Mechanical Engineering Graduate Student Handbook 2016-2017

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I. GENERAL INFORMATION

A. INTRODUCTION

The Department of Mechanical Engineering (ME) at the University of California, Riverside (UCR) offers the opportunity for graduate study in specialized areas of Mechanical Engineering. The information contained in this manual is intended to assist ME graduate students. Other relevant information may be found in:

- *UCR General Catalog*
- *Graduate Student Handbook, Graduate Division*
- *Thesis and Dissertation Format Guide, Graduate Division*
- *Policies and Regulations Governing Graduate Student Employment, Graduate Division*
- *Financial Support Regulations, Graduate Division*
- *UCR Graduate Division Website (www.graddiv.ucr.edu)*

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 listed in these various sources, the more rigorous requirements must be satisfied.

In addition to degree requirements, ME policies and procedures are summarized in this manual. ME graduate students should carefully review this document and become familiar with the information so that they may avoid possible difficulties during their graduate studies. 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 ME graduate program must be approved by the ME Graduate Advisor and the Dean of the Graduate Division. To be approved for admission, an applicant to the graduate program should have a B.S. degree in engineering with a grade point average above 3.0 (based on a 4.0 point system), a combined (verbal and quantitative) GRE score above 1100 or above 300 (new scoring method since 08/2011) and good supporting reference letters. Students from non-English speaking countries also must receive a minimum TOEFL score of 550 (paper based), 213 (computer based), and 80 (internet based). Students with undergraduate degrees of outside of engineering, who meet the above criteria, may be required to complete remedial undergraduate course work before being granted official admission into the ME graduate program. This remedial work may not be used to satisfy graduate degree requirements.

C. FINANCIAL ASSISTANCE

Research and teaching assistantships are awarded on a competitive basis to students with outstanding qualifications. The salary for such awards ranges from $8,195 to $18,000 per academic year. The assistantships are contingent upon annual appropriations, and typically include payment of the Graduate Student Health Insurance **(GSHIP)** fee and a Partial Fee Remission **(PFR)**. Non-resident students receiving an assistantship may also receive a partial or full non-resident tuition remission. Typically, teaching and research assistantships are awarded on an annual basis. Assistants are expected to aid faculty members in the instructional or research programs for 20 hours per week.

Applicants and enrolled students may apply for fellowships. These provide a stipend up to approximately $16,000 per year and include full or partial payment of tuition and fees. To maintain their fellowship, students are expected to maintain a minimum GPA of 3.0 and be enrolled and complete at least 12 units.

The ME department selects and administers teaching assistants (TAs). Faculty members select graduate student research assistants (GSRs). Faculty members also consult with the Graduate Advisor and Graduate Student Affairs Assistant concerning the availability of qualified students seeking support.

Normally, teaching assistantships are awarded to entering graduate students. M.S. students are generally limited to one year as TAs; Ph.D. students are limited to two years as TAs.

To be appointed as a TA, a student whose native language is not English must pass the SPEAK test. This includes international students and students whose first language is not English. The purpose of the SPEAK test is to evaluate spoken English proficiency and to measure student comprehensibility in English. The SPEAK test is administered by the Learning Center when the student first arrives on campus. Ratings based on SPEAK test scores are as follows:

Clear pass:	50
Conditional Pass	40-45
No Pass:	35 or below

Those who score a conditional pass can be appointed as a TA but are required to participate in the appropriate English language classes at the Learning Center and to retake the test. Individuals in this range may be appointed as TAs for up to three quarters (four under unusual circumstances) on a probationary basis with the approval of the Graduate Dean. At the end of this time, students may no longer be required to take English classes or retake the test. For those students within the probationary range, a determination of their continuing eligibility to serve as TAs will be made by the Graduate Dean 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.

Appointments for students who have not achieved a clear pass on the SPEAK test will only be approved for one quarter at a time so that their progress on the SPEAK test can be monitored. If a student does not participate in the ESL program and the student wants to be tested again, the Learning Center requires proof the student has done something that quarter to improve their English skills.

Students who fail the SPEAK Test can be appointed to a Reader title. Although they may not be involved in the classroom, they may conduct activities such as grading.

Please note that the ME department will pay for the first SPEAK test of a student. Students who need to retake the SPEAK test are responsible for paying for their own fees until they have received a Clear Pass. The Graduate Division will also pay for the first ESL course fee. Students who need to retake the ESL course are responsible for paying their own fees.

TAs do not need to turn in a timesheet at this time. However, they must report to the instructor for whom they are performing their teaching assistant duties for and/or inform the ME Administrative Office staff specifically, Paul Talavera, if an emergency arises and they cannot fulfill their TA duties.

D. ADVISEMENT

Upon admission to the ME graduate program by the Graduate Division, each student is assigned a preliminary faculty advisor (generally the Graduate Advisor) to help him/her 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 should select a permanent degree advisor. This advisor becomes, in effect, the chairperson of the student's M.S. or Ph.D. committee(s). Descriptions of these committees are given in the Degree Requirements section elsewhere in this manual.

Graduate study is individual in nature and requires frequent interaction of the student with his/her advisor. The degree 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. An advisor may be also assist and advise in non-degree related matters such as health services, housing, communication deficiencies, and career development.

E. ENROLLMENT

Students are allowed to enroll in core courses via **GROWL** but must fill out a Quarterly Advising form available on the ME website: http://www.me.ucr.edu/graduate/glinks.html and have it signed by their advisor and/or the Graduate Advisor. This needs to be turned into

Paul Talavera, the Graduate Program Assistant, before you enroll in any core course in **GROWL.**

Enrollment in ME 250, ME 290, ME 297, and ME 299 must be done by the Graduate Program Assistant. In addition, students may not enroll in any undergraduate courses or any courses from a different department without the prior approval of the Graduate Advisor. Once you have obtained this permission via the quarterly advising form, Paul Talavera, the Graduate Program Assistant, will coordinate your enrollment with the other department's program assistant.

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. Late enrollment will result in the delay of fellowship fee payment as well as a $50 late fee.

F. SEMINARS

Students enrolled in ME 250, Mechanical Engineering Seminar, are expected to attend **all** department seminars. It is MANDATORY for M.S students to enroll in at least 3 units (3 quarters) of ME 250 and for Ph.D. students to enroll in at least 6 units (6 quarters) of ME 250 before they are eligible for graduation. It is preferred that this is done in the initial years of study. Seminar announcements are posted on Departmental bulletin boards, on the ME website, and are sent via e-mail.

G. MISCELLANEOUS INFORMATION

1. Card Access and Keys

Bourns Hall uses card access for most of the doors in the building. The "key" is the student ID card, the "R'Card". Card key access to general ME 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 must be submitted to the BCOE Dean's office.

2. Office and Desk Space

Office and desk space, if available, is assigned to full-time students by the Department Chair. Preference is given to full-time students with teaching assistantships, full-time students with research assistantships, 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.

3. Mail

Incoming mail and intercampus notices may be picked up from mailboxes in the mailroom, A304 Bourns Hall. Outgoing intercampus mail and official university mail can be deposited in the main office, A342. Students should send and receive all personal mail (e.g. personal letters, bills, non-technical magazines) from their personal residences.

4. Paychecks

Paychecks or surepay receipts for teaching and research assistants can be obtained from the Graduate Program Assistant, Paul Talavera, in A342 Bourns Hall, usually after 10:30 a.m. on payday (the first day of the each month).

5. Telephone

Student offices and laboratories have phone 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. Personal calls should be made at one of the pay phones located throughout Bourns Hall.

6. Copying

There is a Department copier in the grad student TA & mailroom in A318 Bourns Hall, which is available during regular office hours. <u>This copier may only be used by graduate students copying material associated with their duties as a research or teaching assistant.</u>

Research or teaching assistants should submit a request to the Department's Assistant in A342 Bourns Hall for a copy access code. The request must first be approved by the student's advisor or TA faculty supervisor and the Graduate Student Affairs Officer. Copy charges will be billed to the appropriate account.

PERSONAL COPYING, INCLUDING COPYING OF NOTES, HOMEWORK OR EXAM SOLUTIONS AND JOURNAL ARTICLES NOT ASSOCIATED WITH RESEARCH OR TEACHING ASSISTANT DUTIES, AS WELL AS THESIS DRAFTS, IS NOT PERMITTED ON DEPARTMENTAL COPIERS.
** Public copy machines are located in the UCR Bookstore, Rivera Library, Science Library, and the Copy Service store in the Commons.

7. Bulletin Boards

Bulletin boards are maintained in a variety of locations within Bourns Hall as well as Engineering Building Unit II. Seminar announcements, contest announcements, job openings meeting notices, and other general information of interest will be posted on these bulletin boards. Students should view these boards often to remain informed of upcoming events and opportunities. Some announcements will also be sent via e-mail.

8. Machine Shop

The machine shop facilities are located in the ground floor of the laboratory wing of Bourns Hall, room B155. Students may borrow equipment and use certain machine tools with supervision and prior approval of the Principal Mechanician or Machine Shop Manager. Such use is limited to research and is not for personal work.

In order to work in the shop, students must have completed the UCR's EH&S online Safety Laboratory training, review and sign the Machine Shop Chemical Hygiene Plan, and must pass the basic shop safety test. To use the lathe and the mill, students must complete the training and pass the test. Students are required to wear a name badge while working in the shop. Student's UCR ID card will be needed to insert it into the plastic name badge holders provided at the shop entrance.

If you require machining work from the Principal Mechanician or Machine Shop Manager, you will need to complete a requisition form so that we can track the actual progress of work in the shop.

Afterhours Access to the Shop: If you have been certified and have afterhours access, you will need to review and sign the Machine Shop's Chemical Hygiene Plan.

9. Safety

Safety precautions should be followed at all times. Students must complete all the required EH&S training session for their lab and area of specialization. EH&S: http://ehs.ucr.edu/

10. Computers

Computers and a printer available for use by graduate students are located in the ME Computer Lab, B207 Bourns Hall. 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 ME server when they first enroll for graduate studies. Registration forms and submittals can be obtained from the Program System Administrator.

11. Thesis 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.

12. Use of University Letterhead

University letterhead paper should not be used by Graduate Students for correspondence unless it is for official business authorized by the advisor.

13. 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.

H. KEY CONTACT PERSONNEL

The administrative suite is located in A342 Bourns Hall. A listing of key contact personnel in the ME Department and the College of Engineering with whom graduate students may interact is given below.

Guillermo Aguilar, Professor and Chair, A329 Bourns Hall, 951.827.5830, gaguilar@engr.ucr.edu

Suveen Mathaudhu, Assistant Professor and Graduate Advisor, A345 Bourns Hall, 951.827.2445, marko@engr.ucr.edu

Paul Talavera, Graduate Student Affairs Officer, A342 Bourns Hall, 951.827.2115 paul@engr.ucr.edu

Susana Aparicio, Department Manager, Financial & Administrative Officer, A335 Bourns Hall, 951.827.2409, susana@engr.ucr.edu

Robert Godoy, Contracts & Grants Analyst, A337 Bourns Hall, 951.827.2417

Louis Sandoval, Purchasing/Personnel Assistant, A342 Bourns Hall, 951.827.5830, rgodoy@engr.ucr.edu

Machine Shop, B155 Bourns Hall 951.827.2897

John Cleary, Program System Administrator, A308/ A344 Bourns Hall, systems@engr.ucr.edu

II. AREAS OF STUDY AND DEGREE REQUIREMENTS

A. AREAS OF STUDY

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

- *Acoustics and Stress Waves*
- *Air Quality Modeling*
- *Biomedical Devices*
- *Computational Mechanics*
- *Combustion and Fire Behavior Modeling*
- *Cyber-physical systems*
- *Human-Machine Systems*
- *Mechanics and Materials*
- *Porous Media Heat Transfers*
- *Nanostructured Materials*
- *MEMS & BioMEMS*
- *Sensors and Sensor Networks*
- *Engines, Emissions, Nanoparticle Science*
- *Nanoscale Heat Transfer*
- *Micro/Nano Fabrication*
- *Physical Metallurgy*

Graduate study and research programs can be designed to allow for study in two or more related areas, specialization in one area, or for some other specialized or newly evolving areas of Mechanical Engineering. Students choose their areas of research in consultation with their advisor. Typical programs and course requirements the areas listed above are given in Part III of this manual. Proposed M.S. and Ph.D. programs for other emphases must be approved by the Graduate Committee and must include applicable basic core courses prescribed by the ME Department.

B. ME GRADUATE PROGRAM POLICIES

1. Transfer of Credits Taken at Other Universities

Petitions to the Graduate Division for transfer of credits will be considered by the Graduate Committee when the work is necessary to fulfill graduate degree requirements.

The total number of units that a student will be allowed to transfer into their graduate record at UCR from institutions from non-UC campuses is eight (8) quarter credits. These units must have been taken in graduate status in an institution of recognized standing with a grade of "B" or better and cannot be used to reduce the minimum residency requirement or minimum requirement of 200 series courses taken at UCR.

Credit for graduate work completed at other UC campuses may be granted in excess of the eight units. Up to one-half of the units required for a Master's degree may be transferred from other UC campuses including 200 series unit requirements. Students receive both units and grade point for this work when it is transferred to UCR. Approval from both the Graduate Committee and the Graduate Division must be obtained before such units can be accepted for credit.

2. 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. Graduate Students must be doing work equivalent to letter grading of B to be given an S grade in a class. A UCR course taken during graduate status in which a grade of C- or better is earned may be accepted in partial satisfaction of the degree requirements if the student has a grade point average 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 that are taken while registered in graduate status. A grade point average below the B level (3.0) is not satisfactory, and a student whose grade point average is below that level is subject to academic disqualification.

Individual study and research, or other individual graduate work undertaken by a Graduate Student, is normally evaluated by means of the grades Satisfactory/No Credit. No academic work applicable to a graduate program may be graded S/NC unless the course descriptions so indicate. Undergraduate course, which are pure electives, that is, which do not have any significant relationship to the graduate program, may be taken S/NC with the approval of the Graduate Dean. Such courses do not count towards the student's degree objective. A grade of S is equivalent to a grade of B (3.0) or better. No credit is given for a course in which a grade of NC is assigned.

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 grade point average, they are an important factor in evaluating academic progress. Students may not be employed as TA's, GSR's, Teaching Fellows, or Associate-Ins 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 or NC. An advanced degree cannot be awarded if there is an Incomplete on the student's record.

3. Student Progress

Students are considered to have made insufficient progress if:

1. They have 12 or more units of "I" grades (incomplete course work) outstanding
2. The overall GPA falls below 3.00. Students with a GPA of less than 3.00 will be placed on probation.
3. The quarterly GPA falls below 3.00 for two consecutive quarters
4. They fail to fulfill program requirements such as examinations or research in a timely and satisfactory manner, or
5. They have not completed their programs within one year after reaching normative time or
6. They fail to pass comprehensive or qualifying exams in two attempts or
7. They fail to make progress in research for two consecutive quarters

4. Normative and Maximum Time Limits for Degree

The normative time for a student to complete the M.S. degree under either Plan I or Plan II is six (6) quarters.

The suggested time allotments for an M.S. student, entering the program with a Bachelors degree are given below:

- Nine months, or 3 academic quarters for M.S. coursework;
- Nine months, or 3 academic quarters to formulate research plan and complete dissertation.

Full-time, self-funded students may be able to complete these requirements earlier.

Although the formal residence requirement of the Ph.D. degree is six quarters (two academic years), most student spend three to four years (nine to twelve academic year quarters) in full-time study beyond the Master's degree. The normative time to complete the Ph.D. degree for a typical student appointed as an RA or TA (50% time) may vary from 3 to 4 years (9-12 quarters) for students holding an M.S. degree in Mechanical Engineering, or a closely related field, and 4-6 years (12-18 quarters) for those entering the program without an M.S. degree in Mechanical Engineering or a closely related field.

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

The M.S. degree in Mechanical Engineering can be earned by either one of two plans:

1. by completion of a thesis (Plan I), which reports a creative investigation of a defined problem
2. by passing a comprehensive examination (Plan II).

For the M.S. degree, students must meet a minimum residency requirement of three quarters, one complete academic year, in the University of California. At least two of these three quarters must be spent at UCR. Registration in at least 4 units of 100 or 200 level course work is necessary for each quarter of academic residence. Students should enroll in 12 units each quarter unless the Graduate Advisor grants an exception.

1. Master of Science Plan I (Thesis)

The M.S. degree Plan I (Thesis) requires completion of a minimum of 36 units of upper-division and graduate-level approved course work and submission of an acceptable thesis. At least 24 of these units must be in graduate courses (200-series courses), a minimum of 16 units of these being Mechanical Engineering graduate courses (ME 200 or higher, excluding ME 250, ME 290, ME 297, and ME 299). The student must take 3 units of seminar (ME 250) and at least 7 but no more than 11 units of directed or thesis research credits (ME 297 or ME 299). No more than 8 units of course work may be satisfied with directed studies (ME 290). Students must defend a thesis

Course work used to satisfy the student's undergraduate degree requirements may not be applied toward the 36 unit M.S. requirement. However, UCR Undergraduates who have no more than two courses or eight units of course work remaining in their Bachelor Degree program, 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 studies requires that students inform their college offices before beginning the course work in question. After entering the graduate program, these students may petition to transfer these units to their graduate record. These units cannot have been used towards the Bachelor's Degree.

An acceptable M.S. thesis must be submitted. The M.S. thesis may be based on:

- a research or advanced design project, either analytical, computational or experimental;
- an extensive report consisting of theoretical, computational or experimental contribution to mechanical engineering.

The student's M.S. Thesis Committee is responsible for approving the thesis. The thesis committee is composed of three members (including the research advisor).

After submission of the M.S. thesis, the student is required to defend the thesis in a defense.

An abstract and title should be submitted to the Graduate Assistant at least 9 days prior to the scheduled defense so that it can be advertised to the public for a period of at least one week. No exceptions will be made for late abstracts.

The student will then modify the thesis based on comments received during the defense. Upon approval, two unbound copies of the final thesis in a format compatible with the guidelines set forth by the Graduate Division must be submitted to the Graduate Division.

2. Master of Science Plan II (Comprehensive Exam)

The M.S. degree, Plan II (Comprehensive Examination) requires completion of a minimum of 36 units of upper-division and graduate-level approved course work and successfully passing a comprehensive examination. At least 24 of these units must be in graduate courses (200 series courses), a minimum of 16 of these being Mechanical Engineering graduate courses (ME 200 or higher, excluding ME 250, ME 290, ME 297, and ME 299). The student must take 3 units (ME 250) and no more than 7 units of directed studies (ME 290). One additional 4 unit course is required for completing the requirements of the MS Plan II.

Course work used to satisfy the student's undergraduate degree requirements may not be applied toward the 36 unit M.S. requirement. However, UCR undergraduates who have no more than two courses or eight units of course work remaining in their bachelor degree program, and who have been changed 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 studies requires that students inform their college offices before beginning the course work in question. After entering the graduate program, these students may petition to transfer these units to their graduate record. These units cannot have been used towards the Bachelor's Degree.

The M.S. Comprehensive Examination will be prepared and administered by the Graduate Examination Committee. The comprehensive examination covers a broad range of topics chosen from upper-division and graduate courses the student has taken. This examination is prepared and administered by the graduate program committee. The examination is held in the spring quarter and summer of every year.

Subsequent to the examination, the Graduate Examination Committee will issue a passing or failing grade. If a student fails in the first attempt, he or she may retake the examination at the next scheduled comprehensive examination period. No more than two attempts to pass the exam are allowed.

The exam in each subject takes two hours. Students will be notified about permitted material such as calculators and hand-written notes as specified by the examiners.

Notes:

1. A student, who plans to take the M.S. comprehensive exam, must submit a formal request to the Graduate Program Assistant by the deadline announced by the Graduate Program.
2. The Graduate Committee will review the exams in a timely manner and make recommendations for ME Faculty's approval.
3. Students are recommended to take the ME graduate and undergraduate courses offered during the Fall and Winter quarters to prepare for the exam.

The list of the exam areas (Note: More areas will be added as the Faculty grows in the future):

1. **Control Systems (course: ME120):**
    a. Laplace transform and solution of ODEs
    b. Transient and stationary response of 1st and 2nd order systems
    c. Linearization
    d. Poles/Zeros, Bode plots, Nyquist diagrams, root locus
    e. PID control
    f. State-space representation of dynamical systems
    g. Linear algebra

    Suggested reading: Katsuhiko Ogata, Modern Control Engineering.

2. **Dynamics (course: ME103)**
    a. Motion Analysis of Particles and Rigid Bodies
    b. Newton's Laws of Motion
    c. Work and Energy Method
    d. Linear Impulse and Momentum Method
    e. Angular Impulse and Momentum Method

    Suggested reading: W. F. Riley and L. D. Sturges: Engineering Mechanics: Dynamics. John Wiley

3. **Engineering Analysis (course: ME200):**
    a. Linear Equations:
        - Matrix operations, determinants, elimination methods, eigenvalue problems.
    b. Ordinary Differential Equations:
        - Separable equations, first and second order of ODEs, and system of ODEs.
    c. Introductory PDEs
        - Laplace, Poisson and wave equations and their solutions, including Fourier series solutions.
    d. Vector Analysis

- Gradient and curl operations, Green's and Stokes's theorems.

e. Complex Analysis
    - Analytic functions, the residue theorem and contour integral.

Suggested reading: Kreyzig: Advanced Engineering Mathematics, John Wiley.

4. Fluid Mechanics (course: ME113):

a. Stresses in fluids, Hydrostatics, Newtonian fluids
b. Equations of motion
c. Inviscid flow, Bernoulli equation
d. Incompressible internal and external flows, boundary layers, lift and drag forces
e. Pipe flows, friction factors, loss coefficients, pump performance.

Suggested reading: Fox and McDonald: Introduction to Fluid Mechanics

5. Heat Transfer (course: ME116A):

a. Conduction: balance of mass and energy in conduction, steady 1-D, 2-D and 3-D conduction, heat transfer from extended surfaces, conduction in moving media, unsteady lumped systems, unsteady distributed systems (1-D, 2-D, and 3-D), and Heisler charts.
b. Convection: balance of mass, momentum, and energy in convection, laminar and turbulent forced convection in internal and external flows, thermal and momentum boundary layers as well as heat transfer correlations in both forced convection and in natural convection.
c. Radiation: Fundamental physics of thermal radiation, view factors and their algebra, and radiation exchange between gray-diffuse surfaces
d. Multimode heat transfer

Suggested reading: F. P. Incropera and D. P. DeWitt, Introduction to Heat Transfer, latest edition available, J. Wiley, New York

6. Materials properties (course: ME156, ME114)

a. Mechanical behavior
    - Stress-strain relationships, plastic deformation

b. Failure mechanisms (fracture, creep, fatigue)
c. Composite material behavior
d. Electrical properties
    - Metallic conduction
    - Semiconductors

Suggested reading: Mechanical Behavior of Materials, TH Courtney

7. Materials Structure (course: ME114)

a. Atomic bonding
b. Crystalline structure (Bravais lattices, directions, planes, atomic packing factors)

c. Defects (point, line and volume)
d. Thermodynamic stability (phase diagrams)
e. Diffusion (Fick's 1st and 2nd laws)

Suggested reading: Materials Science & Engineering, WD Callister

8. **Solid Mechanics (course: ME110)**
    a. Elements of tensor analysis
    b. Strains and stresses in solids
    c. Equations of motion
    d. Constitutive relations for linear elastic solids
    e. Stress waves in linear elastic solids
    f. Degeneralized 2D theories for anti-plane shear, plane stress, and plane strain
    g. Degeneralized 1D theories for bars, shafts and beams

    Suggested readings: James M. Gere: Mechanics of Materials, A.P. Boresi and K.P. Chong: Elasticity in Engineering Mechanics

9. **Thermodynamics (course: ME100A):**
    a. Energy, work, heat, and the 1st law of thermodynamics
    b. Entropy, irreversibility, and the 2nd law of thermodynamics
    c. Concept of entropy and entropy balance for systems
    d. Open and closed systems. Control volume analysis. Enthalpy.
    e. Properties of a pure substance from tabular data. Properties of an ideal gas. Properties of solids and subcooled liquids.
    f. Nozzles, pumps, turbines, heat exchangers, and other engineering hardware.
    g. Carnot cycle. Power and refrigeration cycles.

    Suggested reading: M. J. Moran and H. N. Shapiro, Fundamentals of Engineering Thermodynamics

D. DOCTOR OF PHILOSOPHY (PH.D.) DEGREE PROGRAM

The Ph.D. degree provides an opportunity for students to pursue a program of research in a specialized area and to develop a dissertation that "embodies the results of original research and gives evidence of high scholarship". The procedures for satisfying the requirements for the Ph.D. degree in Mechanical Engineering at UCR will consist of four (4) principal parts, each of which is discussed in greater detail in subsequent sections:

1. Successful completion of an approved program of course work;
2. Passing of a written and oral preliminary examination;
3. Oral defense of a dissertation proposal written and submitted by the candidate
4. Defense and approval of the dissertation

The Graduate Committee administers the first two requirements while the Ph.D. The Qualifying Committee and the Ph.D. Dissertation Committee oversee the third and fourth requirements respectively. In addition to these requirements, students must meet the minimum residency requirement of six quarters in the University of California, three of which must be spent in continuous residence at UCR. A student must maintain continuous registration until all degree requirements have been fulfilled. If such registration is not possible, the student must secure an approved leave of absence from the department and the Graduate Division.

1. Course Work

The course work should be formulated by the student and his/her faculty advisor within the first quarter year after admission to the Ph.D. program and must be approved by the student's Ph.D. advisor and Ph.D. Examination Committee. It is understood that changes to this may occur as the student's research progresses. These changes should be documented after consultation with the Ph.D. advisor and Ph.D. Examination Committee.

The Ph.D. degree will require completion of a minimum of 72 units of upper-division undergraduate or graduate-level approved course work. At least 24 of these units must be in graduate courses (200-series courses), a minimum of 8 of these being Mechanical Engineering graduate courses (ME 200 or higher, excluding ME 250, ME 290, ME 297, ME 298I, and ME 299). The student may apply a maximum of 8 units of upper division undergraduate level courses towards their 72 unit requirement. The student must take 6 units of seminar (ME 250) and at least 36 units of directed or thesis research credits (ME 297 or ME299). Students who already have an M.S. (either from UCR or elsewhere) may petition to transfer up to 2 graduate courses to apply towards the Ph.D. course requirement. Students who pursue a concurrent M.S. at UCR in a department other than Mechanical Engineering can apply no more than two courses used for that M.S. towards the Ph.D. in Mechanical Engineering. These transferred courses cannot substitute for the necessary UCR ME graduate course requirement mentioned above. Courses taken as part of the Ph.D. requirement can be used to satisfy the course requirements for an M.S. in Mechanical Engineering at UCR and vice versa.

Once accepted into the graduate program, students may pursue a Ph.D. degree, without completing an M.S. degree first.

2. Preliminary Examination

The purpose of the Ph.D. preliminary examination is to screen candidates for continuation in the Ph.D. program. The Ph.D. preliminary examination must be completed in the graduate student’s first year.

The examination is administered by the graduate program committee and has two components:

1. Written Examination designed to test understanding of concepts and methods used in mechanical engineering. It covers three subject areas to be selected by the student. Problems will be typical of those encountered in upper division course of undergraduate engineering curricula in U.S. schools with graduate-level understanding. The exam in each subject takes two hours. Students will be notified about permitted material such as

calculators and hand-written notes as specified by the examiners. Within two weeks upon communication of the exam results candidates can make request to see the exams by contacting Graduate Assistant and Graduate Advisor.

2. Oral component assess the student's ability to conduct independent research. This examination is administered by a committee of 3 faculty members selected by the candidate in consultation with the advisor. The student is required to submit a form that lists the committee members and the outcome of the exam signed by the committee chair. The oral exam has to be completed within four weeks after the written exams. Failure to take the oral exam on time constitutes non-satisfactory progress and disqualifies candidate from awards, fellowships, teaching assistantships and relevant benefits reserved for students in good standing.

It is necessary to pass both components to advance to the dissertation proposal.

First year students will be notified at least one month in advance of the Preliminary Exam Dates. They must submit the Intent to Register Form for the Preliminary Examination form, signed by their advisor prior to the deadline set by the Graduate Committee.

Based on the results of the written examination, the Graduate Committee makes a decision by majority vote. The committee will recommend that the student, either passes or fails the examination. If the student passes, he/she will be permitted to develop a Ph.D. dissertation proposal. If the student fails the examination, he/she is given a second and final opportunity to retake either all, or a portion of the examination at its next offering.

If a student fails the preliminary examination during the second attempt, then one of the following will occur:

1. If the student fails more than one written examination, then the student will be required to withdraw from the Ph.D. program.
2. If the student fails no more than one examination and, in the committee's judgement, the student has demonstrated proficiency in the subject matter, but has some weaknesses, the examination committee may grant a conditional pass. The committee will recommend additional course work and acceptable satisfactory grades for the course work. Once the additional course work is completed satisfactorily, the student is declared to have passed the examination. If the committee does not grant a conditional pass, then the student will be required to withdraw from the Ph.D. program.

A student who withdraws from the Ph.D. program may petition to be change his/ her degree objective to an M.S. If the student has completed all requirements for the M.S. degree, he/she will be awarded the M.S. degree at that time. If the M.S. degree requirements have not been met, the student will be permitted to continue in the program, complete these requirements, and receive the M.S. degree.

The oral exam has to be completed within four weeks after the written exams. The exam evaluates the readiness of students for the dissertation work at the early stage. This exam should be given by a committee, consisting of three faculty members: the dissertation advisor (committee chair) and two members of the Academic Senate, of which one must be a ME regular or collaborative faculty member. The committee members shall be selected by the student together with his/her dissertation advisor. Students must submit a 1-page abstract to the oral examination committee 5 days before the date of the examination. Students should consult their advisor to coordinate. The committee should submit a written recommendation to the Graduate Committee within 2 business days of the examination.

The list of the written exam areas (Note: More areas will be added as the Faculty grows in the future):

1. **Control Systems (course: ME120):**
    a. Laplace transform and solution of ODEs
    b. Transient and stationary response of 1st and 2nd order systems
    c. Linearization
    d. Poles/Zeros, Bode plots, Nyquist diagrams, root locus
    e. PID control
    f. State-space representation of dynamical systems
    g. Linear algebra

    Suggested reading: Katsuhiko Ogata, Modern Control Engineering.

2. **Dynamics (course: ME103):**
    a. Motion Analysis of Particles and Rigid Bodies
    b. Newton's Laws of Motion
    c. Work and Energy Method
    d. Linear Impulse and Momentum Method
    e. Angular Impulse and Momentum Method

    Suggested reading: W. F. Riley and L. D. Sturges: Engineering Mechanics: Dynamics. John Wiley

3. **Engineering Analysis (course: ME200):**
    a. Linear Equations:
        - Matrix operations, determinants, elimination methods, eigenvalue problems.
    b. Ordinary Differential Equations:
        - Separable equations, first and second order of ODEs, and system of ODEs.
    c. Introductory PDEs
        - Laplace, Poisson and wave equations and their solutions, including Fourier series solutions.
    d. Vector Analysis
        - Gradient and curl operations, Green's and Stokes's theorems.
    e. Complex Analysis
        - Analytic functions, the residue theorem and contour integral.

    Suggested reading: Kreyzig: Advanced Engineering Mathematics, John Wiley.

4. **Fluid Mechanics (course: ME113):**
    a. Stresses in fluids, Hydrostatics, Newtonian fluids
    b. Equations of motion
    c. Inviscid flow, Bernoulli equation
    d. Incompressible internal and external flows, boundary layers, lift and drag forces
    e. Pipe flows, friction factors, loss coefficients, pump performance.

    Suggested reading: Fox and McDonald: Introduction to Fluid Mechanics

5. **Heat Transfer (course: ME116A):**
    a. Conduction: balance of mass and energy in conduction, steady 1-D, 2-D and 3-D conduction, heat transfer from extended surfaces, conduction in moving media, unsteady lumped systems, unsteady distributed systems (1-D, 2-D, and 3-D), and Heisler charts.
    b. Convection: balance of mass, momentum, and energy in convection, laminar and turbulent forced convection in internal and external flows, thermal and momentum boundary layers as well as heat transfer correlations in both forced convection and in natural convection.
    c. Radiation: Fundamental physics of thermal radiation, view factors and their algebra, and radiation exchange between gray-diffuse surfaces
    d. Multimode heat transfer

    Suggested reading: F. P. Incropera and D. P. DeWitt, Introduction to Heat Transfer, latest edition available, J. Wiley, New York

6. **Materials properties (course: ME156, ME114)**
    a. Mechanical behavior
        - Stress-strain relationships, plastic deformation
    b. Failure mechanisms (fracture, creep, fatigue)
    c. Composite material behavior
    d. Electrical properties
        - Metallic conduction
        - Semiconductors

    Suggested reading: Mechanical Behavior of Materials, TH Courtney

7. **Materials Structure (course: ME114)**
    a. Atomic bonding
    b. Crystalline structure (Bravais lattices, directions, planes, atomic packing factors)
    c. Defects (point, line and volume)
    d. Thermodynamic stability (phase diagrams)
    e. Diffusion (Fick's 1st and 2nd laws)

    Suggested reading: Materials Science & Engineering, WD Callister

8. **Solid Mechanics (course: ME110)**
    a. Elements of tensor analysis
    b. Strains and stresses in solids
    c. Equations of motion
    d. Constitutive relations for linear elastic solids
    e. Stress waves in linear elastic solids
    f. Degeneralized 2D theories for anti-plane shear, plane stress, and plane strain
    g. Degeneralized 1D theories for bars, shafts and beams

    Suggested readings: James M. Gere: Mechanics of Materials, A.P. Boresi and K.P. Chong: Elasticity in Engineering Mechanics

9. **Thermodynamics (course: ME100A):**
    a. Energy, work, heat, and the 1st law of thermodynamics
    b. Entropy, irreversibility, and the 2nd law of thermodynamics
    c. Concept of entropy and entropy balance for systems
    d. Open and closed systems. Control volume analysis. Enthalpy.
    e. Properties of a pure substance from tabular data. Properties of an ideal gas. Properties of solids and subcooled liquids.
    f. Nozzles, pumps, turbines, heat exchangers, and other engineering hardware.
    g. Carnot cycle. Power and refrigeration cycles.

    Suggested reading: M. J. Moran and H. N. Shapiro, Fundamentals of Engineering Thermodynamics

Ph.D. Dissertation Proposal and Qualifying Committee (The Qualifying Exam)

After successfully completing the Ph.D. preliminary examination, the student, with advice from his/her advisor, recommends a Ph.D. Qualifying Committee and prepares a dissertation proposal. The Ph.D. Qualifying Examination committee consists of 5 members including the student's research advisor and one faculty member from outside the department. Please consult the **Graduate Student Handbook** for details about the Qualifying Examination Committee.

The student must submit both the *Form 2* and the *Report of Department Requirements for the Ph.D.* form at least 2 weeks prior to the Qualifying Exam date. At the time that the exam is taken, the student must submit the *Form 3* reporting their results, this form also serves as the form that nominates the Dissertation Committee. The *Form 3* must be submitted to the Graduate Assistant no later than 48 hours after the exam. All forms should be submitted via the Graduate Assistant and under no circumstances taken to the Graduate Division by the student. *Please contact the Graduate Assistant for Form 2 and Form 3.*

The dissertation proposal consists of a written document and an oral presentation or defense. Typically, a Ph.D. student will submit a dissertation proposal to his/her Ph.D. Qualifying Committee within one (1) year after successfully completing the preliminary examination. The Ph.D. Qualifying committee chairperson will normally schedule an oral defense within one (1) month of the written proposal submission. The presentation is given only to the Ph.D. Qualifying Committee members.

The written dissertation proposal should be typewritten, 15 pages maximum (references not included), double-spaced, in standard typeface (12 pt) with 1" margins all around. Written document has to follow the National Science Foundation (NSF) proposal guidelines. As per NSF, the proposal has to include 1 page Project Summary that includes Intellectual Merits and Broader Impacts with possible Transformative Nature of the proposed research. In addition to the Project Summary, the write-up has to include up to 15 pages of the Project Description. Last part of the write-up is list of references (not included in 15 pages limit). Details of the NSF proposal format requirements are available at the NSF web site: http://www.nsf.gov/pubs/policydocs/pappguide/nsf14001/gpgprint.pdf , Chapter II, Page II-1 (Page 18). Project Summary is described at page II-9 (Page 25) and Project Description and References Cited are described from II-9 to II-11 (Pages 25-27).

Suggested organization for the Ph.D. dissertation proposal is as follows:

Introduction: This section should include the purpose, the objectives (or accomplishments), and the scope of the proposed research.

Background: This section should include a summary of the literature concerning research work related to the proposed dissertation and how the proposed research builds on or relates to previous work.

Approach and Methodologies: A narrative of how the research is to be conducted, including an overview of the general research approach and techniques. Also, any experimental designs, statistical methods, and conceptual or mathematical models to be developed or employed should be discussed.

Preliminary Results and Discussion: Presentation of preliminary research results and their relevance to the proposed dissertation.

Significance of the proposed research: The purpose of this section is to explain why the proposed research is relevant and needed.

Literature cited: All publications referenced within the proposal should be cited in the reference section.

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

The student is advanced to candidacy after successfully completing this examination. Students who fail the qualifying examination are given a second opportunity to take the examination. The committee will typically give suggestions to modify or enhance his/her proposal. Students who fail the examination at the second attempt will be required to withdraw from the Ph.D. program.

Ph.D. Dissertation Defense

Following advancement to Ph.D. candidacy, the student formally begins his/her dissertation research. The progress of the dissertation is monitored by the student's Ph.D. Dissertation Committee. The Ph.D. Dissertation Committee consists of 3 members. It is recommended that the Ph.D. candidate interact frequently with members of his/her dissertation committee to insure that dissertation progress is acceptable.

After completion of the dissertation research, a written draft copy of the completed dissertation must be submitted to the Ph.D. Dissertation Committee for review, evaluation, and determination of whether the draft thesis is ready for oral defense. Once a draft has been approved for defense, an oral defense of the dissertation will be scheduled. The oral defense is open to the entire academic community. It consists of a presentation followed by a question/answer period conducted by the Ph.D. Dissertation Committee and the audience.

An abstract and title should be submitted to the Graduate Assistant at least 9 days prior to the scheduled defense so that it can be advertised to the public for a period of at least one week. No exceptions will be made for late abstracts. Dissertation Committee members should fill out the *Form 5* and return it to the Graduate Assistant as soon as possible after the defense. *Please contact the Graduate Assistant for Form 5.*

Based on the written dissertation and the oral defense, the Ph.D. Dissertation Committee decides to 1) accept the dissertation and recommend to the Graduate Division that the Ph.D. degree be awarded, 2) ask that the dissertation be modified and re-defended, or 3) decline acceptance of the dissertation (normally, only after a second opportunity is given).

Foreign Language Requirements

Following the practices common in this field, there will be no foreign language requirements for the Ph.D. degree in Mechanical Engineering.

III. SAMPLE PROGRAMS AND COURSE DESCRIPTION

A. SAMPLE PROGRAMS

Sample Ph.D. Programs for Design and Control

Year	Fall	Winter	Spring	Summer
1	Methods of Engineering Analysis Theoretical Kinematics Elective	Computational Methods in Engineering Advanced Dynamics Theory of Elasticity	Introduction to Robotics Finite Element Methods in Solid Mechanics Elective	Directed Research (Preliminary Exam)
2	Linear Control Theory ME 297 Directed Research in Mechanical Engineering	Computer-Aided Engineering Theory ME 297 Directed Research in Mechanical Engineering	Elective ME 297 Directed Research in Mechanical Engineering	(Select Dissertation Topic)
3	Directed Research (Dissertation Proposal)	Directed Research (Dissertation Proposal)	Directed Research (Dissertation Proposal)	Dissertation Proposal
4	Dissertation Research	Dissertation Research	Dissertation Research	Dissertation Research
5	Dissertation Research	Dissertation Research	Dissertation Defense	

Sample Ph.D. Programs for Fluid and Thermal Sciences

Year	Fall	Winter	Spring	Summer
1	Methods of Engineering Analysis Fundamentals of Fluid Mechanics I	Computational Methods in Engineering Fundamentals of Fluid Mechanics II	Computational Fluid Dynamics with Application Fundamentals of Heat and Mass Transfer	Directed Research (Preliminary Exam)
2	Transport through Porous Media Special Topics in Fluid and Thermal Science ME 297 Directed Research in Mechanical Engineering	Special Topics in Fluid and Thermal Science ME 297 Directed Research in Mechanical Engineering	Elective ME 297 Directed Research in Mechanical Engineering	(Select Dissertation Topic)
3	Directed Research (Dissertation Proposal)	Directed Research (Dissertation Proposal)	Directed Research (Dissertation Proposal)	Dissertation Research
4	Dissertation Research	Dissertation Research	Dissertation Research	Dissertation Research
5	Dissertation Research	Dissertation Research	Dissertation Defense	

Sample Ph.D. Programs for Mechanics and Materials

Year	Fall	Winter	Spring	Summer
1	Methods of Engineering Analysis Mechanics and Physics of Materials Elective	Computational Methods in Engineering Advanced Dynamics Theory of Elasticity	Elective Finite Element Methods in Solid Mechanics Elective	Directed Research (Preliminary Exam)
2	Dynamic Behavior of Solids ME 297 Directed Research in Mechanical Engineering	Elective ME 297 Directed Research in Mechanical Engineering	Elective ME 297 Directed Research in Mechanical Engineering	(Select Dissertation Topic)
3	Directed Research (Dissertation Proposal)	Directed Research (Dissertation Proposal)	Directed Research (Dissertation Proposal)	Dissertation Research
4	Dissertation Research	Dissertation Research	Dissertation Research	Dissertation Research
5	Dissertation Research	Dissertation Research	Dissertation Defense	

B. ME GRADUATE COURSE DESCRIPTIONS

Descriptions of ME graduate courses are listed below. Descriptions of undergraduate ME courses, as well as those from other departments may be found in the *UCR General Catalog* and on the UCR website (www.ucr.edu).

ME 200: Methods of Engineering Analysis (4)
Lecture: four hours. Prerequisite(s): Graduate standing in engineering or consent of instructor. Topics include linear algebra theory, vector spaces, eigenvalue problems, complex analytic functions, contour integration, integral transforms, and basic methods for solving ordinary and partial differential equations in Mechanical Engineering applications.

ME 201. Computational Methods in Engineering (4)
Lecture, 4 hours. Prerequisite(s): graduate standing or consent of instructor. Explores numerical methods with computer applications. Topics include solution of nonlinear algebraic equations, solution of systems of linear equations, interpolation, integration, statistical description of data, model fitting, Fast Fourier Transform and applications, and numerical solution of ordinary and partial differential equations.

ME 202. Spectral Computational Methods (4)
Lecture, 3 hours; consultation, 1 hour. Prerequisite(s): ME 200 or equivalent; ME 240A is recommended. Introduces data analysis, including discrete Fourier transforms, sampling theorem, and power spectra. Reviews Sturm-Liouville eigenfunction expansions, Gibbs phenomenon, convergence theorems, and Chebyschev transforms. Additional topics include Galerkin, tau, collocation, and pseudospectral methods, aliasing, time-advancement, and numerical stability. Explores applications to incompressible Navier-Stokes equations, compressible flows, reacting flows, and complex geometries. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Course is repeatable as content changes.

ME 203. Design and Analysis of Engineering Experiments (4)
Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor. Introduces research methods in engineering. Topics include design of experiments, basic statistical tools, data analysis in the time-domain and frequency domain, machine learning and pattern recognition approaches, and computational tools. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

ME 210. Sustainable Product Design (4)
Lecture, 3 hours; consultation, 1 hour. Prerequisite(s): graduate standing or consent of instructor. Introduces the principles of sustainable product design. Topics include life cycle design; design for reliability, maintainability, and recycling/reuse/remanufacture; materials selection; and manufacturing processes. Includes project in which students analyze the environmental impact of

a product and redesign it to reduce the impact. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Course is repeatable as content changes. Credit is awarded for only one of ME 176 or ME 210.

ME 220 Optimal Control and Estimation (4)
Lecture, 4 hours; term paper, 1 hour. Prerequisite(s): ME 120, ME 121 or equivalent; or consent of instructor. Intro- duces optimal control and estimation with specific focus on discrete time linear systems. Topics include analysis of discrete Riccati equations; asymptotic properties of optimal controllers; optimal tracking; an introduction to Receding Horizon control; derivation of the Kalman filter; Extended Kalman Filter; and Unscented Kalman filter. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

ME 222: Introduction to Robotics. (4)
Lecture: three hours; discussion, 1 hour. Prerequisite(s): EE 132 or equivalent, ME 120, ME 130; or consent of instructor. Introduces the mechanics of robotics systems. Topics include kinematics, dynamics, task planning, open and closed-loop control strategies, and robot programming languages. Explores the concept of parallel kinematic machines.

ME 230: Computer-Aided Engineering Design. (4)
Lecture: three hours; laboratory: three hours. Prerequisite(s): Graduate standing or consent of instructor. Introduces fundamentals of interactive computer graphics, three-dimensional representations of curves and surfaces, Bezier parameterizations, and optimization methods. Demonstrates applications of computer graphics and computational geometry to mechanical system simulations, computer-aided design, and engineering design.

ME 231: Pen-Based Computing. (4)
Lecture: three hours; discussion, one hour. Prerequisite(s): Graduate standing or consent of instructor; computer programming experience. Introduction to computational techniques for pen-based user interfaces. Covers fundamental issues such as ink segmentation, sketch parsing, and shape recognition. Explores the topic of sketch understanding, including reasoning about context and correcting errors, and issues related to building practical pen-based systems. Includes a project in which students build a pen-based application.

ME 232. Computational Design Tools (4)
Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor. An introduction to the theoretical foundations and practical application of computational techniques for engineering design. Topics include geometric modeling, numerical optimization, and artificial intelligence techniques. Includes programming projects in which both symbolic and numerical computational techniques are used to solve engineering problems. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

ME 233. Artificial Intelligence for Design (4)
Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): graduate standing or consent of instructor. Explores the application of artificial intelligence to engineering design. Topics include the use of search, knowledge-based systems, machine learning, and qualitative physical reasoning for design automation. Addresses the theory behind these techniques and issues related to their

practical application. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor. Course is repeatable as content changes.

ME 235 Linear System Theory (4)
Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): EE 132. Provides a review of linear algebra. Topics include the mathe- matical 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. Cross-listed with EE 235.

ME 240A: Fundamentals of Fluid Mechanics I. (4)
Lecture: four hours. Prerequisite(s): Graduate standing or consent of instructor.
Introduction to fluid mechanics. Explores equations of motion, stress tensor, the Navier-Stokes equations, boundary conditions, exact solutions, vorticity, and boundary layers.

ME 240B: Fundamentals of Fluid Mechanics II. (4)
Lecture: four hours. Prerequisite(s): ME 240A or consent of instructor.
Covers inviscid flow, the Euler and Bernouli equations, potential flow, wing theory, and introduces stability theory and turbulence.

ME 241A: Fundamentals of Heat and Mass Transfer. (4)
Lecture: four hours. Prerequisite(s): ME 240A or consent of instructor.
Introduces in-depth derivations of equations and principles governing heat and mass transfer with an emphasis on formulation of problems. Topics include equations involved in conduction, convection, radiation, energy, and species conservation and the analytical and numerical solution of transport problems.

ME 241B: Transport through Porous Media. (4)
Lecture: four hours. Prerequisite(s): graduate standing.
Covers current theories on flow, heat, and mass transfer and the mechanisms of multiphase transport in porous media.

ME 241C: Electronic Cooling and Thermal Issues in Microelectronics. (4)
Lecture: four hours. Prerequisite(s): graduate standing.
Discusses thermal issues associated with the life cycle of electronic products. Covers passive, active, and hybrid thermal management techniques, computational modeling approaches, and advanced thermal management concepts such as single phase, phase change and heat pipes.

ME 242. Turbulence in Fluids (4)
Lecture, 4 hours.Prerequisite(s): ME 240A or consent of instructor.
An introduction to the application of fundamental conservation laws of mechanics (mass, momentum, and energy) to the modeling of complex turbulent natural and human-made flows. Covers tensor notation, statistical and spectral analysis, and basic turbulent closure techniques, including understanding of turbulence with intuitive insight into the problems that cannot be rigorously solved. May be taken Satisfactory (S) or No Credit (NC) by students advanced to candidacy for the Ph.D.

ME 243. Advanced Mechanical Engineering Thermodynamics (4)
Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 100A or equivalent. Introduces the fundamental statistical foundations of classical thermodynamics. Explores the origins of entropy, temperature, pressure, chemical potential, and the free energies. Applications include chemical equilibrium and reactions, phase equilibrium and transitions including vapor-liquid and solid-solid, fluctuations, and thermodynamics in nanoscale systems. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

ME 244. Nanoscale Heat Transfer and Energy Conversion (4)
Lecture, 4 hours. Prerequisite(s): at least two of EE 201, EE 202, ME 100A, ME 116A, or equivalents. Explores fundamental processes of energy transport and conversion at short length and time scales. Introduces classical and quantum-mechanical size effects on electrons, phonons, and photons. Topics include modes of energy storage, coupling between energy carriers, and electrical and thermal transport using the Boltzmann transport equation and/or kinetic theory. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

ME 245. Radiative Heat Transfer (4)
Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 116A or ME 116B or equivalent or consent of instructor. Offers indepth study of topics related to radiative heat transfer. Builds upon curriculum of radiation presented at the undergraduate level. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

ME 246: Computational Fluid Dynamics with Applications (4)
Lecture: Three hours, laboratory three hours. Prerequisite(s): ME 240A or consent of instructor. Introduces finite difference, finite volume, and finite element; spectral methods, governing equations for nonreacting and reacting flows; and stability and convergence for steady and unsteady problems. Students use commercial computational fluid dynamic (CFD) software for the course project.

ME 248. Internal Combustion Engines (4)
Lecture, 3 hours; discussion, 1 hour. Prerequisite(s): ME 100A; graduate standing. Covers engine types and their operation. Also addresses engine design and operating parameters, thermochemistry of fuel-air mixture, engine cycles, spark ignition and compressed ignition engines, and emissions. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

ME 250: Mechanical Engineering Seminar. (1 or 2)
Seminar: 1-2 hours. Prerequisite(s): Graduate standing. Seminar in selected topics in Mechanical Engineering presented by graduate students, staff, faculty, and invited speakers.

ME 255. Transport Processes in the Atmospheric Boundary Layer (4) Lecture, 4 hours. Prerequisite(s): ME 100A or CHE 100, ME 113 or CHE 114, and ME 116A or CHE 116; or consent of instructor. Examines heat, mass, and momentum transport processes in the atmospheric boundary layer using current understanding of micrometeorology. Topics includes surface energy balance, Monin-Obukhov Similarity theory, and dispersion of pollutants in the atmospheric boundary layer. May be taken Satisfactory (S) or No Credit

ME 261: Theory of Elasticity. (4)
Lecture: four hours. Prerequisite(s): ME 110 or consent of instructor.
Introduction to tensors, strain, equations of motion, and constitutive equations. Topics include typical boundary value problems of classical elasticity, problems of classical elasticity, problems of plane strain and plane stress, and variational principles.

ME 266: Mechanics and Physics of Materials. (4)
Lecture: four hours. Prerequisite(s): Graduate standing or consent of instructor.
Introduces the structure and properties of materials; the characterization and modeling of mechanical, thermal, electric, and magnetic properties of materials; and coupling properties. Topics include phase transformations and brittle-to-ductile-transitions.

ME 267: Finite Element Methods in Solid Mechanics. (4)
Lecture: four hours. Prerequisite(s): ME 261 or consent of instructor.
Covers the formulation and implementation of finite element methods, including the Galerkin and energy methods. Topics include the static and dynamic analysis of mechanical and multiphysical systems and techniques of automatic mesh generation.

ME 270: Introduction to Microelectromechanical Systems. (4)
Lecture: four hours. Prerequisite(s): ME 110, ME 114, or equivalents.
An introduction to the design and fabrication of microelectromechanical systems (MEMS). Topics include bulk and surface micromachining processes; material properties; mechanisms of transduction; applications in mechanical, thermal, optical, radiation, and biological sensors and actuators; fabrication of microfluidic devices; Bio-MEMS and applications; packaging and reliability concepts; and metrology techniques for MEMS. Also discusses directions for future research.

ME 271. Therapeutic Biomedical Microdevices (4)
Lecture, 4 hours. Prerequisite(s): ME 270/MSE 238 or equivalent or consent of instructor. An introduction to the application of micro device technology towards biomedical therapeutics. Topics include emerging micro device fabrication techniques, bio compatibility requirements, and applications in areas such as cardiovascular intervention, minimally-invasive drug delivery, neuroprosthetic interfaces, and cellular engineering. May be taken Satisfactory (S) or No Credit (NC) with consent of instructor and graduate advisor.

ME 272 Nanoscale Science and Engineering (4)
Lecture: three hours, laboratory three hours. Prerequisite(s): Consent of instructor.
ME 01H or consent of instructor. An overview of the machinery and science of the nanometer scale. Topics include patterning of materials via scanning probe lithography; electron beam lithography; nanoimprinting; self-assembly; mechanical, electrical, magnetic, and chemical properties of nanoparticles, nanotubes, nanowires, and biomolecules (DNA, protein); self-assembled monolayers; and naoncomposites and syntheic macomolecules.

ME 273. Principles and Designs of Micro Transducers (4) Lecture, 4 hours; term paper, 1 hour; extra reading, 1 hour; written work, 1 hour. Prerequisite(s): ME 270/ MSE 238 or equivalent; or consent of instructor. Emphasizes physical principles and designs of microscopic sensors and actuators. Topics include macroscopic and microscopic physical phenomena and properties; signal processing; mechanical transducers; thermal transducers; electrical transducers; magnetic transducers; optical transducers; chemical and biological transducers; and applications in areas such as lab-on-a-chip, medical diagnosis and power MEMS.

ME 274. Plasma-aided Manufacturing and Materials Processing (4) Lecture, 4 hours. Prerequisite(s): ME 243 or equivalent; or consent of instructor. Covers the fundamentals of gaseous plasmas and the physics of both equilibrium and non-equilibrium discharges. Covers the basic techniques for plasma diagnostics. Discusses the use of plasmas as a materials processing medium for a variety of manufacturing processes. Advanced topics such as the processing of nanostructured materials using plasmas are included.

ME 278: Imperfections in Solids. (4) Lecture: three hours; discussion 1 hour. Prerequisite(s): Graduate standing in Chemical and Environmental Engineering or Computer Science or Electrical Engineering or Mechanical Engineering. Covers fundamentals of crystal structures and crystal defects, including the generation of point defects; nucleation and propagation of dislocations; perfect and partial dislocations; twins, stacking faults, and transformations; mechanics of semiconductor and metallic thin films and multilayered structures.

ME 290: Directed Studies in Mechanical Engineering. (1-6)
Prerequisite(s): Graduate standing; consent of instructor and graduate advisor.
Individual study, directed by a faculty member, of selected topics in Mechanical Engineering.

ME 297: Directed Research in Mechanical Engineering. (1-4)
Prerequisite(s): Graduate standing; consent of instructor. Research conducted under the supervision of a faculty member on selected problems in Mechanical Engineering.

ME 299: Research for Thesis or Dissertation. (1-12)
Prerequisite(s): Graduate standing or consent of instructor.
Research in Mechanical Engineering for the M.S. thesis or Ph.D. dissertation.

Professional Course

ME 302 Apprentice Teaching (1-4)
Seminar, 1-4 hours. Prerequisite(s): appointment as a teaching assistant or an associate in Mechanical Engineering. Topics include effective teaching methods, such as those involved in leading discussion sections and preparing and grading examinations, and student-instructor relations in lower- and upper-division Mechanical Engineering courses. Required each quarter of teaching assistants and associates in Mechanical Engineering. Graded Satisfactory (S) or No Credit (NC). Course is repeatable to a maximum of 12 units.

IV. FACULTY PROFILES

Reza Abbaschian Distinguished Professor 	**Ph.D. University of California, Berkeley** Research: Materials processing, solidification including low-gravity experiments, crystal growth, functionally graded composites, and diamond processing.	**Elisa Franco** Assistant Professor 	**Ph.D. University of Trieste** **Ph.D. California Institute of Technology** Research: Biological feedback processes. Analysis, design and synthesis of robust biochemical networks. In vitro molecular circuits and control systems.
Guillermo Aguilar Professor & Department Chair 	**Ph.D. University of California, Santa Barbara** Research: Cryogen Spray Cooling, Medical Lasers and Transport Phenomena for Biomedical Applications	**P. Alexander Greaney** Assistant Professor 	**Ph. D. Oxford University** Research: focused on using computation and theory to understand the fundamental structure-property relationships in materials. His group's research encompasses thermal properties of materials, mechanical properties, functional nanostructures materials, and computational design of materials.
Sinisa Coh Assistant Professor 	**Ph.D., Rutgers The State University of New Jersey** Research: Computational materials theorist working on nanostructures, complex oxides, layered materials, topological insulators, superconductors, and optical properties of materials.	**Heejung Jung** Associate Professor 	**Ph.D. University of Minnesota** Research: Engines & Emissions, Air Pollution, Nanoparticle Science
Shane Cybart Assistant Professor 	**Ph.D., UC San Diego** Research: High-transition temperature Josephson devices; Superconducting electronics; Multiferroic and magnetic oxides; Oxide electronic devices for a diverse range of applications.	**Sandeep Kumar** Assistant Professor 	**Ph.D. Pennsylvania State University** Research: His current research interests include thermo-electro-mechanical coupling in thin films at nanoscale, performance issues with Li-ion battery electrodes and high temperature material characterization.

Chen Li Assistant Professor 	**Ph.D., California Institute of Technology** Research: Geophysics. Structure and transportation properties of energy materials under high pressure with diamond anvil cell (DAC) together using Raman, X-ray, and neutron scattering techniques.	**Cengiz Ozkan** Professor 	**Ph.D. Materials Science** **Stanford University** Research: Nanomaterials synthesis and processing; graphene, III-V and II-VI materials; energy storage and photovoltaic devices; nanoelectronics; nanopatterning
Lorenzo Mangolini Associate Professor & Graduate Advisor 	**Ph. D University of Minnesota, Minneapolis** Research: Development of devices based on nanostructured materials for the solution of energy-related issues. Characterization of nano-materials. Plasma Enhanced Chemical Vapor Deposition synthesis of nanostructures and semiconductor quantum dots. Advanced process characterization and modeling of gas-phase reactive systems.	**Fabio Pasqualetti** Assistant Professor 	**Ph.D, University of California, Santa Barbara** Research: multi-agent, large-scale, and networked systems, such as power grids, water distribution networks, and cooperative robotic systems.
Suveen Mathaudhu Assistant Professor & Graduate Advisor 	**Ph.D. Mechanical Engineering** **Texas A&M University** Research interests encompass all aspects of what is going on with fundamental processing-microstructure-property-performance relationships in metallic and composite materials.	**Marko Princevac** Professor 	**Ph.D. Mechanical Engineering** **Arizona State** Research: Fundamental and Applied Fluid Mechanics Research, the Application of Fundamental Turbulence Concepts to Studies in Environmental Flows

Monica Martinez Assistant Professor 	**Ph.D. Cal Tech** Research: Fluid mechanics, oceanography and biology. Biological fluid dynamics, turbulence and two-phase flows	**Masaru P. Rao** Associate Professor 	**Ph.D. Material Engineering** **University of California, Santa Barbara** Research: Development and application of novel micro/nanofabrication methods and materials for microelectro-mechanical systems (MEMS), microfluidics, and biomedical microdevices
Tom Stahovich Professor 	**Ph.D. Mechanical Engineering** **Massachusetts Institute of Technology** Research: Design, Artificial Intelligence, pen-based computing, sketch-understanding, and human-computer interaction	**Akula Venkatram** Professor 	**Ph.D. Mechanical Engineering** **Purdue University, West Lafeyette, Indiana** Research: Comprehensive Modeling of Systems Governing Air Quality, Theoretical Aspects of Small-Scale Dispersion, Application of Micrometeorology to Dispersion Problems, Development of Simplified Models for Complex Systems
Hideaki Tsutsui Assistant Professor 	**Ph.D. Mechanical Engineering** **University of California, Los Angeles** Research: Biomedical microdevices. Stem cell engineering. Three-dimensional micro/nano fabrication. Bio-inspired self-assembly.	**Richard Wilson** Assistant Professor 	**Ph.D. University of Illinois** Research: Electronic, magnetic, and thermal transport phenomena

Kambiz Vafai Distinguished Professor 	**Ph.D. Mechanical Engineering University of California, Berkeley** Research: Transport Through Porous Media, Multiphase Transport, Natural Convection in Complex Configurations, Analysis of Porous Insulations, Heat Flux Applications, Free Surface Flows, Unconventional Heat Pipes, and Power Electronics, Transport Through Biological Membranes, Mine Detection	**Guanshui Xu** Professor 	**Ph.D. Engineering Brown University** Research: Mechanics, Material, and Geophysics with an emphasis on Analytical and Computational Modeling, and their Scientific and Engineering Applications

Lecturers	Adjunct Faculty
John Dougherty Mechanical Engineering Bourns Hall A338 University of California, Riverside Riverside, CA 92521 Telephone: 951-827-5830 E-mail: jdougher@engr.ucr.edu	**Santiago Camacho-Lopez** Adjunct Professor CICESE E-mail: camachol@cicese.mx
James Sawyer Mechanical Engineering Bourns Hall A338 University of California, Riverside Riverside, CA 92521 Telephone: 951-827-3394 E-mail: sawyer@engr.ucr.edu	**Carlos F. de Menezes Coimbra** Adjunct Professor UC San Diego E-mail: ccoimbra@ucsd.edu
V. Sundararajan Mechanical Engineering Bourns Hall A317 University of California, Riverside Riverside, CA 92521 Telephone: 951-827-2446 E-mail: vsundar@engr.ucr.edu	**Christopher Dames** Adjunct Professor UC Berkeley E-mail: cdames@me.berkeley.edu

COOPERATING FACULTY MEMBERS

Bahman Anvari **Professor of Bioengineering** General Overview: Dr. Anvari's research is directed towards development and application of photonics-based instrumentation to obtain quantitative information that will provide insight into the fundamental mechanisms underlying a biological phenomenon, and to achieve effective optical modalities for diagnosis and therapy of specific tissue malformations.	Materials Science & Engineering 211 University of California, Riverside Riverside, CA 92521 Telephone: 951-827-5726 Facsimile: 951-827-6416 E-mail: anvari@engr.ucr.edu
Matthew Barth **Professor of Electrical Engineering** Dr. Barth's research focuses on applying engineering system concepts and automation technology to Transportation Systems, and in particular how it relates to energy and air quality issues. The	342 Winston Chung Hall University of California, Riverside Riverside, CA 92521 Telephone: 951-827-5782 Facsimile: 951-827-5744 E-mail: barth@ee.ucr.edu
Bir Bhanu **Distinguished Professor of Electrical Engineering Director, The Center for Research in Intelligent Systems** Computer vision, machine learning and pattern recognition, video networks, image and video databases, biological and medical image & signal processing, sensor fusion, computer graphics and visualization, robotics, artificial intelligence, commercial, medical, military and intelligence applications.	216 Winston Chung Hall University of California, Riverside Riverside, CA 92521 Telephone: 951-827-3954 Facsimile: 951-827-2425 E-mail: bhanu@ee.ucr.edu
Ashok Mulchandani **Professor of Chemical Engineering** Nanobiotechnology, Environmental Biotechnology, Biosensors, Bioengineering	Bourns Hall A317 University of California, Riverside Riverside, CA 92521 Telephone: 951-827-6419 Facsimile: 951-827-5696 E-mail: adani@engr.ucr.edu
Wei Ren **Associate Professor of Electrical Engineering** Multi-agent systems, cyber-physical systems, cooperative control, distributed control, networked control systems, autonomous vehicles, robotics	Winston Chung Hall 416 University of California, Riverside Riverside, CA 92521 Telephone: 951-827-6204 Fax: 951-827-2425 E-mail: ren@ee.ucr.edu

V. ME FACILITIES

The Department of Mechanical Engineering is housed in the recently opened $41 million, 105,000 square-foot modern engineering complex, Bourns Hall. In Bourns Hall, the Mechanical Engineering Department occupies 1,800 square feet of teaching lab space, 8,000 square feet of research lab space, and 600 square feet of computing lab space. To meet the space needs of additional faculty and students in this growing department, a second engineering building is in the construction stage.

A. AIR QUALITY LABORATORIES

The air quality laboratory facilities are associated with The College of Engineering Center for Environmental Research and Technology (CE-CERT) and the Air Pollution Research Center (APRC). Descriptions of these facilities follow.

1. CE-CERT

Director: Matthew Barth, Ph.D.
1084 Columbia Avenue
Riverside, CA 92507
(951) 781-5791; fax (951) 781-5790
info@cert.ucr.edu ; www.cert.ucr.edu

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 facility, and a number of the labs, especially the vehicle emissions research laboratory, contain equipment, which is unique to a university research facility.

2. Air Pollution Research Center

The APRC research labs are housed in the Fawcett Lab on the UCR campus. The atmospheric chemistry group at APRC has four large volume (6000-8000 liter each) chambers for kinetic and product studies, with product analysis by gas chromatography (with flame ionization, Fourier transform infrared (FTIR) and mass spectrometric detection), in suit FT-IR absorption spectroscopy, and a PE SCIEX API MS/MS direct air sampling, atmospheric pressure ionization tandem mass spectrometer. Equipment for plant sciences research includes a greenhouse with continuous stirred flow Teflon chambers and computer controlled fumigation capabilities.

VI. ADDITIONAL BOURNS COLLEGE OF ENGINEERING FACILITIES

1. Center for Nanoscale Science and Engineering

Director: Robert C. Haddon, Ph.D.
robert.haddon@ucr.edu; **www.cnse.ucr.edu**

Engineers, physicists, computer scientists, neuroscientists, biologists, chemists, and biomedical scientists explore nanoscale materials, such as organic compounds, carbon nanotubes, and magnetic materials, for use in nanoelectronics, spintronics, sensors, and biomedical devices to develop new or improved technologies.

2. Center for Research in Intelligent Systems

Director: Bir Bhanu, Ph.D.
B232 Bourns Hall
(951) 827-3954; fax (951) 827-2425; **www.cris.ucr.edu**

Promotes interdisciplinary research for developing computer systems that are flexible, adaptive, and intelligent. Involves an interdisciplinary team of faculty from Electrical Engineering, Computer Science, Psychology, Economics, Statistics, Mathematics, and Management. The goal is the research and development of autonomous/semiautonomous systems with sensing capabilities that can communicate and interact with other intelligent (biological and artificial) systems.

VI. STUDENT ORGANIZATIONS

Mechanical Engineering Graduate Student Association (MEGSA)

The purpose of the Mechanical Engineering and Materials Science Engineering Graduate Student Association (M.E.M.S.E.G.S.A.) is to promote the social and academic well-being of the Mechanical Engineering and Materials Science Engineering graduate students at the University of California, Riverside. This includes, but is not limited to increasing student involvement in the surrounding community, organizing events, and ensuring that the concerns of M.E. and M.S.E. graduate students are known and represented in their respective programs. The M.E.M.S.E.G.S.A. is a member of the Bourns College of Engineering Leadership Council and strives to promote the interests of the Department of Mechanical Engineering, the Materials Science Engineering Program, the Bourns College of Engineering, and UC-Riverside as a whole.

Contact Information:

Mechanical Engineering Graduate Student Association
University of California, Riverside

3401 Watkins Dr.
Bourns Hall, A342
Attn: MEMSEGSA
Riverside, CA 92521

Email: megsa@engr.ucr.edu
Webpage: www.engr.ucr.edu/megsa/
Facebook: https://www.facebook.com/megsa.ucr

A. Graduate Student Association

All graduate students are members of the Graduate Student Association (GSA), which seeks to represent their views and promote their interests with the faculty and administration, both at the campus level and university wide.

For a more detailed description of GSA activities and services, call
(951) 827-3740.

Further information can also be found under Graduate Student Association in the Services for Students section of this catalog, or e-mail **gsaucr@ucr.edu**.

VII. ACADEMIC RESOURCES

Graduate Division:
http://www.graduate.ucr.edu/
(951) 827-4302 or 951-827-3315

Graduate Division Student Affairs & Academic Regulations:
http://www.graduate.ucr.edu/studAfftoc.html
(951) 827-3315

Registrars Office:
http://registrar.ucr.edu/
(951) 827-7284

GROWL:
www.growl.ucr.edu

Financial Aid:
http://www.finaid.ucr.edu/
(951) 827-3878

Student Business Services:
http://www.sbs.ucr.edu/
(951) 827-3204

International Services:
http://www.internationalcenter.ucr.edu/
(951) 827-4113

Schedule of Classes:
http://classes.ucr.edu/

General Catalog :
http://catalog.ucr.edu/

VIII. ADDITIONAL RESOURCES

Campus Health Center (www.campushealth.ucr.edu)

Located in Veitch Student Center across from Parking Lot 15
Email: health@ucr.edu
Phone: (951) 827-3031

Child Development Center (**www.childrenservices.ucr.edu**)

Phone: (951) 827-5130

Housing Services (www.housing.ucr.edu)

Email: info.housing.ucr.edu
Phone: (951) 827-6350

Student Recreation Center (**http://src.ucr.edu**)

Phone: (951) 827-5738

Services for Students with Disabilities (**www.specialservices.ucr.edu**)

Hours 8-12, 1-5 or by appointment
Phone: (951) 827-4538

Transportation and Parking Services (**www.parking.ucr.edu**)

Phone: (951) 827-4395

Help: (951) 827-4395 ext.0

UCR Bookstore (**www.bookstore.ucr.edu**)

Phone: (951) 827-2665

UCR Libraries (**http://library.ucr.edu**)

Department of Motor Vehicles (DMV) (**http://www.dmv.ca.gov/fo.cgi?fo=riverside545**)

Riverside East DMV Office
6235 East Rivercrest Dr., #10-R
Riverside, CA 92507
(800) 777-0133

City of Riverside (www.riversideca.gov)

The Riverside Community *(www.smartriverside.com/stomping.cfm)*

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