEERING

This is to certify that SID ___________________________ has completed all departmental or program degree requirements as stated below:

I. Admission Deficiencies (if any were present at time of admission, please indicate how they were met): ______

II. Course Work (a minimum of 36 units of graduate level and upper division courses exclusive of seminar and research is recommended)

   A. Major Area of Study (at least 24 units recommended):

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<th>Course #</th>
<th>Quarter</th>
<th>Grade</th>
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   B. Minor Area of Study (at least 12 units recommended):

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I. T.A. Service (three quarters recommended):

   Quarter   Grade
   EE301      ________  ________

   Course ___________________________   Quarter/Year _______________________
   Course ___________________________   Quarter/Year _______________________
   Course ___________________________   Quarter/Year _______________________

II. English as a Second Language (non-native speakers ONLY)

   TAST test date _________   score (23 = clear pass) _________
   SPEAK test date _________   score (50 = clear pass) _________

   Signature of Graduate Advisor ___________________________   Date __________
REPORT ON QUALIFYING EXAMINATION FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY & NOMINATION OF DISSERTATION COMMITTEE

NAME OF CANDIDATE

ADDRESS _____________________________________________ S I D _________________

DEPARTMENT ________________________________________ FIELD OF STUDY ____________

To the Dean of the Graduate Division:

The qualifying committee in charge reports that the candidate has been given a series of qualifying examinations
(oral and written), the last of which was completed on:

Date of Written ___________________________ Date of Oral ___________________________

The committee reports on these examinations as follows:

Members (type or print names)  Signatures of Members  Approved (Y/N)

____________________________________  ______________________________  __________
Chairperson

____________________________________  ______________________________  __________

____________________________________  ______________________________  __________

____________________________________  ______________________________  __________

____________________________________  ______________________________  __________

Outside Member

Date: ___________________________  Accepted: __________________________________________

Dean of the Graduate Division  Date

The finding of the committee must be reported within 48 hours to the Graduate Division.

Re-examination in the event of failure:

Recommended: ___________________________  Permitted: ___________________________

Signature of Committee Chair  Graduate Dean  Date

Not Recommended: ___________________________  Accepted: ___________________________

Signature of Committee Chair  Graduate Dean  Date

The department nominates the following persons to serve as the dissertation committee: (this committee should be
appointed at the time the exams are reported – must report at least the chair of the committee to be advanced to candidacy)

____________________________________
Chairperson

____________________________________  Department Chairperson or Graduate Advisor

____________________________________  Approved: Graduate Dean  Date

5/01
Report on Final Examinations for the Degree of Doctor of Philosophy

Name of Candidate: ________________________________

Address: ______________________________________

Dissertation Title: ________________________________

Major: ___________________ SID: ________________

To the Dean of the Graduate Division:
The Committee in charge of the dissertation and final examination reports upon the candidate’s final examination on ___________ as follows:

<table>
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<tr>
<th>Date</th>
<th>Exam Passed (Yes or No)</th>
<th>Exam Waived** (Yes or No)</th>
<th>Signatures of Members</th>
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Accepted: ____________________________________________ Date ________________

Dean of the Graduate Division

** Report of final examination waiver MUST be accompanied by a memo of justification from the chair of the dissertation committee.