A PROPOSAL

FOR A

MASTER OF ADVANCED STUDIES DEGREE

IN

Wireless Embedded Systems

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Proposal for a Master of Advanced Studies (MAS) Degree in Wireless Embedded Systems
– Preamble

The Department of Electrical and Computer Engineering (ECE), in conjunction with Department of Computer Science and Engineering (CSE), proposes a new Master of Advanced Studies (MAS) in “Wireless Embedded Systems” (WES). This program targets industry professionals in markets that involve wireless communications and embedded systems through a combined ECE and CSE graduate curriculum. Students who enroll in this program will have a background in computer science and/or electrical engineering.

Mobile telephony has reached roughly three billion people in the world today, and approximately one billion cellular telephones are sold each year - more than thirty a second. UCSD has established a dominant position in education and research in this field, and is widely recognized as the leading “wireless” research University in the United States. It is home to the Center for Wireless Communications and the Center for Networked Systems, which are supported by leading industries in the wireless field.

The next step in this wireless revolution is the interconnection of everyday devices through wireless technology (so-called “embedded wireless”). This market is expected to explode in the next decade. An embedded wireless device is a piece of electronic hardware with integrated software dedicated to perform a particular task, which connects wirelessly to the internet and may require very powerful processors.

Since the embedded device is dedicated to a specific task, its size, cost, reliability and performance need to be optimized. Embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. In the future, we expect all of these devices to be interconnected wirelessly.

The engineering skill set required to develop these new devices fundamentally spans the disciplines of Computer Science and Engineering and Electrical and Computer Engineering. As a result, a new approach to education needs to be considered when developing a program for professionals working in this field. And given the emergence of this new discipline, there is a strong need for a targeted high-quality program aimed at high-level training of professional engineers.

The UCSD MAS is designed to be a “Professional Master’s degree,” addressing the needs of students on an industrial or government career track, rather than a research track, with a focus on innovating new uses of existing technologies as opposed to inventing new technologies. The UCSD MAS in Wireless Embedded Systems will build on our historic strengths in the ECE and CSE Departments. Specifically, we have a substantial legacy in the Wireless and Embedded Systems areas, in terms of faculty, course offerings and industry contacts. In addition, we intend for this professional degree to impart the knowledge and skills that will serve the students well in a career in engineering design and engineering management.
# Table of Contents

1 **INTRODUCTION** .............................................................................................................................................4

1.1 AIMS AND OBJECTIVES OF THE PROGRAM ....................................................................................................4

1.2 HISTORICAL DEVELOPMENT OF THE FIELD ..................................................................................................4

1.3 TIMETABLE FOR DEVELOPMENT OF THE PROGRAM .....................................................................................5

1.4 RELATIONSHIPS OF THE PROGRAM TO EXISTING PROGRAMS ........................................................................5

1.5 INTERRELATIONSHIP OF THE PROGRAM WITH OTHER UC INSTITUTIONS ......................................................5

1.6 DEPARTMENT OR GROUP WHICH WILL ADMINISTER THE PROGRAM ....................................................................6

1.7 PLAN FOR EVALUATION OF THE PROGRAM WITHIN THE OFFERING DEPARTMENT(S) & CAMPUWSIDE. ........6

2 **PROGRAM** ........................................................................................................................................................6

2.1 REQUIREMENTS ...........................................................................................................................................6

2.2 FOREIGN LANGUAGE ...................................................................................................................................7

2.3 PROGRAM OF STUDY ....................................................................................................................................7

2.3.2 **Required Courses** .......................................................................................................................................8

2.4 CAPSTONE PROJECT, EVALUATION, AND EXAMINATIONS ...........................................................................9

2.5 QUALIFYING EXAMINATIONS ....................................................................................................................10

2.6 THESIS AND/OR DISSERTATION ..................................................................................................................10

2.7 FINAL EXAMINATION ..................................................................................................................................10

2.8 SPECIAL REQUIREMENTS OVER AND ABOVE GRADUATE DIVISION MINIMUM REQUIREMENTS ...................10

2.9 RELATIONSHIP OF MASTER’S AND DOCTOR’S PROGRAMS .........................................................................10

2.10 SPECIAL PREPARATION FOR CAREERS IN TEACHING ...................................................................................10

2.11 SAMPLE PROGRAM ....................................................................................................................................10

2.12 NORMATIVE TIME FROM MATRICULATION TO DEGREE. .............................................................................11

3 **PROJECTED NEED** ...........................................................................................................................................11

3.1 STUDENT DEMAND FOR THE PROGRAM ......................................................................................................11

3.2 OPPORTUNITIES FOR PLACEMENT OF GRADUATES .....................................................................................13

3.3 IMPORTANCE TO THE DISCIPLINE ...............................................................................................................14

3.4 WAYS IN WHICH THE PROGRAM WILL MEET THE NEEDS OF SOCIETY .........................................................14

3.5 RELATIONSHIP OF THE PROGRAM TO RESEARCH / PROFESSIONAL INTERESTS OF THE FACULTY .................14

3.6 PROGRAM DIFFERENTIATION ....................................................................................................................14

4 **FACULTY** ........................................................................................................................................................15

5 **COURSES** .........................................................................................................................................................15

5.1 CORE COURSES .........................................................................................................................................15

6 **RESOURCE REQUIREMENTS** ........................................................................................................................17

7 **GRADUATE STUDENT SUPPORT** ..................................................................................................................18

8 **CHANGES IN SENATE REGULATIONS** ...........................................................................................................18

9 **PROGRAM GOVERNANCE AND ADMINISTRATION** ......................................................................................18

10 **APPENDICES** ..................................................................................................................................................21
1  INTRODUCTION

1.1  Aims and objectives of the program

The Department of Electrical and Computer Engineering (ECE), in conjunction with Department of Computer Science and Engineering (CSE), proposes a new Master of Advanced Studies (MAS) in “Wireless Embedded Systems” (WES). This program targets industry professionals in markets that involve wireless communications and embedded systems through a combined ECE and CSE graduate curriculum. Students who enroll in this program will have a background in computer science and/or electrical engineering.

1.2  Historical development of the field

Mobile telephony has reached roughly three billion people in the world today, and approximately one billion cellular telephones are sold each year - more than thirty a second. UCSD has established a dominant position in education and research in this field, and is widely recognized as the leading “wireless” research University in the United States. It is home to the Center for Wireless Communications and the Center for Networked Systems, which are supported by leading industries in the wireless field. There are many innovations that have resulted from research at UCSD that have enabled the preeminence and growth of the wireless industry in the region.

The next step in this wireless revolution is the interconnection of everyday devices through wireless technology. This market is expected to explode in the next decade. For example, at this year’s Mobile World Congress, Ericsson CEO Hans Vestberg said that his company predicts that there will be 50 billion wirelessly connected devices by 2020. Vestberg added that these embedded devices will be used for communications with both machine-to-machine applications and consumer devices.

An embedded wireless device is a piece of electronic hardware with integrated software dedicated to perform a particular task, which connects wirelessly to the internet and may require very powerful processors. A recent high-profile example is the Amazon Kindle, which downloads books in seconds through a wireless network.

Since the embedded device is dedicated to a specific task, its size, cost, reliability and performance need to be optimized. Embedded systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure. In the future, we expect all of these devices to be interconnected wirelessly.

Embedded wireless devices have some unique requirements. Their form factor, cost and power consumption must be dramatically smaller than existing cellular phones, yet with almost all the
functionality of a complete phone! The engineering skill set required to develop these new devices fundamentally spans the disciplines of Computer Science and Engineering and Electrical and Computer Engineering. As a result, a new approach to education needs to be considered when developing a program for professionals working in this field. And given the emergence of this new discipline, there is a strong need for a targeted high-quality program aimed at high-level training of professional engineers.

The MAS is designed to be a “Professional Master’s degree,” addressing the needs of students on an industrial or government career track, rather than a research track, with a focus on innovating new uses of existing technologies as opposed to inventing new technologies.

Our plan for the Professional MAS has been influenced by a variety of considerations:

- The UCSD MAS in Wireless Embedded Systems will build on our historic strengths in the ECE and CSE Departments. Specifically, we have a substantial legacy in the Wireless and Embedded Systems areas, in terms of faculty, course offerings and industry contacts.

- A professional degree should impart knowledge and skills that will serve the students well in a career in engineering design and engineering management.

- Our plan builds on a comprehensive set of existing courses that will provide the foundation curriculum for this specialization.

1.3 Timetable for Development of the Program

We anticipate that this program will begin in the Fall of 2011 with an enrollment of 10-20 new students during the first year and with 20-30 new students per year at steady-state.

1.4 Relationships of the program to existing programs

The program is unique and there are no existing programs that we are aware of like that proposed at UCSD. There are several other MAS programs at UCSD. However, none of them are in the field of Wireless Embedded Systems, or Wireless Communications, or Embedded Systems. We currently have existing MS programs focused on wireless communications (in the ECE Department) and in embedded systems (in the CSE Department) but there is no program that spans both these areas, and neither of these programs is geared towards the working professional. The recently approved MAS in AESE is an example of a similar Professional MAS degree within the Jacobs School of Engineering at UCSD.

1.5 Interrelationship of the program with other UC Institutions

There is no interrelationship with other UC Institutions.
1.6 Department or group which will administer the program.

We propose that the degree program be a joint degree, either from the Department of Electrical and Computer Engineering degree or the Department of Computer Science and Engineering (at the discretion of the student). In this sense, the joint program will be very similar to the already existing UCSD Computer Engineering undergraduate program, which is jointly offered between the Departments of Electrical and Computer Engineering and Computer Science and Engineering.

At the same time, the pedagogical direction of the program, admission decisions, outreach to industry, financial decision making, and strategy for student advising, will be guided by a five-member steering committee. The steering committee will consist of two members from each Department and a Program Director (appointed by the Dean of the Jacobs School of Engineering). The composition of this steering committee, and its role in the administration of the program, are described later in this proposal.

1.7 Plan for evaluation of the program within the offering department(s) & campus-wide.

At the end of each course, enrollees will rate their experience on a number of dimensions. Standardized feedback instruments will be used to assess the responses. Enrollees will provide feedback on aspects of the course, including the curriculum, the faculty, the learning resources that were recommended or made available, and the practical experience provided by projects or assignments. Appropriate changes will be recommended to improve the program to see that learning objectives of the program are met. Faculty will be evaluated based on student course evaluations and overall engagement and participation in the program.

A written survey of students’ thoughts and professional activities related to the program will be conducted upon graduation each year. The compilation of these responses will provide input into the review process and will aid in the evaluation of the merit of the program.

Since the ultimate goal of the program is to improve its students’ performance in their professions, an important aspect of assessments will be whether the students can apply the knowledge and skills they have learned. The fundamental measure in making these assessments is provided by the capstone project. Periodic alumni surveys following graduation will also be considered. Information from these surveys will be reviewed to assess the impact of the program. As with all MAS programs, the Academic Senate will review the program on an 8 year cycle as per Senate requirements.

2 PROGRAM

2.1 Requirements

The MAS in Wireless Embedded Systems is directed to students who are engineers and engineering professionals. Because prospective students are expected to be full-time working
professionals, the lecture-style courses will be offered in the evenings and on weekends. As a result, we anticipate that the MAS versions of these courses will be taught as separate sections.

Admissions requirements are equivalent to Master of Science programs in ECE and CSE except that work experience may be substituted for GRE test scores. Admission requirements are as follows:

(i) Bachelor’s degree in engineering, mathematics, or physics
(ii) Undergraduate GPA of at least 3.0
(iii) 2 years work experience (in lieu of GRE)
(iv) Three letters of recommendation, one of which must be from the applicant’s current employer. For those who are unemployed, this requirement may be waived.
(v) TOEFL or TSE (international applicants only)

The proposed admission criteria are the same as those for the recently approved MAS in AESE – administered by the CSE Department. The GPA requirements are the same as for those for admission to our regular MS program. The GRE requirement, which is typical for our MS program, is waived for the MAS. But we substitute significant work experience as a requirement for admission to the MAS program, which provides an alternative quality assessment mechanism. Waiving the GRE requirement is a standard feature of existing MAS programs. On example is the UCSD IRPS MAS-IA program (http://irps.ucsd.edu), which has identical requirements to the proposed MAS-WES proposal.

The MAS degree is intended for people who have taken a hiatus from academic pursuits, and so require extra time and support to achieve high-level results. Admission to the program will be very rigorous, but the criteria will be different from those of an MS student.

2.2 Foreign Language

Foreign language is not required for this degree.

2.3 Program of Study

The burgeoning discipline of Wireless Embedded Systems (WES) is focused on methodologies and tools to develop next-generation wireless embedded systems. The proposed Professional MAS in WES is concerned with educating students at the intersection of a variety of multi-disciplinary engineering skills. Because the field of WES is still maturing, this program will provide students with the opportunity for a state-of-the art interdisciplinary engineering education as well as a rich area for significant and heretofore largely unexplored challenges. The expected result will be the development and maturation of a much needed engineering discipline that will address the upcoming technical challenges of this century.

The program of study for this degree arises from a core foundation of wireless communications and embedded system design. Historically, these two disciplines have been separated intellectually and by Department – with the wireless discipline arising from the field of communication theory and embedded systems arising from the field of computer systems. We
have found that these two fields are merging in this new domain of wireless embedded systems, and that a unified perspective on their development is required. For example, students need to understand the tradeoffs between the hardware/software capabilities in the wireless embedded devices and the limitations of the communications channel and the communications algorithms. Our existing graduate programs, which are deep but narrow, give students no formal tools for addressing these tradeoffs. Our proposed Professional MAS in Wireless Embedded Systems will give students valuable training and insight into both areas, and the capstone project will give them a unique opportunity to combine these two fields in a creative and original way.

2.3.1 Unit requirements

The MAS Wireless Embedded Systems program proposes a 36-unit degree that is to be taken over the course of two years in consecutive quarters. The curriculum consists of nine 4-unit courses. The capstone project (4 units) will require a combination of in-class, laboratory (either here at UCSD or at the engineers place of work), and off-campus work.

2.3.2 Required Courses

The Program is envisioned to include four engineering courses (at four units each) that focus on the general discipline of Wireless Communications

- Wireless Embedded and Networked Systems (WES267A Professor Curt Schurgers 2nd year)
- Communication Systems Laboratory I (WES268A Professor George Papen 1st year)
- Communications Systems Laboratory II (WES268B Professor George Papen 1st year)
- Communications Circuit Design (WES265A Professor James Buckwalter 2nd year)

Four engineering courses (at four units each) that focus on the general discipline of Embedded Systems

- Embedded Computing (WES145 Professor Ryan Kastner, Fall, 1st year)
- Advanced Processor Architecture (WES237A Professor Tajana Rosing Spring 1st year)
- Software for Embedded Computing (WES237B Professor Rajesh Gupta Fall 2nd year)
- Testing and Validation of Embedded Systems (WES237C Professor Rajesh Gupta Winter 2nd year)

The descriptions of these classes from the catalog are included in the Appendix.

Each class will culminate in a student final exam. Individual student grades for a course will be assigned, based on written understanding assessed through exams and class participation.

Finally WES 207 (Wireless Embedded Systems), a four unit capstone project - this project requires that students apply the course material to a realistic wireless embedded system engineering problem. This capstone requirement could be taught by several faculty within either Department, but Professor Curt Schurgers has offered to be the initial faculty member in charge of the capstone requirement.
The MAS in Wireless Embedded Systems will enroll approximately 20-30 new students per year (approximately 40-60 enrolled students at any given time) at steady-state. Courses will be offered on nights and weekends. The students are expected to take 1-2 courses per quarter, requiring two years to complete the degree.

This schedule will not impact current graduate programs, as there is currently a capacity within the faculty involved to teach the program on load; however should this situation change or if there is a need, we may consider offering the courses off load.

The program is required to be self-supporting, so no financial resources whatsoever can be diverted from the Departments to support the MAS program. A small amount of faculty time will also be diverted to the MAS program. However, we anticipate it will have no impact on the existing MS and PhD programs for several reasons. First, in many cases, the teaching of the MAS courses will be “off-load” and so the program will have no impact on the current faculty teaching load (both graduate and undergraduate). In those cases, where the faculty will be teaching “on-load,” the program fees will reimburse the Departments for the lost curse, and the Departments will use the funds to pay for an outside lecturer. So, in this scenario, there will be no loss of instruction.

We have structured the program in such a way that distance learning is not an integral feature of the educational experience at this time, but we will use educational technology where appropriate to enhance the experience for our professional students. For example, depending on the interest and availability of the videoconference rooms at UCSD and at a few distant locations, we would like to offer the program synchronously. But we would only do this if the distance learning adheres to all the requirements put in place by the Academic Senate.

http://senate.ucsd.edu/committees/CEP/PolicyChanges/DistanceAndOnlineInstruction.htm

In these cases, when exams are administered, students may be required to attend on campus or distant proctoring will be arranged. Should the Academic Senate approve other methods for offering courses at a distance, perhaps asynchronously, we would consider these in the future.

We also plan to videotape the lectures in selected classes and make them available for streaming to enrolled students, but the recording of courses is strictly for review of material, as working professionals may have business related travel demands that occasionally make them unable to attend lectures.

2.4 Capstone Project, Evaluation, and Examinations

The Professional MAS WES program will require a 4-unit capstone course. The project topic will be selected during the quarter prior to the final program in the quarter and will be determined with the assistance of the lead faculty member for the course. If students are unable to select a topic of relevant interest, possible topics for consideration will be provided for them. The intent is that the capstone project will be a 2-3 person team design project conducted with people who work in the same company. If this is not possible the capstone project may be an individual effort supervised by the lead faculty member.
The main objective of this project will be for small teams to demonstrate their critical thinking, organization, and design skills in attacking a problem within the WES field. The groups may approach this project as consultants hired to develop a new type of embedded wireless device for a specific application. They might be responsible for designing the device and implementing a working prototype. At the end of the quarter, a final “consultancy” report must be handed in, and a short technical oral presentation must accompany the deliverable. In addition, there might be a demonstration of the working prototype. The presentation and report will be reviewed by both the instructor and the other class participants in a peer-to-peer review process.

Performance on the capstone project will be used as an important measure of the student’s learning in the MAS Program. Each student will be evaluated based on his/her grasp of the course material and his/her ability to apply the course material to the capstone project. Satisfactory completion of the capstone team project is required for award of the MAS degree. Evaluation of the completed capstone project will serve as the final examination for the capstone project.

2.5 Qualifying Examinations
No Qualifying Examination is required.

2.6 Thesis and/or dissertation
No Thesis or dissertation is required.

2.7 Final examination
No final examination is required.

2.8 Special requirements over and above Graduate Division minimum requirements.
There are no special requirements over and above Graduate Division requirements.

2.9 Relationship of master’s and doctor’s programs.
This program will result in a supplemental Masters degree with no relationship to a doctoral program.

2.10 Special preparation for careers in teaching.
Teaching is not a component of this degree.

2.11 Sample program

There are nine courses required for completion of this program. Courses could be scheduled according to the following sample plan:

<table>
<thead>
<tr>
<th></th>
<th>Fall</th>
<th>Winter</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>WES 145</td>
<td>WES268A</td>
<td>WES268B</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>WES237A</td>
</tr>
<tr>
<td>Year 2</td>
<td>WES237B</td>
<td>WES237C</td>
<td>WES207</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Capstone</td>
</tr>
</tbody>
</table>
Note that the program starts with the “fundamentals” of embedded systems and wireless communications at the upper division undergraduate and graduate level in the first two quarters. Also note that each student is only expected to take one course per quarter initially, to ease them back into academic life. Then it moves into graduate courses and a higher level of engagement for the next year. The course are interrelated so that the student gains increasing expertise in the two key domain areas, with the capstone project synthesizing the learning at the end of the process.

2.12 Normative time from matriculation to degree.

The normative time from matriculation to degree is two years. This takes into account the target student population of experienced working professionals, as well as the course sequence as outlined in the previous section.

3 PROJECTED NEED

3.1 Student demand for the program

We expect that there will be a robust demand for this program, due to the large availability of wireless companies in the San Diego area, including Qualcomm, ViaSat, Motorola, Nokia, Huawei, Texas Instruments, etc. Of course, this is also a fertile area for entrepreneurial activity, and the “Qualcomms of the future” will also be supporters of this program. Table I on the next page, illustrates the estimated growth of employment in the high-tech area in the San Diego area in the next decade.1

Table I shows that the high-tech area is expected to grow in the San Diego area in the coming years, with large growth coming in the computer software and hardware fields, which are the focus of this program. The increase will be close to 5000 jobs, and a large portion of this will be in the wireless communications filed, which is the historic strength of the San Diego area.

While high-tech employment is slated to grow in the San Diego region in the coming years, the potential need for a Professional Masters degree in this area is evident by the letters of support from industry (included in the Appendix).

Overall, the number of master’s degrees awarded in the U.S. has increased by 43% from 1996 to 2006. While science and engineering fields have seen a slower-than-average growth, it is also substantial at 26%. Engineering is one of those fields where the master’s degree is generally recognized as an entry point to the profession.

Another indication of professional engineers’ needs for a mater’s degree, especially from distance-learning, is reflected by the fact that the Viterbi School of Engineering at USC enrolls

1 http://www.sandiegoatwork.org/pdf/lmi/employment_projections/06_16_projections_alpha.pdf
more than 4,000 MS students through its Distance Education Network program.\textsuperscript{2} Many of these students are employees of the companies in the San Diego County.

According to salary surveys, the master’s graduate commands a relatively high salary during the early years of a career\textsuperscript{3}. Data from the National Science Foundation (NSF) reveal that median salaries of master’s degree recipients one to five years after the degree was conferred tend to be higher than those with a Bachelor’s degree. More importantly, salaries of master’s degree holders in science and engineering have grown faster over the past 10 years than salaries of baccalaureate or doctorate holders.\textsuperscript{3}

<table>
<thead>
<tr>
<th></th>
<th>Average Employment</th>
<th>Employment Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2006</td>
<td>2016</td>
</tr>
<tr>
<td>Aerospace Engineers</td>
<td>1270</td>
<td>1440</td>
</tr>
<tr>
<td>Biomedical Eng.</td>
<td>380</td>
<td>510</td>
</tr>
<tr>
<td>Chemical Eng.</td>
<td>160</td>
<td>190</td>
</tr>
<tr>
<td>Civil Eng.</td>
<td>3200</td>
<td>3630</td>
</tr>
<tr>
<td>Computer Hardware Eng.</td>
<td>1610</td>
<td>1790</td>
</tr>
<tr>
<td>Computer Software Eng. (Apps)</td>
<td>6550</td>
<td>9290</td>
</tr>
<tr>
<td>Computer Software Eng. (Sftwre)</td>
<td>4140</td>
<td>5160</td>
</tr>
<tr>
<td>Electrical Eng.</td>
<td>1760</td>
<td>1910</td>
</tr>
<tr>
<td>Electronics Eng.</td>
<td>4040</td>
<td>4420</td>
</tr>
<tr>
<td>Engineering Manager</td>
<td>3980</td>
<td>4480</td>
</tr>
<tr>
<td>All Other Eng.</td>
<td>4170</td>
<td>4510</td>
</tr>
<tr>
<td>Environmental Eng.</td>
<td>740</td>
<td>890</td>
</tr>
<tr>
<td>Industrial Eng.</td>
<td>1540</td>
<td>2020</td>
</tr>
<tr>
<td>Materials Eng.</td>
<td>220</td>
<td>250</td>
</tr>
<tr>
<td>Mechanical Eng.</td>
<td>3080</td>
<td>3350</td>
</tr>
<tr>
<td>Operational Eng.</td>
<td>3030</td>
<td>3310</td>
</tr>
</tbody>
</table>

\textit{Table I: Estimated Growth of Engineering Employment in the San Diego Region\textsuperscript{1}.}

In addition, master’s graduates who do not pursue a doctorate have four extra years or so to earn their relatively high salaries. Overall, then, a typical student should obtain a substantial financial

\textsuperscript{2} http://viterbi.usc.edu/assets/096/66664.pdf
return for their tuition investment. The “market premium” for a master’s degree also signals
good employment opportunities for graduates, and a compelling value proposition for employers.
This market premium is illustrated in Fig. 1 on the next page, which shows the lifetime earnings
trends of people with BS, MS and PhD’s in the S&E fields. There is a $200k to $300k lifetime
premium for an MS degree compared to a BS.

![Fig. 1: Median salaries of S&E graduates\(^3\).](image)

The proposed program is designed for experienced working professionals who want to augment
their education in engineering. Industry need and student demand for this program is very strong.

### 3.2 Opportunities for placement of graduates

The program is intended for working engineers who will be supported by their companies and
employed during the program. As a result, the placement of graduates is not a primary concern to
this program except that it may improve prospects for advancement and future employment
opportunities. For students who are unemployed, the Jacobs School Engineering Student
Services and the campus Career Service Center can provide some assistance in terms of résumé
advising, internship opportunities, and jobs listing.
3.3 Importance to the discipline
The burgeoning discipline of Wireless Embedded Systems (WES) is focused on methodologies and tools to develop next-generation wireless embedded systems. The proposed MAS in WES is concerned with educating students at the intersection of multi-disciplinary engineering skills. Because the field of WES is still maturing, this program will provide students with the opportunity for a state-of-the-art interdisciplinary engineering education as well as a rich area for significant and heretofore largely unexplored challenges.

The discipline of embedded wireless systems also requires a fundamental re-engineering of the educational approach. The classic issue of “deep but narrow” vs. “shallow but broad” requires re-evaluation. In this field, engineers need to be both deep and broad. The purpose of this program is to enable this training in an area that draws on several different engineering disciplines, and where expertise is required in all the areas to make really effective progress.

3.4 Ways in which the program will meet the needs of society
California and the United States need more highly qualified engineers. This simple statement is a reflection of a deeper truth: to maintain our standard of living as a nation, we need to continue to innovate and lead in Science and Engineering. A recent speech by Senator Ted Kaufman marking the recent 40th anniversary of the Apollo 11 mission to the moon captured the essence of the need for highly trained, innovative, engineers. A few quotes from that speech are:

“The vitality of our economy rests with our ability to be the world's leader in innovation. As we face some of our greatest economic challenges, the scientific and engineering community has the greatest potential to find avenues for what we need most: new, sustainable jobs.”

“I am confident that engineers will continue to foster the research and innovation that will lead America on a path to economic recovery and prosperity. They will help us build a clean energy economy, stay competitive in a globalizing world, and drive the real-world applications from our nation's health and science research to improve our quality of life. Moreover, these discoveries and innovations will create millions of new jobs and invest in our future.”

3.5 Relationship of the program to research / professional interests of the faculty
As demonstrated in the faculty biographies in the appendices, the program directly overlaps and aligns perfectly with the research interests of every proposed faculty member. For example, Professor Rajesh Gupta is a world expert in the field of embedded systems (Founder of the IEEE Journal in Embedded Systems). Professor Curt Schurgers is a leading expert in the field of underwater networked devices. Professor Tajana Rosing is an expert in the field of low-power wireless devices.

3.6 Program Differentiation
The proposed program does not duplicate any existing program nation-wide, but rather enhances the offerings provided in this field of study and meets a particular need of industry.

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4 http://kaufman.senate.gov/press/press_releases/release/?id=a34d34d6-6515-4763-83b0-12f7ed61df42
4 Faculty
The program incorporates the expertise of eight ladder rank faculty members who are interested in participating in the program. The course matrix provided in 2.1.1 indicates which faculty will serve as courses instructors. The capstone course will be initially managed by Professor Curt Schurgers. All faculty associated with the program will have equal opportunity to provide input into development and evolution of the program. All of the faculty members have indicated their willingness to serve on the executive committee (discussed in Section 9), if asked to do so. The Appendix includes CVs of participating faculty.

5 Courses

5.1 Core Courses
The core courses for the program have been designed to provide an integrated program that incorporates the most advanced instruction in the fields of embedded systems and wireless communications. The order of the courses was chosen to start with advanced undergraduate material, to give the students an opportunity to “re-acclimate” to rigorous academic work. Then, after the first two quarters, they are exposed to more rigorous graduate level work that builds on the material form the beginning of the program.

All but one of the courses (the Capstone course) is currently being offered in the ECE or CSE Department. The course descriptions are as follows:

WES 268A (ECE 157A/ECE268A) Communications Systems Laboratory I - Experiments in the modulation and demodulation of baseband and pass-band signals. Statistical characterization of signals and impairments. This course is currently under review for “co-listing” as a graduate course in ECE.

WES268B (ECE 157B/ECE268B), Communications Systems Laboratory II - Students will plan and implement design projects in the laboratory, updating progress weekly and making plan/design adjustments based upon feedback. This course is currently under review for “co-listing” as a graduate course in ECE.


WES267A (ECE267A). Wireless Embedded and Networked Systems: Study of wireless networked systems from a system design perspective, covering the protocol stack from physical to network layer with a focus on energy. Topics include digital communications, networking and programming, and a basic knowledge of these is recommended.

WES145 (CSE 145). Embedded System Design Project: Project class building an embedded computing system. Learn fundamental knowledge of microcontrollers, sensors, and actuators. Introduction to the hardware and software tools to build project in a team environment and end-to-end system building.


WES 207 (Wireless Embedded Systems), a four-unit capstone project. The project topic will be selected during the quarter prior to the final program in the quarter and will be determined with the assistance of the lead faculty member for the course. If students are unable to select a topic of relevant interest, possible topics for consideration will be provided for them. The intent is that the capstone project will be a 2-3 person team design project conducted with people who work in the same company. If this is not possible the capstone project may be an individual effort supervised by the lead faculty member.

We do not feel that the additional strain of these added courses is significant at this point in time for several reasons. First, we have recruited new faculty in this area (Ryan Kastner in CSE most recently), and two of the principal faculty (Larson and Papen) will be stepping down from administrative roles and will have additional time to devote to these courses. Second, our current teaching load (in ECE especially) is modest, as measured by the modified Penner ratio (ECE is 0.94 for FY 2009 and CSE is 1.0 for FY 2009). So, both Departments are prepared and able to devote resources to this effort.

The program is required to be self-supporting, so no financial resources whatsoever can be diverted from the Departments to support the MAS program. A small amount of faculty time will also be diverted to the MAS program. However, we anticipate it will have no impact on the existing MS and PhD programs for several reasons. First, in many cases, the teaching of the MAS courses will be “off-load” and so the program will have no impact on the current faculty teaching load (both graduate and undergraduate). In those cases, where the faculty will be teaching “on-load,” the program fees will reimburse the Departments for the lost curse, and the Departments will use the funds to pay for an outside lecturer. So, in this scenario, there will be no loss of instruction.

However, it is not realistic to say that this additional program can be created without any cost, and we need to be completely honest about the tradeoffs. The ECE department expects that this new
program will cause a modest reduction in course buyouts, roughly two fewer buyouts per year. This will negatively effect some aspects of the Department budget, but the effect is small compared to the overall total Department budget. In addition, the faculty and staff will have to respond to increased advising responsibilities for these students in both Departments. But this will be offset by the higher fees charged for this program, which will allow us to maintain proper staffing of the student affairs office.

6 Resource requirements
No new campus resources will be required to support this program as it is completely self supporting. Based on the experience of administering other self supporting programs in the Jacobs School, enrollment is estimated to be approximately 10 students the first year and increase by an increment of 5 students per year.

There are several similar self-supporting Master’s programs currently being offered. Stanford’s EE MS degree (15 courses) charges $58,950.5 USC’s online M.S. in Computer Engineering (9 courses) charges $36,720.6 UCLA’s online MS in Engineering program (36 units) charges $30,000 per student.7 The UCSD SOM’s MAS in Leadership of Healthcare Organizations (42 units) charges $28,500;8 its MAS in Clinical Research (36 units) charges $26,000.9 The MAS in International Studies offered by the International Relations and Pacific Studies (48 units) charges $30,000 per student. Students in the proposed UCSD MAS in Wireless Embedded Systems (36 units) will be charged $27,000. All of the above numbers are just program fees, not including health insurance fees ($516 per quarter) and registration fees ($480.50) per quarter). As shown in the accompanying Table, ten students in the program will generate an annual income of approximately $270,000 and will be sufficient to support the program and generate a small surplus that will allow some reinvestment. The program financial forecast is summarized below in Table II. The following paragraph presents a summary of the financial analysis.

Section 2.3.2 mentions that because of the enough capacity in the ECE and CSE departments the faculty involved to teach the program will be on load; but, if necessary, we may consider offering the courses off load. Here we assume the 4 instructors of core and project courses are paid off load at 1.5 months of their salary but capped at $15,000 per course. This cap, slightly higher than 1.5 months of a Full Professor, Step II ($14,250), is substantially higher than the cap of $10,000 the summer session pays its instructor. In addition, ½ TA (10 hours/week) is assigned for 10-15 students and 1 TA (20 hours/week) is assigned for 16-29 students in the class. This is substantially more generous than the current TA allocation in the department (1/2 TA for 50 students in ECE) and is required in order to provide these MAS students the additional high-quality support that they will need to re-enter the academic environment after their hiatus. The ½ TA costs about $3,000 in stipend and $4,000 in fees, and 1 TA costs $6,000 in stipend and $4,000 in fees. The IT cost (video server and some IT support) is estimated to be $45,000 for

5 http://scpd.stanford.edu/public/category/courseCategoryCertificateProfile.do?method=load&certificateId=1227185#searchResults
6 http://mapp.usc.edu/mastersprograms/tuitionandfees/tuitionfees.html
7 http://msengrol.seas.ucla.edu/
8 http://lhco.ucsd.edu/prospectivestudents/fees.cfm
9 http://clre.ucsd.edu/prospectivestudents/fees.cfm
videotaping the lectures for those students who might miss a class due to work-related travel. The TA will do the videotaping.

Each course requires one TA per quarter. There are nine courses offered per year, so there are nine TA-quarter’s required per year. Each of the TAs is used only for the one quarter class. These TAs will not be diverted from TA assignments in the existing undergraduate or graduate courses. Full TA coverage for these MAS courses is especially important for students returning to an academically challenging environment after several years away from the University. The full-scope of the TA duties involves grading homeworks and quizzes, supervising Laboratory Sessions, responding to student questions during office hours and by e-mail where necessary, installing and running software design packages, assisting the faculty during exams, and possibly videotaping the courses when needed.

The Dean’s Office in the Jacobs School charges 8.15% for administrating the program (room reservation, receiving payments, and paying faculty, etc.). Finally about 15% of the fees generated will be reserved for financial aids for those whose tuition fees are not covered by their employers. The financial aid will be in the form of 4 $10,000 scholarships.

<table>
<thead>
<tr>
<th># students</th>
<th>10</th>
<th>$ 270,000</th>
<th>20</th>
<th>$ 540,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Instructors’ stipend</td>
<td>$ 60,000</td>
<td>$ 60,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 TAs</td>
<td>$ 63,000</td>
<td>$ 90,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT (video, website)</td>
<td>$ 45,000</td>
<td>$ 45,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Admin fee @ 8.1%</td>
<td>$ 22,000</td>
<td>$ 44,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Aid @ 14.8%</td>
<td>$ 40,000</td>
<td>$ 80,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total expenses</td>
<td>$ 230,000</td>
<td>$ 319,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net income to depts</td>
<td>$ 40,000</td>
<td>$ 221,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table II: Projected Income from the MAS WES Program

7 Graduate Student Support

MAS students are ineligible for merit-based aid due to the fact that students enrolled in the program are already working professionals.

8 Changes in Senate regulations

No changes to Senate regulations are proposed.

9 Program Governance and Administration

The program is interdisciplinary in nature and involves two departments within the Jacobs School of Engineering. The program will be jointly administered by the Department of Electrical and Computer Engineering and the Department of Computer Science and Engineering, much like the undergraduate Computer Engineering program. In this case, it will be administered by the MAS Steering Committee, which is made up of faculty from both departments. This will be an ECE–CSE joint degree program offered in both departments. The student can receive an MAS in either ECE or
an MAS in CSE (at the student’s discretion), although admissions to the MAS will be decided by the MAS steering committee. In this sense, the joint program will be very similar to the already existing UCSD Computer Engineering undergraduate program, which is jointly offered between the Departments of Electrical and Computer Engineering and Computer Science and Engineering.

The MAS program itself will be administered by an MAS WES Executive Steering Committee, consisting of two members of each Department (ECE and CSE). One additional member of the steering committee will be designated as the Program Director by the Dean of the Jacobs School of Engineering, and the Director will appoint the other members, in consultation with the Department Chairs of the Jacobs School. The steering committee is charged to

- Oversee student recruitment and admissions decisions.
- Recommend academic standards as well as other requirements, for continued student enrollment in the program.
- Provide curriculum oversight for the program.
- Advise the departments and the Dean of Graduate Studies concerning students who fail to fulfill requirements of the program.
- Oversee management of funds.
- Guide the continuous evaluation of the program.
- Oversee/organize events and program-wide activities, discussions, retreats, etc.

Students will be mentored by faculty involved in the program. Admission into the MAS program will be limited to the number of students who can be appropriately supervised by the available and interested faculty. Ultimate authority rests with the Steering Committee to determine student requirements, admissions, and management of the program. While intended to provide program guidance, the Steering Committee’s role is advisory to both the Program the Director and the ECE and CSE Departments, ultimately resting with the faculty who are members of the Academic Senate.

Academic Advising will be handled through the Departments (with ECE providing support for ECE courses, CSE providing support for CSE courses, and ECE providing support for general programmatic advising in terms of courses, degree planners, etc). At the same time, we want to ensure that the MAS students are integrated with the rest of the engineering student body within the Jacobs School of Engineering and benefit from close relationships with the entire Jacobs School graduate student infrastructure. This aspect of the relationship will be managed by the Engineering Student Services (ESS) operation, which is administered by the Divisional Dean. The ECE, CSE and ESS staff may be accessible to students outside of standard business hours to ensure that MAS students are integrated with the rest of the engineering student body and benefit from close relationships with the entire Jacobs School graduate student infrastructure. Fees from MAS students will finance the extra advising required by the Departments and ESS so that it does not impact the support provided to traditional graduate students at the Jacobs School.

One administrator will be designated to serve as a liaison between the university and the MAS students to ensure the unique needs of working adult students are met and to provide guidance to students regarding university procedures. These student service functions include:
• Organizing prospective students’ application packets, supporting the Admissions Committee, and helping to determine appropriate fees
• Assisting students with expediting enrollment, enforcing deadlines, and ascertaining that students receive ancillary services such as parking stickers, ID cards, and computer registration
• Checking fee waivers and exemption contracts, providing loan packets, explaining financial obligations to the students
• Conveying student comments concerning administration to course planners and making sure that students’ needs are met
• Ascertaining that students complete courses needed for the degree, assisting them with career transitions or placement interests
• Assistance with visa, housing, insurance and other arrangements for students from outside the San Diego region

Financial management involves setting program fees, planning a budget, monitoring actual vs. projected income, monitoring expenditures, reporting to campus and OP budget and audit offices, and negotiating fee discounts.

Faculty services are one additional element of program administration. Instructor services will be handled directly by the Jacobs School with resources funded by MAS fees. This function involves reserving and obtaining access to suitable classrooms, scheduling course meetings, ordering textbooks and obtaining audiovisual materials, administering class evaluations and grade reports, preparing occasional instructors for their teaching assignments and negotiating salaries with them.

All program promotion will be done with the close collaboration of the Jacob School’s Corporate Affiliates Program (CAP).
10 APPENDICES

A. Biography of the ECE and CSE Faculty
RESEARCH PROGRAM

Analog, Mixed-Signal, and Millimeter-wave Integrated Circuit Design for Broadband Communication

EDUCATION

California Institute of Technology  Pasadena, CA
Department of Electrical Engineering
Ph.D., Electrical Engineering  January 2006
Dissertation: Deterministic Jitter in Broadband Communication
Advisor: Prof. Ali Hajimiri

University of California, Santa Barbara  Santa Barbara, CA
Department of Electrical and Computer Engineering
M.S., Electrical Engineering  December 2001

California Institute of Technology  Pasadena, CA
Department of Electrical Engineering
B.S. with Honors, Electrical Engineering  June 1999

RESEARCH EXPERIENCE

University of California-San Diego  La Jolla, CA
Assistant Professor  July 2006-Present
Department of Electrical and Computer Engineering

Luxtera Inc.  Carlsbad, CA
Senior Engineer  May-July 2006

California Institute of Technology  Pasadena, CA
Graduate Research Assistant  July 2002- Jan. 2006

IBM T. J. Watson Research Center  Yorktown Hts., NY
Student Internship  June-Sept. 2004

University of California, Santa Barbara  Santa Barbara, CA
Graduate Research Assistant  Sept. 2000- July 2002

Telcordia Technologies  Morristown, NJ
TEACHING EXPERIENCE

<table>
<thead>
<tr>
<th>Course</th>
<th>Institution</th>
<th>Terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 265A Communications Circuits</td>
<td>UCSD</td>
<td>Winter 2008, 2009, 2010</td>
</tr>
<tr>
<td>ECE 283 Broadband Communications Circuits</td>
<td>UCSD</td>
<td>Fall 2006</td>
</tr>
</tbody>
</table>

SCHOLARLY ACTIVITIES

IEEE Transactions of Circuits and Systems II, Associate Editor; IEEE Microwave Theory and Techniques Society, Member; IEEE International Microwave Symposium 2010, Steering Committee Member; IEEE Solid-state Circuit Society, Member; IEEE Journal of the Solid-State Circuits, Reviewer; IEEE Transactions on Microwave Theory and Techniques, Reviewer; IEEE Transactions of Circuits and Systems I, Reviewer; IEEE Transactions on Antenna and Propagation, Reviewer

REFEREED JOURNAL PUBLICATIONS


Rajesh Gupta works on energy efficient and mobile computing systems. He has earlier led as PI or Co-PI on DARPA-sponsored projects on Adaptive/Reconfigurable Architectures (Data Intensive Systems) and Compiler-Controlled Energy Efficient Systems (Power-Aware Computing Communications). His recent contributions include SystemC modeling and SPARK parallelizing high-level synthesis, both of which are publicly available and have been incorporated into industrial practice. His ongoing research efforts concern models and methods for using and improving localization information in mobile computing systems.

EDUCATION


RELEVANT RESEARCH AND WORK EXPERIENCE

2003-now  Qualcomm Chair Professor, Computer Science & Engg., UC San Diego
2006  Visiting Professor, EPFL, Lausanne, Switzerland
2005  Visiting Professor, Electrical Engineering, Stanford University
2002-2003  Professor of Information and Computer Science, UC Irvine
1998-2002  Associate Professor of Information and Computer Science, UC Irvine
1996-1997  Assistant Professor of Information and Computer Science, UC Irvine
1994-1996  Assistant Professor of Computer Science, U. Illinois, Urbana-Champaign.
1986-1993  Senior Design Engineer, Intel Corporation, Santa Clara, California.

AWARDS AND HONORS

IEEE Computer Society Golden Core Member 2006.
IEEE Fellow, 2004
A. K. Chowdhary Best Paper Award, VLSI Design Conference, Delhi, India, 2003
Chancellor’s Fellow, UC Irvine, March 2002
Distinguished Lecturer, IEEE Circuits and Systems Society 2001-02, ACM SIGDA 2001
Chancellor’s Award for Excellence in Undergraduate Research, UC Irvine, 1997.
NSF CAREER Award, National Science Foundation, 1995.
Departmental Achievement Award, Microprocessor Division, Intel, 1989 & 1987

RECENT AND ONGOING SYNERGISTIC ACTIVITIES

Editor-in-Chief, IEEE Embedded Systems Letters, 2009-.
Chair, Steering Committee, IEEE Transactions on Mobile Computing, 2004-2006
TPC Chair, 21st Symposium on Integrated Circuits and Systems Design, SBCCI 2008, Brazil
RELEVANT RECENT PUBLICATIONS


OTHER RECENT PUBLICATIONS


LIST OF COLLABORATORS IN THE LAST 48 MONTHS: Michael Todd (UCSD), Tajana Rosing (UCSD), Sanjoy Dasgupta (UCSD), Stephen Boyd (Stanford), Mani Srivastava (UCLA).

PhD ADVISOR: Giovanni De Micheli (EPFL) / PhD ADVISEES: Ravindra Jejurikar, Nick Savoiu, Jian R. Li (Cisco), Ali Dasdan (Synopsys), Dinesh Ramanathan (Cypress Semiconductor), Sumit Gupta (Tensilica).
Ryan Kastner
Department of Computer Science and Engineering
University of California, San Diego CA 92093
http://www.cse.ucsd.edu/~kastner

Professional Preparation

Northwestern University  BS, Electrical Engineering  1999
Northwestern University  BS, Computer Engineering  1999
Northwestern University  MS, Computer Engineering  2000
University of California, Los Angeles  PhD, Computer Science  2002

Appointments

UCSD Department of Computer Science and Engineering
Associate Professor – San Diego, CA  Nov 2007 – present

UCSB Department of Electrical and Computer Engineering
Assistant, Associate Professor – Santa Barbara, CA  Sept 2002 – Nov 2007

UCLA Embedded and Reconfigurable Computing Lab
Graduate Research Assistant – Los Angeles, CA  Sept 2000 – Sept 2002

Northwestern University VLSI CAD Group
Graduate Research Assistant – Evanston, IL  Jan 1999 – Aug 2000

Publications Related to the Proposed Project


Additional Publications


**Synergistic Activities**

Professor Kastner has served as a member of numerous conference technical committees in the CAD and reconfigurable computing communities including the International Conference on Computer Aided Design (ICCAD), Design Automation Conference (DAC), Design, Automation and Test in Europe (DATE), International Symposium on FPGAs (FPGA), Engineering of Reconfigurable Systems and Algorithms (ERSA), and the International Conference on Field Programmable Logic and Applications (FPL). He served as the Publicity Chair for the 2009 International Workshop on Underwater Networks (WUWNet).

**Affiliations**

**Collaborators in Prior 48 Months**
Grace Chang, SeaEngineering
Farzan Fallah - Fujitsu Laboratories of America, Inc.
Rajesh Gupta - UCSD
Cynthia Irvine – Naval Postgraduate School, CS Dept
Ronald Ilitis - UCSB, Dept. of ECE
Ted Huffmire – Naval Postgraduate School, CS Dept
Derek Manov, UCSB, Dept. of Geology
Hua Lee - UCSB, Dept. of ECE
Timothy Levin – Naval Postgraduate School, CS Dept
Thuy Nguyen – Naval Postgraduate School, CS Dept
Timothy Sherwood – UCSB, CS Dept.
Curt Schurgers – UCSD, ECE Dept.
Xing Zhang – Peking University

**PhD Students**: Chris Barngrover, Bridget Benson, Wei Hu, Ali Irturk, Janarbek Matay, Shahnam Mirzaei, Deborah Goshorn, Ying Li

**Post Doctoral Research**: Jung Uk Cho, Ali Irturk

**Undergraduate Students**: Brian Faunce, Robert Chen, Samuel Wood

In the past 5 years, Ryan has supervised 10 PhD students and 3 MS students.

**Ph.D. Advisor**: Professor Majid Sarrafzadeh at the University of California, Los Angeles.
George C. Papen  
Professor of Electrical & Computer Engineering  
University of California at San Diego  
Phone: 858-822-1728  Fax: 858-534-1225  Email: gpapen@ucsd.edu

Research Areas  
Systems applications of optics in computing and communication

Education  
Ph.D., Electrical Engineering, University of Wisconsin - Madison, 1989  
M.S., Electrical Engineering, University of Wisconsin - Madison, 1987  
B.A., Physics, Bowdoin College, 1980

Professional Experience  
1986-1989  Research and Teaching Assistant University of Wisconsin-Madison  
1989-1995  Assistant Professor Department of ECE University of Illinois  
1989-present  Research Associate - Beckman Institute University of Illinois  
1995-present  Associate Professor Department of ECE University of Illinois  
1995-present  Group leader Center for Optical Science and Technology  
1995-1997  Co-leader Critical Research Initiatives group on Sensor Development  
2000-2002  Professor Department of ECE University of Illinois  
2002-present  Professor Department of ECE University of California at San Diego

Societies and Professional Activities  
Member IEEE Lasers and Electro-Optics Society, Optical Society of America  
Member Technical Committee Conference on Lasers and Electro-Optics 1996, 1997  
Member Technical Committee OSA Optical Remote Sensing, 1997  
Member ECE Department Advisory Board 1997  
Technical Program Chair OSA Optical Remote Sensing, 1999  
Tutorial Program Chair, High Speed Interconnects within Digital Systems, 1999.  
Co-chair CEPS workshop 1999, 2000  
Tutorial Program Chair, High Speed Interconnects within Digital Systems, 1999  
Program Chair, High Speed Interconnects within Digital Systems, 2000  
General Chair, OSA Optical Remote Sensing Conference, 2001  
General Chair, High Speed Interconnects within Digital Systems, 2001  
IEEE Communication Society Technical Committee Chair – High Speed Interconnections  
Within Digital Systems 2001 – present

Patents  
G. C. Papen, D. J. Brady and W. M. Murphy,  

R. Adrian, D. Barnhart and G. C. Papen, "Stereo Multiplexed Holographic Particle  

G. C. Papen, P. Dragic, “Method to Suppress Stimulated Brillouin Scattering in Optical  

Five Relevant Publications  


Five Other Significant Publications


Synergistic Activities
1) Developed course on remote sensing while at UIUC based on research.
2) Develop a lab-based course on optical communications based on research in fiber amplifiers and systems.
3) Served on several conference committees (see above).
4) In the process of refining first-year Electrical Engineering course at UCSD.

Other Collaborators in Last 48 Months

Student Supervision and Ph.D. Graduates
Graduate advisor: B. Saleh
Ph.D. graduates

MS Graduates
Biographical Sketch: Tajana Šimunić Rosing

Professional Preparation
Northern Arizona University   BS in Electrical Engineering   1992
University of Arizona      MS in Electrical and Computer Engineering   1993
Stanford University       MS in Engineering Management        2000
Stanford University       PhD in Electrical Engineering         2001

Appointments
98 – pres.   UCSD,  Assistant Professor in CSE Department
98 – 05    Hewlett-Packard Laboratories, Project Manager and Research Scientist
97 – 05    Stanford University, Researcher
93 – 97    Altera Corporation, Senior Design Engineer
92 – 93    University of Arizona, Graduate Research Assistant
88 – 92    Northern Arizona University, Undergraduate Research Assistant

Sample Publications (available at http://www.cse.ucsd.edu/~trosing/index.html)
Most closely related to the proposed work:

Other publications:

Synergistic Activities
Faculty Advisor for Women in Computing, UCSD, 2005 – pres.
Organization of Workshop for Women in Design Automation 2006 and panelist at the workshop in 2005
Initiated and led retraining of Bosnian refugees as chip layout technicians 1995-1997
Tutoring of underrepresented minorities in computer systems, math and physics, 1988-1992
Collaborations and Other Affiliations

Collaborators and Coeditors
- John Ankcorn, HP Labs
- Luca Benini, University of Bologna
- Hans-Werner Braun, UCSD
- Stephen Boyd, Stanford University
- Chuck Farrar, LANL
- Peter Glynn, Stanford University
- Kenny Gross, Sun Microsystems
- Rajesh Gupta, UCSD
- Mat Hans, Motorola
- Nikil Jiant, Gatech
- Faraydon Karim, ST Microelectronics
- Dilip Krishnaswamy, Intel
- Yusuf Leblebici, EPFL
- Geetha Manjunnath, HP
- Alain Mellan, ST Microelectronics
- Subhashish Mitra, Stanford
- Vincent Mooney, Gatech
- Sumit Roy, HP Labs
- Mark Smith, KTH
- Jean Tourrilhes, HP Labs
- Haris Vikalo, Caltech
- Keith Whisnant, Sun Microsystems

Graduate Advisors
- Giovanni De Micheli, EPFL
- Jerzy Rozenblit, University of Arizona

Thesis Advisor
- Andrea Acquaviva, University of Ferrara
- Priti Aghera, UCSD
- Raid Ayoub, UCSD
- Jamie Bradely, UCSD
- Ozgur Celebican, Gatech
- Ayse Coskun, UCSD
- Brian Delaney, MIT Research Lab
- Gaurav Dhiman, UCSD
- Daeseob Lim, UCSD
- C.T. Mar, Gatech
- Kresimir Mihic, Stanford University
- Armita Peymandoust, Synopsis
- Wajahat Qadeer, Stanford University
- Edoardo Regini, UCSD
- Shervin Sharifi, UCSD
Curt Schurgers, Assistant Professor of Electrical and Computer Engineering

Department of Electrical and Computer Engineering
9500 Gilman Drive
University of California, San Diego, CA 92093-0407
(858) 534-4865 [Voice], (858) 822-3427 [Fax], curts@ece.ucsd.edu [Email]

PROFESSIONAL PREPARATION

Katholieke Universiteit Leuven, Belgium Electrical Engineering M.S. 1997
U.C. Los Angeles (UCLA) Electrical Engineering Ph.D. 2002
Massachusetts Institute of Technology Postdoctoral Associate, EECS 2002-2003

APPOINTMENTS

July 2002 – present Assistant Professor, Electrical and Computer Engineering, UCSD
Courses taught: ECE 102 (7x), ECE 111, ECE 108 lab, ECE 284 (3x), ECE 267 (3x)
April 2002 – June 2002 Lecturer, Electrical Engineering, UCLA
Courses taught: EE 116B
April 1999 – March 2002 Graduate Student Researcher, UCLA

PUBLICATIONS

a. Closely Related Publications
• Mirza, D., Schurgers, C., “Energy-efficient localization in networks of underwater drifters,”
  ACM WWUWNet’07, Montreal, Canada, 2007.
  http://circuit.ucsd.edu/~curts/wisl/documents/JSAC08_UW.pdf
• Diba Mirza and Curt Schurgers, “Collaborative Tracking in Mobile Underwater Networks,”
  ACM WWUWNET’09, Berkeley, CA, 2009.

b. Other Significant Publications
  http://fleece.ucsd.edu/~curts/papers/TECS02.pdf


SYNERGISTIC ACTIVITIES
• Program committee member for related conferences: ISLPED’03, MobiHoc’03, SECON’04, IPSN’05, SECON’05, IPSN’06, SECON’06, MASS’06, SECON’07, SECON’08, WUWNET’08, SENSAPPEAL’09.
• Executive committee member of related conferences: SenSys’05, SECON’07, SECON’08, WUWNet’09.
• Reviewer for related journals/magazines: Transactions on Mobile Computing (IEEE), Transactions on Embedded Computing Systems (ACM), Transactions on Vehicular Technology (IEEE), Transactions on VLSI Systems (IEEE), Transactions on Wireless Communications (IEEE), Journal on Selected Areas in Communication (IEEE, special issue Underwater Wireless Communications and Networks)

COLLABORATORS & OTHER AFFILIATIONS
a. Collaborators & Co-editors
Mr. Yuvraj Agarwal (UCSD), Prof. Anantha Chandrakasan (MIT), Prof. Sujit Dey (UCSD), Mr. Saurabh Ganeriwal (UCLA), Prof. Rajesh Gupta (UCSD), Dr. Jules Jaffe (SIO), Dr. Gautam Kulkarni (UCLA), Dr. Rex Min (NSA), Prof. Vijay Raghunathan (UCLA), Prof. Mani Srivastava, Dr. Vlasios Tsiatsis (UCLA), Prof. Ryan Kastner (UCSD), Dr. Douglas Palmer (Calit2), Prof. Tom Bewley (UCSD).

b. Graduate & Post-doctoral Advisors
Postdoctoral sponsor: Prof. Anantha Chandrakasan (EECS, M.I.T.)
Primary Ph.D. Advisor: Prof. Mani B. Srivastava (EE, U.C. Los Angeles)
Primary M.S. Advisor: Prof. Hugo De Man (KUL, Belgium)

c. Thesis Advisor & Post-graduate Scholar Sponsor
Periklis Liaskovitis (UCSD, Ph.D. advisor, 01/04–07/09), Diba Mirza (UCSD, Ph.D. advisor, 09/04–current), Maryam Owrang (UCSD, Ph.D. advisor, 09/04–12/05), Aaron Jow (UCSD, M.S. advisor, 01/05–09/07), Shoubhik Mukhopadhyay (UCSD, Ph.D. co-advisor, 04/05-02/09), Feng Lu (UCSD, PhD. Advisor, 09/08–current), Clement Kam (UCSD, PhD. Advisor, 01/08–present).
B. Letters of Support
24 March, 2010

Chair, Department of Electrical and Computer Engineering
University of California, San Diego
La Jolla, CA 92093-0407

Dear Chair Larson:

I am writing to express my support for the proposal by the Department of Electrical and Computer engineering in conjunction with the Department of Computer Science and Engineering to establish a new program leading to a Master of Advanced Studies in Wireless Embedded Systems. This program could come at an ideal time my company, ViaSat, and the wireless and embedded systems industry.

There is a growing and urgent need for engineers who can work effectively in a multi-disciplinary environment. These engineers also need continued education in the advanced skills and techniques required for this rapidly changing new field. The proposed program addresses the development of the understanding and skills required for engineers working at ViaSat.

ViaSat was started in 1986 by three engineers, two of whom were UC San Diego alumni. In the years since, we have grown to a company of about 2,000 employees, about half of whom are engineers. Our success has depended greatly on our engineering and innovation skills, continually augmented by hiring new graduates from UC San Diego (and other universities), and by continued education of our workforce.

We have taken advantage of many of the unique opportunities offered by the University, such as the Masters of Engineering program, the Architecture-based Enterprise Systems Engineering (AESE) program, and the Team Internship program. I believe the proposed Master of Advanced studies will be of great interest to our engineers, and directly beneficial to our company. We encourage all of our employees to pursue advanced education, providing them with tuition reimbursement and flexible work schedules.

I look forward to participation by our engineers in this valuable program, as it will help us maintain a competitive advantage in this rapidly developing technology sector.

Best regards,

Steve Hart
Chief Technical Officer, ViaSat Inc.
March 27, 2010

Chair, Department of Electrical and Computer Engineering
University of California, San Diego
La Jolla, CA 92093-0407

Dear Chair Larson:

I am writing to express my support for the proposal by the Department of Electrical and Computer engineering in conjunction with the Department of Computer Science and Engineering to establish a new program leading to a Master of Advanced Studies in Wireless Embedded Systems. The development of this program could not come at a better time for the wireless and embedded systems industry.

There is a growing and urgent need for engineers who can work effectively in a multi-disciplinary environment. At the same time, these engineers need continued training in the advanced skills and techniques required for this rapidly changing new field. The proposed program addresses the development of the understanding and skills required for engineers working in Wireless Systems in my company.

Qualcomm, as the world leader in providing chips and software solutions to the wireless industry, strives to maintain its leadership and competitive position. One of the most important components of our efforts is the continuous education of our workforce. The program you propose would help us greatly to achieve this goal.

I look forward to the participation of our engineering employees in this valuable program as I believe it will give us a competitive advantage in this rapidly developing technology sector.

Best regards,

Roberto Padovani
EVP & CTO
QUALCOMM, Incorporated
DATE, March 22, 2010

Chair, Department of Electrical and Computer Engineering
University of California, San Diego
La Jolla, CA 92093-0407

Dear Chair Larson:

I am writing to express my support for the proposal by the Department of Electrical and Computer engineering in conjunction with the Department of Computer Science and Engineering to establish a new program leading to a Master of Advanced Studies in Wireless Embedded Systems. The development of this program could not come at a better time for the wireless and embedded systems industry.

There is a growing and urgent need for engineers who can work effectively in a multi-disciplinary environment. At the same time, these engineers need continued training in the advanced skills and techniques required for this rapidly changing new field. The proposed program addresses the development of the understanding and skills required for engineers working in Wireless Systems in my company. Headquartered in San Diego, we employ more than 200 people in our local office, 75% of whom are technical contributors with undergraduate degrees in engineering.

This proposed program certainly rounds out the curriculum currently available in the community for continuing technical education and in a program that seeks to balance the priorities of most working professionals. This is appealing to Entropic as an employer as it enables our current and future employees to access something that is valuable and as yet not available, without jeopardizing their role and commitment to their professional endeavors at Entropic.

I look forward to the participation of our engineering employees in this valuable program as I believe it will give us a competitive advantage in this rapidly developing technology sector.

Best regards,

Anton Monk, PhD
Co-founder and VP Technology
March 26, 2010

Dr. Lawrence Larson  
Chair, Department of Electrical and Computer Engineering  
University of California, San Diego  
Room 5607, EBU-I  
9500 Gilman Drive  
La Jolla, CA 92093-0407

Dear Chair Larson:

I am writing to express my support for the proposal by the Department of Electrical and Computer engineering in conjunction with the Department of Computer Science and Engineering to establish a new program leading to a Master of Advanced Studies in Wireless Embedded Systems. The development of this program could not come at a better time for the wireless and embedded systems industry.

There is a growing and urgent need for engineers who can work effectively in a multi-disciplinary environment. At the same time, these engineers need continued training in the advanced skills and techniques required for this rapidly changing new field. The proposed program addresses the development of the understanding and skills required for engineers working in Wireless Systems in my company.

Broadcom Corporation is a fabless semiconductor company with forefront technologies in Wireless, Cellular and in general Broadband and Networking Communications, with more than 7,200 employees worldwide. Embedded Systems is a core technological need for our engineers and I visualize that the proposed program will be most attractive for our employees seeking a higher level of knowledge/expertise and an advanced professional degree in order to advance their career.
I visualize that our engineers at many of our locations but particularly those at the San Diego area will be interested to attend this program. Broadcom can be helpful in terms of flexible work schedules.

I look forward to the participation of our engineering employees in this valuable program as I believe it will give us a competitive advantage in this rapidly developing technology sector.

Best regards,

[Signature]

Nicolaos G. Alexopoulos
Vice President
Antennas and RF Research and University Relations
Broadcom Corporation
5300 California Avenue
Irvine, CA 92617
March 25, 2010

Chair, Department of Electrical and Computer Engineering
University of California, San Diego
La Jolla, CA 92093-0407

Dear Chair Larson:

I am writing to express my support for the proposal by the Department of Electrical and Computer engineering in conjunction with the Department of Computer Science and Engineering to establish a new program leading to a Master of Advanced Studies in Wireless Embedded Systems. The development of this program could not come at a better time for the wireless and embedded systems industry.

There is a growing and urgent need for engineers who can work effectively in a multi-disciplinary environment. At the same time, these engineers need continued training in the advanced skills and techniques required for this rapidly changing new field. The proposed program addresses the development of the understanding and skills required for engineers working in Wireless Systems in my company.

Agilent Technologies, the world’s premier measurement company, offers a full range of design, test, and management solutions that span the range of wireless technologies—from legacy 1G systems through 3G systems such as HSPA to 3GPP Long Term Evolution (LTE) and 1xEV-DO. Agilent products cover the lifecycle from early design and development, through volume manufacturing, to network deployment and service assurance. To stay current with leading state-of-the-art technologies, Agilent’s engineers will look forward to taking advantage of the excellence and flexibility of the proposed MAS program at UCSD.

I look forward to the participation of our engineering employees in this valuable program as I believe it will give us a competitive advantage in this rapidly developing technology sector.

Best regards,

Bill Wallace
Director of University Business Development
Agilent Technologies
March 26, 2010

Chair, Department of Computer Science and Electrical Engineering  
University of California, San Diego  
La Jolla, CA 92093-0085

Dear Chair Larry Larson:

I am writing to express my support for the proposal by the Department of Computer Science and Electrical Engineering in conjunction with the Department of Computer Science and Engineering to establish a new program leading to a Master of Advanced Studies in Wireless Embedded Systems. The development of this program is ideally suited to the needs of a growing industry and workforce demands for this talent set.

There is also a growing and urgent need for engineers who can work effectively in a multi-disciplinary environment. The proposed program addresses the development of the understanding and skills required for engineers working in a number of divisions within my company. L-3 has over 100 separate divisions working with many sectors of the Defense, Homeland Security, and Energy Departments as well as many advanced communications and robotics systems that rely heavily on the skills and technology in the wireless domain and the embedded systems field.

My personal opinion is that this program directly addresses important technology issues for a number of business sectors. I believe it could provide a significant competitive advantage in this rapidly developing technology sector. I will be interested in learning more about this effort as you more fully develop the curriculum.

Best regards,

Arthur A. Morrish, Ph.D.  
VP and CTO Products Group,  
L-3 Communications
C. Information Required by CPEC
INFORMATION REQUIRED BY CPEC

1. **Name of Program:** Jacobs School of Engineering, Departments of Electrical and Computer Engineering (ECE) and Computer Science and Engineering (CSE) for a Master of Advanced Study

2. **Campus:** University of California, San Diego

3. **Degree:** Master of Advanced Study in Wireless Embedded Systems

4. **CIP Classification:**

5. **Date to be started:** Fall, 2011

6. **If modification of existing program, identify that program and explain change:**
   This is a new interdepartmental, interdisciplinary program. Coursework for the program, with the exception of the capstone project course, is based on, but not identical to, existing UCSD graduate courses.

7. **Purpose (academic or professional training) and distinctive features (how does this program differ from other, if any, offered in California?):**
   This program will equip graduates with the knowledge they need to address engineering challenges posed in the development of embedded wireless systems. This program focuses on working engineers and provides a unique education and training program at the interface of traditional disciplines.

8. **Type(s) of students to be served:**
   Prospective students for this program include mid-career professional engineers from businesses and government agencies.

9. **If program is not in current campus academic plan, give reason for proposing program now:**
   The proposed program is in response to the needs of industry and government, as evidenced by requests from industry and government entities, to provide supplemental short courses to employees in this area.

10. **If program requires approval of a licensure board, what is the status of such approval?**
    No licensure board approval is required.

11. **Please list special features of the program:**
    The MAS degree brings together the expertise of UCSD faculty in Electrical Engineering and Computer Science Engineering to address an important need of industry and government. The program is geared toward working professionals and prepares them for leadership in wireless embedded systems so that new generations of these devices can be designed and deployed. The program employs a capstone project that will emphasize team engineering on topics of relevance to the students' employment.
12. List all courses required:

ECE 157A/ECE268A(WES268A) Communications Systems Laboratory I
ECE 157B/ECE268B(WES268B) Communications Systems Laboratory II
ECE 265A(WES265A) Communications Circuit Design
ECE 267A (WES267) Wireless Embedded and Networked Systems
CSE 145 (WES145) Embedded System Design Project
CSE 237A(WES237A) Introduction to Embedded Computing
CSE 237B(WES237B) Software for Embedded Systems
CSE 237C(WES237C) Validation and Testing of Embedded Systems
ECE 207M (Wireless Embedded Systems Capstone Project)

13. List all other required courses:
See above

14. List UC campuses and other California Institutions, public or private, which now offer or plan to offer this program or closely related programs:
In surveying existing programs at other universities in California, we find that none address the specific focus proposed in this program.

15. List any related program offered by the proposing institution and explain relationship:
None.

16. Summarize employment prospects for graduates of the proposed program. Give results of job market survey if such have been made:
The primary purpose of this degree is not to improve prospects for employment, but to help working engineers. Because the enrollees already possess basic relevant knowledge, the MAS degree program supplements this knowledge to help them be more effective in their current employment, and to help them have greater influence and leadership within their organization. While a market survey has not been conducted faculty teaching in the program have been asked by industry and government entities to provide supplemental short courses to their employees in this area. It is the opinion of these faculty that employees trained in this area will be rare and in high demand. Furthermore, the letters of support and the local industry employment data supplied in the proposal demonstrate the need for this program.

17. Give estimated enrollment for the first 5 years and state basis for estimate:
Enrollment for the first year of the program is estimated to be 10 professional engineers. As the program gains acceptance in the general community, enrollment is expected to grow to 20-30 students/year. This is based on the experience of the Jacobs School's other self-supporting programs and contacts through the Corporate Affiliates Program as well as contacts of the ECE and CSE faculty conducting research in this area.
18. **Give estimates of the additional cost of the program by year for 5 years in each of the following categories: FTE Faculty, Library Acquisitions, Computing, Other Facilities, Equipment. Provide brief explanation of any of the costs where necessary.**

The program is completely self-supporting; no additional campus resources are anticipated.

19. **How and by what agencies will the program be evaluated?**

The MAS degree program will be evaluated every 8 years by the Academic Senate at UCSD. In addition, end-of-course surveys will be conducted of students participating in the program in terms of the quality of teaching and program delivered. Alumni surveys are also anticipated.
D. Course Approval Forms
UNIVERSITY OF CALIFORNIA, SAN DIEGO
REQUEST FOR COURSE APPROVAL

Subject & Number | Units | Title
--- | --- | ---
WES 207 | 4 | Capstone Project: Wireless Embedded Systems

Hours Per Week Expected of Student
Lec 3 | Sem | Dis | Lab | Studio | Tut | Practicum | PE Act | Med Clerk | Outside Prep 9 | Other (describe)

If the course has multiple discussion or other sections, how should the grade reports be printed (check one)?
- Single List of all students
- By Dis Section
- By Lab Section
- By Studio Section
- By Tut Section
- P/NP Only
- Standard Grading (letter or P/NP)
- Standard Option (Graduate)
- S/U Permitted (Graduate)
- S/U Only
- H/P/F (SOM Core only)

May be taken for credit 1 time(s). If more than once, justify:
- Final Exam Given
- If not, explain:

COURSE DESCRIPTION (in concise catalog description style, 40 word limit)
Small teams will demonstrate their critical thinking, organization, and design skills in attacking a problem within the WES field. The groups may approach this project as consultants hired to develop a new type of embedded wireless device for a specific application. They may be responsible for designing the device and implementing a working prototype.

Prerequisites: Satisfactory completion of the MAS-WES courses.

ENFORCEMENT List prerequisites and other restrictions to be enforced by computer (see Instructions).

Prerequisites that must be completed:
Prerequisites that may be concurrent:
Corequisites (must be concurrent):
Other restrictions: MAS only

Special course characteristics. Check all boxes that apply and see instructions for required explanations.
- Use of animals
- Use of computer resources
- IP Grading
- Cross listed with
- Conjoined with

Instructor and title: Larry Larson, Professor

JUSTIFICATION:
To be included in MAS proposal: Embedded Systems

Department Chair 6/21/10
Registrar

APPROVALS – GRADUATE COURSE

Dean, School of Medicine

Dean of Graduate Studies

Graduate Council

APPROVALS – UNDERGRADUATE COURSE

Council of Provosts

CEP Subcommittee on Courses

Extent of approval: Indefinite

Expires at the end of quarter, 19

FO 2073 (REV. 7/90)
COURSE DESCRIPTION (in concise catalog description style, 40 word limit)

Prerequisites: ECE 186 or consent of instructor

ENFORCEMENT List prerequisites and other restrictions to be enforced by computer (see instructions).
Prerequisites that must be completed:
Prerequisites that may be concurrent:
Corequisites (must be concurrent):
Other restrictions: graduate standing, MAS only

Special course characteristics. Check all boxes that apply and see instructions for required explanations.
☐ Use of animals  ☐ Use of computer resources  ☐ IP Grading  ☐ Cross listed with  ☐ Conjoined with

Instructor and title: Larry Larson, Professor

JUSTIFICATION:
Course included in ECE/CSE MAS proposal.
UNIVERSITY OF CALIFORNIA, SAN DIEGO
REQUEST FOR COURSE APPROVAL

☐ New Course ☐ Reinstatement ☐ Deletion ☐ Renumbering: old number ______ ☐ Summer Session Only
☐ Change In Course Nature of change:

Subject & Number
WES 267A

Units
4

Title
Wireless Embedded and Networked Systems

Hours Per Week
3

Expected of Student
Sem Dis Lab Studio Tut Practicum PE Act Med Clerk Outside Prep
9

If the course has multiple discussion or other sections, how should the grade reports be printed (check one)?
☐ Single List of all students ☐ By Dis Section ☐ By Lab Section ☐ By Studio Section ☐ By Tut Section

Grading - Undergraduate
☐ Standard Grading (letter or P/NP)
☐ P/NP Only

Grading - Graduate and SOM
☐ Standard Option (Graduate)
☐ S/U Permitted (Graduate)
☐ S/U Only ☐ H/P/F (SOM Core only)

May be taken for credit 1 time(s). If more than once, justify:
☐ Final Exam Given If not, explain:

COURSE DESCRIPTION (In concise catalog description style, 40 word limit)
Study of wireless networked systems from a system design perspective, covering various layers of the protocol stack from physical to network layer. Focus is on energy efficiency, interaction between the different layers, emerging networked systems, and ubiquitous computing. Topics include digital communications, networking and programming, and a basic prior knowledge of these topics is recommended. (Recommended prerequisite: Concepts of instructor.) (F)

Prerequisites:

ENFORCEMENT List prerequisites and other restrictions to be enforced by computer (see Instructions).
Prerequisites that must be completed:
Prerequisites that may be concurrent:
Corequisites (must be concurrent):
Other restrictions: MAS only

Special course characteristics. Check all boxes that apply and see Instructions for required explanations.
☐ Use of animals ☐ Use of computer resources ☐ IP Grading ☐ Cross listed with ______ ☐ Conjoined with ______

Instructor and title: Curt Schurgers, Assistant Professor

JUSTIFICATION:
Course description change(s) reflect the evolution of course materials and more appropriately meet the changing needs of this area of study.

Facilitate graduate student enrollment by not requiring the consent of instructor, enforcement of graduate standing only.

Department Chair date Registrar date

APPROVALS - GRADUATE COURSE

Dean, School of Medicine date

Dean of Graduate Studies date

Graduate Council date

APPROVALS - UNDERGRADUATE COURSE

Council of Provosts date

CEP Subcommittee on Courses date

Extent of approval: ☐ Indefinite ☐ Summer Only Expires at the end of ______ quarter, 19

FO 2073 (REV. 7/90)
UNIVERSITY OF CALIFORNIA, SAN DIEGO
REQUEST FOR COURSE APPROVAL

New Course □ Reinstatement □ Deletion □ Renumbering: old # □ Summer Session Only
Change In Course □ Nature of change:

Subject & Num.: WES 268A Units: 4 Title: Communication Systems Laboratory 1

<table>
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<tr>
<th>Hours Per Week</th>
<th>Lec 2</th>
<th>Sem</th>
<th>Dis</th>
<th>Lab 3</th>
<th>Studio</th>
<th>Tut</th>
<th>Practicum</th>
<th>PE Act</th>
<th>Med Clerk</th>
<th>Outside Prep</th>
<th>Other (describe)</th>
</tr>
</thead>
</table>

If the course has multiple discussion or other sections, how should the grade reports be printed (check one)?

□ Single List of all Students □ By Dis Section □ By Lab Section □ By Studio Section □ By Tut Section

Grading-Undergraduate □ Standard Grading (letter or P/NP) □ P/NP Only
Grading-Graduate and SOM □ Standard Option (Graduate) □ S/U Permitted (Graduate) □ S/U Only □ H/P/F (SOM Core only)

May be taken for credit [1] time(s). If more than once, justify:

□ Final Exam Given. If not, explain:

COURSE DESCRIPTION (In concise catalog description style, 40 word limit)

Experiments in the modulation and demodulation of baseband and passband signals. Statistical characterization of signals and impairments. Course material and/or program fees may apply.

Prerequisites: ECE 154A with a grade of C+ or better

ENFORCEMENT (List prerequisites and other restrictions to be enforced by computer - see instructions).

Prerequisites that must be completed: ECE 154A with a grade of C+ or better.
Prerequisites that may be concurrent:
Corequisites (must be concurrent):
Other restrictions: MAS only

Special course characteristics. Check all boxes that apply and see instructions for required explanations.

□ Use of animals □ Use of computer resources □ IP Grading □ Cross listed with □ Conjoined with

Instructor and title: Professor George C. Papen.

JUSTIFICATION:

[Signature] Department Chair date Registrar date

<table>
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<tr>
<th>APPROVALS-GRADUATE COURSE</th>
<th>APPROVALS-UNDERGRADUATE COURSE</th>
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<td>Dean, School of Medicine</td>
<td>date</td>
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<td>Dean of Graduate Studies</td>
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<td>Graduate Council</td>
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<td>Council of Provosts</td>
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<tr>
<td>CEP Subcommittee on Courses</td>
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</table>

Extent of approval: □ Indefinite □ Summer Only Expires at the end of Quarter, 20
UNIVERSITY OF CALIFORNIA, SAN DIEGO
REQUEST FOR COURSE APPROVAL

☑ New Course ☐ Reinstatement ☐ Deletion ☐ Renumbering: old # ☐ Summer Session Only ☐ Nature of change:

Effective SP11

Subj & Num.: WES 268B
Title: Communication Systems Laboratory II

Units: 4
Hours Per Week
Lec 2
Sem
Dis
Lab 3
Studio
Tut
Practicum
PE Act
Med Clerk
Outside Prep 9
Other (describe)

If the course has multiple discussion or other sections, how should the grade reports be printed (check one)?
☐ Single List of all Students ☐ By Dis Section ☑ By Lab Section ☐ By Studio Section ☐ By Tut Section

Grading-Undergraduate ☑ Standard Grading (letter or P/NP) ☐ P/NP Only
Grading-Graduate and SOM ☑ Standard Option (Graduate) ☐ S/U Permitted (Graduate) ☐ S/U Only ☐ H/P/F (SOM Core only)

May be taken for credit [1] time(s). If more than once, justify:
☐ Final Exam Given. If not, explain: Projects class

COURSE DESCRIPTION (In concise catalog description style, 40 word limit)

Advanced projects in communication systems. Students will plan and implement design projects in the laboratory, updating progress weekly and making plan/design adjustments based upon feedback.

Prerequisites: ECE 268AM with a grade of C+ or better and consent of instructor

ENFORCEMENT (List prerequisites and other restrictions to be enforced by computer - see instructions).
Prerequisites that must be completed: ECE 268AM with a grade of C+ or better.
Prerequisites that may be concurrent:
Corequisites (must be concurrent):
Other restrictions: MAS only

Special course characteristics. Check all boxes that apply and see instructions for required explanations.
☐ Use of animals ☑ Use of computer resources ☐ IP Grading ☐ Cross listed with ☐ Conjoined with

Instructor and title: Professor George C. Papen.

JUSTIFICATION:

[Signature]
Department Chair date

Registrar date

APPROVALS-GRADUATE COURSE

Dean, School of Medicine date

Dean of Graduate Studies date

Graduate Council date

Council of Provosts date

CEP Subcommittee on Courses date

Extent of approval: Indefinite Summer Only Expires at the end of Quarter, 20
UNIVERSITY OF CALIFORNIA, SAN DIEGO
REQUEST FOR COURSE APPROVAL

Subject & Num.: CSE 145M  Units: 4  Title: Embedded System Design Project

New Course  □ Reinstatement  □ Deletion  □ Remumbering: old number  □ Summer Session Only  Effective Qtr Yr: Fall 2011
□ Change In Course  Nature of change:

<table>
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<th>Lec</th>
<th>Sem</th>
<th>Dis</th>
<th>Lab</th>
<th>Studio</th>
<th>Tut</th>
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</table>

If the course has multiple discussion or other sections, how should the grade reports be printed (check one)?
□ Single List of all Students  □ By Dis Section  □ By Lab Section  □ By Studio Section  □ By Tut Section

Grading-Undergraduate  □ Standard Grading (letter or P/NP)  □ P/NP Only
Grading-Graduate and SOM  □ Standard Option (Graduate) □ S/U Permitted (Graduate)  □ S/U Only  □ H/P/F(SOM Core only)

May be taken for credit [ ] time(s). If more than once, justify:
□ Final Exam Given.  If not, explain: Project and Assignments

COURSE DESCRIPTION (In concise catalog description style, 40 word limit)
Project class building an embedded computing system. Learn fundamental knowledge of microcontrollers, sensors and actuators. Introduction to the hardware and software tools to build project in a team environment and end-to-end system building.

Prerequisites:

ENFORCEMENT (List prerequisites and other restrictions to be enforced by computer (see instructions).
Prerequisites that must be completed:
Prerequisites that may be concurrent:
Corequisites (must be concurrent):
Other restrictions:

Special course characteristics. Check all boxes that apply and see instructions for required explanations.
□ Use of animals  □ Use of computer resources  □ IP Grading  □ Cross listed with  □ Conjoined with

Instructor and title: Dr. Ryan Kastner, Associate Professor

JUSTIFICATION:

This is a new course for the Master of Advanced Studies Degree in Wireless Embedded Systems.

Department Chair  9/21/11  Registrar  

APPROVALS-GRADUATE COURSE  APPROVALS-UNDERGRADUATE COURSE

Dean, School of Medicine  date

Dean of Graduate Studies  date  Council of Provosts  date

Graduate Council  date  CEP Subcommittee on Courses  date

Extent of approval:  □ Indefinite  □ Summer Only  Expires at the end of Quarter, 19

FO 2073 (REV. 7/90) Approved for Use by CEP on November 17, 1994
UNIVERSITY OF CALIFORNIA, SAN DIEGO
REQUEST FOR COURSE APPROVAL

Subject & Num.: CSE 237AM  Title: Introduction to Embedded Computing

<table>
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<tr>
<th>Hours Per Week</th>
<th>Lec</th>
<th>Sem</th>
<th>Dis</th>
<th>Lab</th>
<th>Studio</th>
<th>Tut</th>
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</table>

If the course has multiple discussion or other sections, how should the grade reports be printed (check one)?

- [X] Single List of all Students
- [ ] By Dis Section
- [ ] By Lab Section
- [ ] By Studio Section
- [ ] By Tut Section

Grading-Undergraduate
- [X] Standard Grading (letter or P/NP)
- [ ] P/NP Only

Grading-Graduate and SOM
- [X] Standard Option (Graduate)
- [ ] S/U Permitted (Graduate)
- [ ] S/U Only
- [ ] H/P/F (SOM Core only)

May be taken for credit [1] time(s). If more than once, justify:

- [X] Final Exam Given. If not, explain:

COURSE DESCRIPTION (In concise catalog description style, 40 word limit)
Embedded system technologies including processors, DSP, memory and software. System interfacing basics, communication strategies, sensors and actuators. Mobile and wireless technology in embedded systems. Using pre-designed hardware and software components. Design case studies in wireless, multimedia, and/or networking domains.

ENFORCEMENT (List prerequisites and other restrictions to be enforced by computer (see instructions).
Prerequisites that must be completed:
Prerequisites that may be concurrent:
Corequisites (must be concurrent):
Other restrictions:

Special course characteristics. Check all boxes that apply and see instructions for required explanations.
- [ ] Use of animals
- [X] Use of computer resources
- [ ] IP Grading
- [ ] Cross listed with
- [ ] Conjoined with

Instructor and title: Tajana Rosing, Professor

JUSTIFICATION:
This is a new course for the Master of Advanced Studies Degree in Wireless Embedded Systems.

[Signature] 4/21/10
Department Chair

[Signature]  _______________________
Registrar

APPROVALS-GRADUATE COURSE

Dean, School of Medicine  date

Dean of Graduate Studies  date

Graduate Council  date

Extent of approval:  [ ] Indefinite  [X] Summer Only

APPROVALS-UNDERGRADUATE COURSE

Council of Provosts  date

CEP Subcommittee on Courses  date

Expires at the end of  Quarter, 19

FO 2073 (REV. 7/90) Approved for Use by CEP on November 17, 1994
**UNIVERSITY OF CALIFORNIA, SAN DIEGO**  
**REQUEST FOR COURSE APPROVAL**

- New Course  
- Reinstatement  
- Deletion  
- Remumbering: old number  
- Summer Session Only  
- Change In Course  
- Nature of change:  
- Effective Qtr Yr: Fall 2011

### Subject & Num.: CSE 237BM  
### Units: 4  
### Title: Software for Embedded Systems

<table>
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<tr>
<th>Hours Per Week</th>
<th>Loc</th>
<th>Sem</th>
<th>Dis</th>
<th>Lab</th>
<th>Studio</th>
<th>Tut</th>
<th>Practicum</th>
<th>PE Act</th>
<th>Med Clerk</th>
<th>Outside Prep</th>
<th>Other(describe)</th>
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<td>Expected of Student</td>
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If the course has multiple discussion or other sections, how should the grade reports be printed (check one)?

- Single List of all Students
- By Dis Section
- By Lab Section
- By Studio Section
- By Tut Section

Grading-Undergraduate
- Standard Grading (letter or P/NP)
- P/NP Only

Grading-Graduate and SOM
- Standard Option (Graduate)
- S/U Permitted (Graduate)
- S/U Only
- HI/P/F(SOM Core only)

May be taken for credit [1] time(s). If more than once, justify:

- Final Exam Given. If not, explain:

**COURSE DESCRIPTION (In concise catalog description style, 40 word limit)**


**ENFORCEMENT (List prerequisites and other restrictions to be enforced by computer (see instructions).**

- Prerequisites that must be completed:
- Prerequisites that may be concurrent:
- Corequisites (must be concurrent):
- Other restrictions:

**Special course characteristics. Check all boxes that apply and see instructions for required explanations.**

- Use of animals  
- Use of computer resources  
- IP Grading  
- Cross listed with  
- Conjoined with

**Instructor and title: Rajesh Gupta, Professor**

**JUSTIFICATION:**

This is a new course for the Master of Advanced Studies Degree in Wireless Embedded Systems.

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**APPROVALS-GRADUATE COURSE**

- Dean, School of Medicine date
- Dean of Graduate Studies date
- Graduate Council date

**APPROVALS-UNDERGRADUATE COURSE**

- Council of Provosts date
- CEP Subcommittee on Courses date

**Extent of approval:**

- Indefinite  
- Summer Only  

Expires at the end of Quarter, 19

---

FO 2073 (REV. 7/90) Approved for Use by CEP on November 17, 1994
UNIVERSITY OF CALIFORNIA, SAN DIEGO
REQUEST FOR COURSE APPROVAL

Subject & Num.: CSE 237CM Units: 4 Title: Validation and Testing of Embedded Systems

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<th>Hours Per Week Expected of Student</th>
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If the course has multiple discussion or other sections, how should the grade reports be printed (check one)?

- [ ] Single List of all Students
- [ ] By Dis Section
- [ ] By Lab Section
- [ ] By Studio Section
- [ ] By Tut Section

Grading: Undergraduate
- [ ] Standard Grading (letter or P/NP)
- [ ] P/NP Only

Grading: Graduate and SOM
- [x] Standard Option (Graduate) □ S/U Permitted (Graduate)
- □ S/U Only □ H/P/F (SOM Core only)

May be taken for credit [1] time(s). If more than once, justify:
- [ ] Final Exam Given. If not, explain:

COURSE DESCRIPTION (In concise catalog description style, 40 word limit)


ENFORCEMENT (List prerequisites and other restrictions to be enforced by computer (see instructions).

Prerequisites that must be completed:
- 

Prerequisites that may be concurrent:
- 

Corequisites (must be concurrent):
- 

Other restrictions:
- 

Special course characteristics. Check all boxes that apply and see instructions for required explanations.

- [ ] Use of animals
- [x] Use of computer resources
- [ ] IP Grading
- [ ] Cross listed with
- [ ] Conjoined with

Instructor and title: Rajesh Gupta, Professor

JUSTIFICATION:
This is a new course for the Master of Advanced Studies Degree in Wireless Embedded Systems.

Department Chair: [Signature] Date: 4/2/16
Registrar: [Signature] Date:

APPROVALS-GRADUATE COURSE

Dean, School of Medicine Date:

Dean of Graduate Studies Date:

Graduate Council Date:

APPROVALS-UNDERGRADUATE COURSE

Council of Provosts Date:

CEP Subcommittee on Courses Date:

Extent of approval: [ ] Indefinite [ ] Summer Only Expires at the end of Quarter, 19

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E. Catalogue Copy

Electrical and Computer Engineering Program

Master of Advanced Studies
The Department of Electrical and Computer Engineering offers the Master of Advanced Studies (MAS) degree in Wireless Embedded Systems (WES). The degree requires thirty-six units of work, including a Capstone Team Project. This program is for part-time students with an adequate background in engineering. All the requirements can be completed in two years, with one or two courses taken each quarter.

Final Project Capstone Requirement, No Thesis
In the MAS-WES Program, an “alternative plan” requirement is satisfied by a 4-unit capstone project requirement.

Required Courses
Students entering the MAS program in Electrical and Computer Engineering for a degree in Wireless Embedded Systems will undertake courses in Electrical and Computer Engineering and Computer Science and Engineering.

The program requires eight four-unit core courses totaling 32 units and one four-unit Capstone Team Project course for a total of 36 units.

All courses must be completed with an average grade of B and no grade below B-. The courses required of all students are as follows:

- ECE267A(WES267A) Wireless Embedded and Networked Systems
- ECE157A/ECE268A (WES268A) Communication Systems Laboratory I
- ECE157B/ECE268B (WES268B) Communications Systems Laboratory II
- ECE265A (WES265A) Communications Circuit Design
- CSE145 (WES145) Embedded System Design Project
- CSE237A (WES237A) Introduction to Embedded Computing
- CSE237B (WES237B) Software for Embedded Systems
- CSE237C (WES237C) Validation and Testing of Embedded Systems
- WES 207 Capstone Project: Wireless Embedded Systems

The course descriptions are as follows:

WES 268A(4). Communications Systems Laboratory I - Experiments in the modulation and demodulation of baseband and passband signals. Statistical characterization of signals and impairments. This course is currently under review for “co-listing” as a graduate course in ECE. **Prerequisite:** ECE 154A with a grade of C+ or better or consent of instructor.

WES 268B (4). Communications Systems Laboratory II - Students will plan and implement design projects in the laboratory, updating progress weekly and making plan/design adjustments based upon feedback. This course is currently under review for “co-listing” as a
graduate course in ECE. **Prerequisite:** ECE 154A with a grade of C+ or better or consent of instructor.


WES 267 (4). Wireless Embedded and Networked Systems
Study of wireless networked systems from a system design perspective, covering the protocol stack from physical to network layer with a focus on energy. Topics include digital communications, networking and programming, and a basic knowledge of these is recommended. **Prerequisite:** graduate standing.

WES 207 (4). Capstone Project: Wireless Embedded Systems. The project requires that students apply the course material to a realistic wireless embedded system engineering problem. **Prerequisite:** satisfactory completion of the MAS-WES courses.

WES 145 (4). Embedded System Design Project: Project class building an embedded computing system. Learn fundamental knowledge of microcontrollers, sensors, and actuators. Introduction to the hardware and software tools to build project in a team environment and end-to-end system building. **Prerequisite:** CSE 30 or consent of instructor.

WES 237A (4). Introduction to Embedded Computing. Embedded system technologies including processors, DSP, memory, and software. System interfacing basics, communication strategies, sensors, and actuators. Mobile and wireless technology in embedded systems. Using pre-designed hardware and software components. Design case studies in wireless, multimedia, and/or networking domains. **Prerequisites:** basic courses in digital hardware, algorithms and data structures, elementary calculus, and probability; or consent of instructor.

WES 237B (4). Software for Embedded Systems. Embedded computing elements, device interfaces, time-critical IO handling. Embedded software design under size, performance, and reliability constraints. Software timing and functional validation. Programming methods and compilation for embeddable software. Embedded runtime systems. Case studies of real-time software systems. **Prerequisites:** CSE 237AM; or basic courses in programming, algorithms and data structures, elementary calculus, discrete math, computer architecture; or consent of instructor.

WES 237C (4). Validation and Testing of Embedded Systems. Embedded system building blocks including IP cores. Co-simulation. Formal verification using model checking. Verification environments. Test challenges in core integration: compliance, feature, random, and collision testing. Core access and test integration. Interface-based verification and standards. **Prerequisites:** CSE 237AM; or basic courses in algorithms and data structures, elementary calculus, discrete math, symbolic logic, computer architecture; or consent of instructor.