MASTER of SCIENCE DEGREE PROGRAMS
and
GRADUATE CERTIFICATE PROGRAMS
in
COMPUTER ENGINEERING
and
ELECTRICAL ENGINEERING

Graduate programs leading to the master of science and doctor of philosophy degrees with majors in engineering and graduate certificates, prepare students for careers in industry, government, or academia. The following degree programs and certificates are being offered:

- M.S. in Computer Engineering
- M.S. in Electrical Engineering
- M.S. in Telecommunications*
- Certificate in Communications and Networking
- Certificate in Signal Processing
- Certificate in VLSI Design/Manufacturing
- Ph.D. in Electrical and Computer Engineering
- Ph.D. in Information Technology*

This brochure describes two M.S. programs: Computer Engineering, and Electrical Engineering, and the three Certificate programs listed above. Details about the other programs are available in other publications, in the George Mason Catalog, and also at http://ece.gmu.edu.

The Department is committed to high standards of teaching and research excellence in the vibrant areas of communications, signal and image processing, computer networks, computer engineering, control systems, intelligent systems, microelectronics, microwaves, electromagnetics, optoelectronics and telecommunications. The Department strives to augment and enhance these areas through the use of modern information technology.

The courses in graduate programs are offered during the evening or late afternoon hours to permit persons who are employed full time to enroll in the programs. For those who enter the programs on a full-time basis, some financial aid may be available in various forms such as Teaching Assistantships, Research Assistantships, work-study, or co-op agreements with local industry.

Students in M.S. and Certificate programs may take courses through schools that are a part of the Commonwealth Graduate Engineering Program. Appropriate courses may be transferred, with advisor approval, into these George Mason degree programs.

For Additional Information

Inquiries concerning graduate computer engineering or electrical engineering programs should be directed to Dr. Andre Manitius, Chairman, Electrical and Computer Engineering Department or the ECE Graduate Coordinator [(703) 993-1569, **ece@gmu.edu** or **http://ece.gmu.edu**]

*Administered by the School of Information Technology and Engineering

2005-06

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Computer Engineering and Electrical Engineering

ADMISSION, CREDIT TRANSFER and ADVISING

Admissions are strictly competitive. The Department's policy is to admit only those students who have demonstrated a potential for outstanding performance in their graduate work.

Admission Categories - Students may be admitted into one of the following categories: Degree, Provisional, or Non-degree.

Provisional admission is granted to students whose past performance provides reasonable, but not strong, evidence of their capacity to pursue graduate work toward a degree. To be advanced to Degree status, Provisional students must achieve a 3.0 grade point average after 12 semester hours, must remove all undergraduate deficiencies (by completing the corresponding courses with a B or better), and must receive a grade of B or better in specific courses representing two of the graduate electrical engineering core areas or in the two courses satisfying the computer engineering core courses requirement. Specifically, for the Electrical Engineering degree these courses are: ECE 521, ECE 528, ECE 548, and one of ECE 584 or ECE 565. For the Computer Engineering degree the courses are: ECE 548 and CS 571. (See pages 6 and 11.)

The Non-degree category is used primarily by students who wish to take graduate courses but not necessarily pursue a degree. Non-degree students pursuing a certificate must submit a standard Graduate Application form, annotated with "Certificate program" before they can be awarded the certificate. Non-degree students who wish to enter a degree program must formally apply for degree status admission. See "Transfer of Credit" for limitations on the number of credit hours of course work completed while in Non-degree status that can be applied to a degree or certificate.

Admission Requirements - To be considered for Degree or Provisional admission to the master's programs, applicants should have the following:

1. An earned baccalaureate in electrical engineering, computer engineering, or a closely related discipline from an accredited program with a reputation for high academic standards.
2. A grade average of B or better during the last 60 semester hours.
3. Three letters of recommendation, preferably from academic references, or from references in industry or government, who are familiar with the applicant's professional accomplishments.
4. A detailed statement of career goals and aspirations.
5. For students who have not earned a Bachelor's degree from a United States university, satisfactory performance on the Graduate Record Examination, and for those students whose native language is not English a minimum score of 230 (computer based) or 575 (paper based) on the Test of English as a Foreign Language and 4.5 on the TOEFL Test of Written English (essay). A minimum score of 250 (computer based) or 600 (paper based) is required for applicants who wish to be considered for a graduate teaching or research assistantship.

Non-ECE Students - Students with B.S. or M.S. degrees in ECE-related disciplines (for example, computer science, mathematics, mechanical engineering, physics, electrical engineering

technology) are encouraged to apply for admission. Such students may initially be admitted into the provisional category and will advance to degree status by satisfying the requirements described in the Admissions Categories and Admissions Requirements paragraphs. Such students may also be advised to take some courses from the undergraduate electrical or computer engineering curricula, according to their intended area of specialization and specific background.

Transfer of Credit

- **For the MS degree**, up to twelve credit hours of transfer course work may be applied. Courses taken in Non-Degree Status are considered part of the twelve credit hour limit. Only courses that have not been applied towards a previous degree and for which one has received a grade of B or better can be considered for transfer. Transfer courses must have been taken within six years of first enrollment at George Mason following admission in Degree or Provisional status. The Department Chair or Program Director must approve transfer courses. All University requirements for transfer courses as listed in the George Mason catalog also apply.

- **For Certificates**, a maximum of three credit hours of graduate course work completed at another institution may be applied. Only courses for which one has received a grade of B or better can be considered for transfer. Transfer courses must have been taken within six years of the date of enrollment at George Mason for the first Certificate course. The Department Chair or Program Director must approve transfer courses.

- Courses are transferred into specific graduate degree programs, not into George Mason University. Consequently a transfer course presented for and approved for transfer into one graduate degree or degree concentration, may not be applied to a different graduate degree or a different concentration without resubmitting the proposed transfer course to the new degree or degree concentration for approval.

Student Advising

Newly admitted graduate students should consult with the ECE graduate coordinator **specific to their degree program** before they register for classes. Each student selects a major area of concentration/specialization when they apply for admission (see details in the Electrical Engineering and Computer Engineering degree Requirements sections [p. 7 and p. 11 respectively]. The student then is assigned an academic advisor from that area. Before the end of the second semester, each student must submit a Plan of Study (See sample form on page 25.) that has been approved by his or her academic advisor to the ECE Department office. A final, signed, version of this Plan of Study must be turned in when the student submits a Graduation Application. Appropriate forms are available in the ECE Department office.

REQUIREMENTS APPLICABLE to ALL MSEE and MSCpE DEGREES

Plan of Study - Before the end of the second semester, each student must submit a Plan of Study (approved by his or her academic advisor) to the ECE Department. This Plan should be kept up to date by regular consultation with the student's academic advisor. A final, signed, version of this Plan of Study must be turned in when the student submits a Graduation Application. Appropriate forms are available in the ECE Department office. (See sample form on page 25.)

Seminar Requirement - Each student must attend a minimum of 10 approved seminars. MSEE students must attend approved ECE Department seminars. MSCpE students must attend approved ECE or CS seminars. It is the students' responsibility to maintain their own personal record of the seminars they have attended and also to ensure their attendance at each seminar is recorded on the attendance sheet and promptly reported to the ECE Department office. The Seminar Attendance Record form (sample on p. 26) that **must** be submitted when applying for graduation is available in the ECE Department office. As with all other aspects of the EE degree, the George Mason Honor Code applies to attendance and reporting of Seminar attendance. See the ECE Bulletin Board outside the ECE Department office or the ECE homepage at **http://ece.gmu.edu** for approved seminars.

Thesis and Scholarly Paper Options

Thesis Option. Thesis students must complete ECE 799, Master's Thesis, (6 credit hours), and 24 hours of course work. The thesis option is particularly recommended for those students who wish to develop and document their research skills, and/or who contemplate subsequent enrollment in a Ph.D. program. The thesis involves a significant research effort, which is conducted under the guidance of a faculty advisor. In some cases, permission may be granted to complete a portion of the work at the student's place of employment. The final written thesis and oral defense are approved by the student's advisory committee. Thesis students may not register for ECE 798 Research Project.

Students must register for at least 3 credit hours of thesis for their first thesis semester. Following their first thesis semester they must register for at least one credit hour of thesis each Fall and Spring Semester until graduation.

Scholarly Paper Option. Students who select this option must complete 30 credits of course work or 27 credits of course work plus 3 credits of ECE 798, Research Project. In addition the student must research, write and present a scholarly paper. The scholarly paper is a technical report on an independent study, laboratory or computer experimentation, or literature search done by the student on a current scientific or technological topic, such as a survey of some new technologies, or new methodologies, or a case study of new applications, on a theme selected under the guidance of a faculty advisor. Full and appropriate references must be noted. The student must demonstrate knowledge of the topic and make a satisfactory technical presentation of the paper in a Graduate Seminar. The Scholarly Paper and the final oral presentation must be approved by the student's Advisory Committee. When a student elects to base the Scholarly Paper presentation on an ECE 798, Research Project final report it is expected that the 3 credit hours of effort in ECE 798 will result in a much more substantial paper than a Scholarly Paper submitted *in addition to* 30 hours of regular course work.

Procedures and Guidelines for the Scholarly Paper are on page 17.

Scholarly Paper/Thesis Presentation. Following **completion** of all required faculty and room arrangements, the Scholarly Paper or Thesis presentation must be announced at least **one week prior** to the presentation via: (a) a flyer, prepared by the student and given to the ECE Department secretary, which contains the title, student name, advisor(s) name(s), location and time of presentation and an abstract, and (b) an electronic form in text or HTML format (email preferred, disc accepted), prepared by the student, containing the same information as the flyer, and provided to the ECE Department secretary (disc) or emailed to ece@gmu.edu, so that it can be posted on the ECE Department "Seminars" web page. It is the student's responsibility to arrange for a presentation day and time that is acceptable to all members of the Advisory Committee. It is the student's responsibility to arrange for a presentation room (normally the ECE Department conference room). It is the student's responsibility to arrange for any audio visual equipment needs (laptop computer, projector, overhead projector, etc.)

GPA Requirements - A maximum of two courses with a C grade may be applied toward the degree. The student must present a GPA of at least 3.0 for all courses submitted for the degree. Students receiving grades of F in two courses, C grades in 9 credit hours of course work, or whose overall GPA falls below 3.0 may face Academic Dismissal or Academic Termination as described in the Graduate Policies of the George Mason catalog.

Time Requirement - All degree requirements (transfer courses, George Mason courses, seminars, thesis, scholarly paper) must be completed within a 6 year period. Non-course work (thesis, scholarly paper, seminars) must be completed before the Degree Conferral Date. Course work must be completed by the 6th week after the Degree Conferral Date.

Electronic Archiving - In addition to submitting their Scholarly papers, or Research Project Reports, or MS Thesis in hard copy, students are encouraged to also develop electronic versions of these documents in MS Word, HTML, Power Point or Acrobat (PDF) and submit them to the Department for posting. These documents can be copyrighted. Posting on the ECE website is at the discretion of the ECE Department. This will make work of the student more visible and will help students in subsequent years.

MASTER of SCIENCE in ELECTRICAL ENGINEERING

The Department of Electrical and Computer Engineering offers the Master of Science degree in Electrical Engineering with specializations in the following areas:

- Communications and Networks
- Signal Processing
- Control and Robotics
- Microelectronics and Electromagnetics/Microwaves
- Architecture-Based Systems Integration

Computer Engineering, formerly a specialization area, is now a separate degree program, Master of Science in Computer Engineering. Students in the MSEE program can continue to take computer engineering courses as part of their degree program.

The Department of Electrical and Computer Engineering has an outstanding faculty of twenty-five full time professors, six of whom are Fellows of IEEE or other Professional Societies. The department offers more than fifty graduate-level courses in the areas listed above.

Sponsored Research Projects within the Department include the following:

Mobile Communications Networks; High Speed Data Networks; Variable Bit-Rate Videocoding; Signal Processing for Hearing Impaired; Non-Gaussian Detection; Self Adaptive Equalization; Signal Processing in Spatially Arrayed Sensors; RISC Computing; Fault Detection and Diagnosis; Computational Control Applied to Flexible Structures; Autopilots for Submarine Depth Control; Tracking Algorithms for Robots with Redundant DOF; Power Microwave Devices; Ion Implantation in Compound Semiconductors; Fabrication and Characterization of SiC material and devices; Characterization of Semiconductor Materials and Silicon on Insulator Devices; Image Processing; Sensor Management and Scheduling; Efficient Implementations of Cryptographic Algorithms; Wireless Network Security; Computer Arithmetic; Reconfigurable Computing.

Many of these projects provide opportunities for Research Assistantships. In addition the department has a number of Teaching Assistantships.

DEGREE REQUIREMENTS

Plan of Study - See Page 3 for details.

Course Work - Each student must complete a minimum of 30 semester hours of graduate-level credits beyond the bachelor's degree under one of the two options listed below. This work must represent a cohesive set of courses leading to comprehensive knowledge in one specialization area. It can not be a set of disjoined courses.

The plan of study for the degree must include the following:

1. A minimum of two core courses (with B or better in each) from the following list:

- ECE 521 Modern Systems Theory
- ECE 528 Introduction to Random Processes in Electrical and Computer Engineering
- ECE 548 Sequential Machine Theory
- ECE 584 Semiconductor Device Fundamentals
  or ECE 565 Introduction to Optical Electronics

2. A minimum of three courses with a grade of B or better at the 600 or above level (not including ECE 798 or 799) from a chosen area of specialization. Approved doctoral level courses (800 - 900 level) may also be taken for credit towards the MSEE. **For the Architecture-Based Systems Integration specialization** the following **four** 600 level courses **must** be taken: ECE 672, ECE 673, ECE 674 and ECE 675, and a grade of B or better earned in each.

3. A maximum of six credit hours of non-ECE courses, subject to prior departmental approval. Selected TCOM courses have been approved for inclusion in the MSEE program. See TCOM course listings and limitations on page 9. IT courses (including doctoral level, 800-900 level courses) that cover Electrical Engineering topics may be taken for credit toward the MSEE. Electrical Engineering oriented IT courses do not count toward the **six credit hours** of non-ECE courses allowed. However, **all non-ECE courses are subject to prior departmental approval**. Students taking two or more of the ECE 672, ECE 673, ECE 674 and ECE 675 courses **may not** take non-ECE courses as part of their degree program.

Seminar Requirement - See Page 3 for details.

Thesis and Scholarly Paper Options

Thesis Option. The thesis advisory committee consists of at least three full-time faculty members, including two from the student's specialization area and one from outside the area. Students must register for at least 3 credit hours of thesis for their first thesis semester. Following their first thesis semester they must register for at least one credit hour of thesis each Fall and Spring Semester until graduation. See Page 3 for further details.

Scholarly Paper Option. The Scholarly Paper and the final oral presentation must be approved by the student's Scholarly Paper Advisor and Co-Advisor. See Page 3 for further details.

Procedures and Guidelines for the Scholarly Paper are on page 17.

GPA Requirements - See Page 3 for details.

Time Requirement - See Page 3 for details.

COURSES in ELECTRICAL ENGINEERING SPECIALIZATION AREAS

COMMUNICATIONS and NETWORKS

ECE 528 Introduction to Random Processes in Electrical and Computer Engineering
ECE 542 Computer Network Architectures and Protocols
ECE 630 Statistical Communication Theory
ECE 633 Coding Theory
ECE 642 Design and Analysis of Computer Communication Networks
ECE 643 Telecommunication Switching Systems
ECE 646 Cryptography and Computer Network Security
ECE 670 Principles of C^3I, Part I
ECE 671 Principles of C^3I, Part II
ECE 731 Digital Communications
ECE 732 Mobile Communication Systems
ECE 733 Advanced Coding Theory
ECE 735 Data Compression
ECE 737 Spread Spectrum Communications
ECE 739 Satellite Communications
ECE 741 Wireless Networks
ECE 742 High-Speed Networks
ECE 743 Multimedia Networking and Communications Software
ECE 746 Secure Telecommunication Systems
ECE 751 Information Theory

SIGNAL PROCESSING

ECE 528 Introduction to Random Processes in Electrical and Computer Engineering
ECE 535 Digital Signal Processing
ECE 537 Introduction to Digital Image Processing
ECE 635 Adaptive Signal Processing
ECE 638 Fast Algorithms and Architectures for Digital Signal Processing
ECE 670 Principles of C^3I, Part I
ECE 671 Principles of C^3I, Part II
ECE 734 Detection and Estimation Theory
ECE 738 Advanced Digital Signal Processing

CONTROL and ROBOTICS

ECE 521 Modern Systems Theory
ECE 549 Theory and Application of Artificial Neural Networks
ECE 612 Real-Time Embedded Systems
ECE 620 Optimal Control Theory
ECE 621 Systems Identification
ECE 624 Control Systems
ECE 650 Robotics
ECE 673/SYST 620 Discrete Event Systems
ECE 720 Multivariable and Robust Control
ECE 721 Nonlinear Systems
ECE 749 Neural Networks for Control
ECE 750 Intelligent Systems for Robots

COMPUTERS

ECE 511 Microprocessors
ECE 545 Introduction to VHDL
ECE 548 Sequential Machine Theory
ECE 611 Advanced Microprocessors
ECE 612 Real-Time Embedded Systems
ECE 645 Computer Arithmetic: Hardware and Software Implementations
ECE 646 Cryptography and Computer Network Security
ECE 681 VLSI Design Automation
ECE 682 VLSI Test Concepts
ECE 746 Secure Telecommunication Systems

MICROELECTRONICS, ELECTROMAGNETICS/MICROWAVES

ECE 513 Applied Electromagnetic Theory
ECE 520 Applications of Analog and Digital Integrated Circuits
ECE 563 Introduction to Microwave Engineering
ECE 565 Introduction to Optical Electronics
ECE 567 Optical Fiber Communications
ECE 584 Semiconductor Device Fundamentals
ECE 586 Digital Integrated Circuits
ECE 587 Design of Analog Integrated Circuits
ECE 662 Microwave Electronics
ECE 665 Fourier Optics and Holography
ECE 680 Physical VLSI Design
ECE 684 MOS Device Electronics
ECE 689 VLSI Processing
ECE 745 ULSI Microelectronics
ECE 780 High Frequency Electronics

ARCHITECTURE-BASED SYSTEMS INTEGRATION

ECE 672/SYST 619 Introduction to Architecture-Based Integration
ECE 673/SYST 620 Discrete Event Systems
ECE 674/SYST 621 System Architecture Design
ECE 675/SYST 622 System Integration and Architecture Evaluation

Students taking two or more of the ECE 672, ECE 673, ECE 674 and ECE 675 courses **may not** take non-ECE courses as part of their degree program.

TCOM COURSES FOR MSEE

TCOM courses are considered "non-ECE" courses, hence no more than 6 credit hours of TCOM courses may be included in an MSEE program. To be included in an MS program the TCOM course/"course pair" must be taken from the list below and must be approved by the student's academic advisor, with the written approval filed in the student's Department Academic file, **prior to enrollment** in the TCOM course.

The following TCOM courses and "course pairs" have been approved for study (with prior advisor approval!) as part of the MSEE program:

All students/Any specializations:

TCOM 503/513: Fiber Optic Communications/Optical Communications Networks
TCOM 506/518: Personal Communication Systems/3G Cellular Telephony
TCOM 509/519: Internet Protocols/Voice over IP
TCOM 516/517: Global Positioning System/Introduction to Propagation Effects
TCOM 521: Systems Engineering for Telecommunications Management
TCOM 540/541: Telecommunications Network Optimization/Network Design and Pricing
TCOM 548/556: Security and Privacy Issues in Telecommunications/Applied Cryptography
TCOM 555: Network Management Foundations and Applications
TCOM 707: Advanced Link Design

The following courses/"course pairs", while approved, **may not be submitted as part of an MSEE degree program which includes ECE 630, Statistical Communications Theory**, (primarily students with a Communications Specialization):

TCOM 551: Digital Communication Systems
TCOM 552: Introduction to Mobile Communication Systems
TCOM 607: Satellite Communications (Upgraded from TCOM 507/508)

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MASTER of SCIENCE in COMPUTER ENGINEERING

The Department of Electrical and Computer Engineering offers the Master of Science degree in Computer Engineering in conjunction with the Computer Science Department. Computer Engineering is one of the fastest growing fields nationwide and it attracts a growing number of students. Computer Engineering is a field which is at the interface between the Computer Science and Electrical Engineering disciplines, as it involves knowledge of both hardware development, from microelectronics to devices and to digital systems, and software at all levels of digital system architectures. The major distinction between Computer Engineering and Computer Science is that the Computer Engineer is more concerned with the physical implementation of computing devices, the interaction between hardware and software, and the methodologies for designing digital systems. The major distinction between Computer Engineering and Electrical Engineering is that the Computer Engineer is more concerned with the computational aspects of Electrical Engineering problems and the implementation of these solutions in digital devices.

The prime concentration areas of Computer Engineering at George Mason include:

- Digital Systems Design
- Computer Networks
- Microprocessors and Embedded Systems
- Network and System Security

DEGREE REQUIREMENTS

Plan of Study - See Page 3 for details.

Course Work - Each student must complete a minimum of 30 semester hours of graduate-level credits beyond the bachelor's degree under one of the two options listed below. This work must represent a cohesive set of courses leading to comprehensive knowledge in one area of Computer engineering. It can not be a set of disjoined courses. The plan of study for the degree must include the following:

1. Two core courses with B or better in each.

- ECE 548, Sequential Machine Theory
- CS 571, Operating Systems

2. Four required courses, determined by the chosen concentration area. See pages 13 - 14 for the specific courses for each concentration area.

3. Four elective courses, which must be chosen from the list of elective courses common for all concentration areas (see pages 15 - 16). All elective courses must be approved by the Concentration Area advisor prior to the registration for a given course. Out of the four elective courses, at least one must be an ECE course. With the concurrence of the Concentration Area Advisor, Computer Engineering oriented IT courses and courses transferred from other universities may be considered as ECE courses.

4. The Plan of Study should include a minimum of three courses with a grade of B or better at the 600 or above level (not including ECE 798 or 799). The Plan of Study must include a minimum of 15 credit hours of ECE designated courses.

5. Before courses are transferred into the Computer Engineering program, they must be submitted to and receive an approval of the respective computer engineering Concentration Area advisor and the Chair of the Electrical Engineering Department.

6. Before transfer courses may be applied to the computer engineering degree they must be submitted to and receive the approval of the computer engineering Concentration Area advisor and the Chair of the Electrical and Computer Engineering Department.

Seminar Requirement - See Page 3 for details.

Thesis and Scholarly Paper Options

Thesis Option. The thesis advisory committee consists of at least three full-time faculty members from the ECE and/or CS Departments, including at least two affiliated with the MSCpE program (one of whom must be from the ECE Department) and one from outside the MSCpE program. Students must register for at least 3 credit hours of thesis for their first thesis semester. Following their first thesis semester they must register for at least one credit hour of thesis each Fall and Spring semester until graduation. See Page 3 for further details.

Scholarly Paper Option. The Scholarly Paper and the final oral presentation must be approved by the student's Advisory Committee. See Page 3 for further details.

Procedures and Guidelines for the Scholarly Paper are on page 17.

GPA Requirements - See Page 3 for details.

Time Requirement - See Page 3 for details.

CONCENTRATION AREAS

The required courses for each concentration area are presented here along with the list of elective courses common to all concentration areas.

DIGITAL SYSTEMS DESIGN

Digital Systems Design covers the entire digital integrated circuit design process, from the behavioral description to physical layout. Topics range from the sophisticated architectures for computer arithmetic to the fundamentals of basic semiconductor devices used in today's integrated circuits. The VLSI design automation tools and methodologies used at all design layers are discussed, as well as techniques for testing and fault-diagnosis of complex integrated circuits. Through the course projects, laboratories, and homework assignments, students gain the practical knowledge of modern computer-aided design tools from leading vendors, such as Mentor Graphics, Synopsys, Sinplicity, Aldec, Xilinx, and Altera.

Required Courses for the Concentration:

1. ECE 545 Introduction to VHDL
2. ECE 586 Digital Integrated Circuits
3. ECE 645 Computer Arithmetic: Hardware and Software Implementations
4. ECE 681 VLSI Design Automation

COMPUTER NETWORKS

Computer Networks emphasizes the analysis and design of computer networks and distributed computing architectures. It covers network protocols and architectures, statistical analysis methods, performance evaluation, scalability, and the interaction between operating systems and network resources. Students receive a broad knowledge of specialized topics such as cryptography, network security, coding theory, and multimedia.

Required Courses for the Concentration:

1. ECE 528 Introduction to Random Processes in Electrical and Computer Engineering
2. ECE 542 Computer Network Architectures and Protocols
3. ECE 642 Design and Analysis of Computer Communication Networks
4. ECE 742 High-Speed Networks

MICROPROCESSOR AND EMBEDDED SYSTEMS

The Microprocessor and Embedded Systems plan of study covers the full range of microprocessor implementations from the simplest and ubiquitous 4/8 bit embedded microcontrollers to the advanced reduced instruction set (RISC) microprocessors which form the basis for modern small computer systems. It includes the basics of sequential machine theory up to and including advanced computer architectures as well as real-time operating systems and device drivers for embedded computers.

Required Courses for the Concentration:

1. ECE 511 Microprocessors
2. ECE 545 Introduction to VHDL
3. ECE 611 Advanced Microprocessors
4. ECE 612 Real-Time Embedded Systems

NETWORK AND SYSTEM SECURITY

The Network and System Security plan of study covers the entire spectrum of topics related to security in computer networks and distributed systems. The focus is on implementation aspects of cryptographic algorithms, protocols, and systems; trade-off between security and efficiency; and the close integration of cryptography, computer security, and communications. Through projects and labs, students get acquainted with various means of implementing security transformations in both software and hardware.

Required Courses for the Concentration:

1. ECE 542 Computer Network Architectures and Protocols
2. ECE 646 Cryptography and Computer Network Security
3. ECE 746 Secure Telecommunication Systems
4. INFS 766 Internet Security Protocols

ELECTIVE COURSES COMMON FOR ALL CONCENTRATION AREAS

The following is a list of ECE, CS, INFS, and TCOM courses available as electives for MS students in Computer Engineering. Each student has to choose four electives, out of which at least one must be an ECE course. All elective courses must be approved by the concentration area advisor prior to the registration for a given course.

1. All required courses from other concentration areas can be used as electives.
The numbers and names of these courses are repeated below for your convenience:

ECE 511 Microprocessors
ECE 528 Introduction to Random Processes in Electrical and Computer Engineering
ECE 542 Computer Network Architectures and Protocols
ECE 545 Introduction to VHDL
ECE 645 Computer Arithmetic: Hardware and Software Implementations
ECE 586 Digital Integrated Circuits
ECE 611 Advanced Microprocessors
ECE 612 Real-Time Embedded Systems
ECE 642 Design and Analysis of Computer Communication Networks
ECE 646 Cryptography and Computer Network Security
ECE 681 VLSI Design Automation
ECE 742 High Speed Networks
ECE 746 Secure Telecommunication Systems
INFS 766 Internet Security Protocols

2. Selected ECE courses available as electives for MS students in Computer Engineering:

ECE 584 Semiconductor Device Fundamentals
ECE 587 Design of Analog Integrated Circuits
ECE 595 Discrete Event Systems
ECE 630 Statistical Communication Theory
ECE 633 Coding Theory
ECE 641 Computer System Architecture
ECE 680 Physical VLSI Design
ECE 682 VLSI Test Concepts
ECE 684 MOS Device Electronics
ECE 698 Independent Reading and Research
ECE 699 Mixed Signal IC Design
ECE 731 Digital Communications
ECE 732 Mobile Communication Systems
ECE 741 Wireless Networks
ECE 798 Research Project
ECE 799 Master's Thesis (6 credit hrs = 2 course equivalents)

3. Selected CS courses available as electives for MS students in Computer Engineering:
   CS 540 Language Processors
   CS 583 Analysis of Algorithms
   CS 635 Foundations of Parallel Computation
   CS 672 Computer System Performance Evaluation
   CS 756 Performance Analysis of Computer Networks
   CS 773 Real-Time Systems Design and Development

4. Selected INFS courses available as electives for MS students in Computer Engineering:
   INFS 762 Information Security Principles
   INFS 767 Secure Electronic Commerce
   INFS 765 Database and Distributed Systems Security
   INFS 774 Intrusion Detection

5. Selected TCOM courses available as electives for MS students in Computer Engineering:
   TCOM 505/510 Networked Multi-Computer Systems/Client-Server Architectures and Applications
   TCOM 509/513 Internet Protocols/Optical Communications Networks

SCHOLARLY PAPER PROCEDURES AND GUIDELINES

The ECE department posts topics for scholarly papers at http://ece.gmu.edu/ScholarlyTopics.htm. Interested students should contact the respective professor to sign up for a given topic. Once a topic has been chosen, the professor sends a note to Professor Ephraim at yephraim@gmu.edu indicating the name of the student and the selected topic. The selected topic will be reserved, and other students will have to choose from the remaining topics. Students who could not find a suitable topic should contact Professor Ephraim at yephraim@gmu.edu. Please do not address questions to the staff at the ECE office.

As part of the scholarly paper requirement, the student must present the work in a departmental seminar in the presence of the advisor and an additional ECE faculty member no later than the tenth week of classes of each semester. The seminar must be announced at least two weeks before the presentation date. Please coordinate your seminar presentation with the ECE Department Office, at ece@gmu.edu.

The seminar announcement must include:

1. Title of seminar, student's name, advisor's name, and attending faculty
2. Date and location of seminar
3. Abstract

A scholarly paper is mandatory for all students who choose not to write an MS research thesis. As an option, the student may choose to present a scholarly paper based on the final report in ECE 798 - Research Project. It is expected that the 3 credit hours of effort in ECE 798 will result in a much more substantial paper than a Scholarly Paper submitted in addition to 30 hours of regular course work. The scholarly paper is a technical report on an independent study, laboratory or computer experimentation, or literature search done by the student on a current scientific or technological topic, such as a survey of some new technologies, or new methodologies, or a case study of new applications, on a theme selected under the guidance of a faculty advisor.

Guidelines for an MS Scholarly Paper

The Scholarly Paper should be done by the student with minimum supervision of the professor. Essentially it is a proof that, at the end of the MS study, the student can develop the project by himself or herself without the repeated advising by the professor. The role of the professor is to verify that the final paper meets the requirements for graduation with a Master of Science degree from the ECE Department.

The Scholarly Paper should be an expository article based on well researched facts, expressed at the level appropriate to electrical or computer engineers with a Masters degree.

If the student wants to engage in a more substantive study of the topic that requires several consultations with the professor, the student should ask the professor to serve as an advisor for the ECE 798 Research Project.

The paper, either as a Scholarly Paper or a Research Report from ECE 798, should follow accepted standards for English, technical writing, citations of references, copyright, and George Mason Honor Code.

Students should plan to deliver their paper to the professor well ahead of the expected date of graduation, e.g. at least five weeks before the end of the classes in a given semester.

The professor is under no obligation to approve the paper as is. In fact, if the professor finds the paper unsatisfactory, the student may have to rework the paper, even at the expense of missing the student's intended graduation date.

The professor may decline to read multiple revisions of an unsatisfactory draft, and the professor may reject the final version of the paper. If the professor does not approve the paper, the student may have to, in the extreme circumstance, choose another topic and another professor.

A corrected final copy of the paper should be delivered to the ECE Department to be included in a repository of such papers in the ECE library in room 235.

In addition to submitting their Scholarly papers, or Research Project Reports, or MS Thesis in hard copy, students are encouraged to also develop electronic versions of these documents in MS Word, HTML, Power Point or Acrobat (PDF) and submit them to the Department for posting. Posting on the ECE website is at the discretion of the ECE Department. Posting of an exemplary Scholarly Paper will make the work of the student more visible and will help students in subsequent years. When the Department exercises the right to put some of the exemplary Scholarly Papers on the ECE website, the student may copyright the paper and, in such situation, the student is required to give the Department a written permission for posting. In some cases, the student may be asked to authorize the faculty to use the Power Point slides in lectures and presentations to other students. In some cases, the material developed by the student may be used, subject to an agreement between the student and the professor, in scholarly publications such as survey papers, books etc. In such case student's contribution will be acknowledged, or, if appropriate, the student may become a co-author of the publication.

CERTIFICATE PROGRAM in COMMUNICATIONS and NETWORKING

The Department of Electrical and Computer Engineering offers the Certificate in Communications and Networking which provides graduate students with the opportunity to reach a demonstrated level of competence in one of the concentration areas in communications and networking. Course-work towards the graduate certificate can be used for credit towards the M.S. degree in Electrical Engineering or Computer Engineering. However, the primary purpose of the certificate is to provide a well-defined target for students who want to advance their knowledge of modern communications but do not necessarily wish to complete all requirements for the M.S. degree. While all 15 credit hours required for the Certificate may be taken in Non-degree status, only 12 hours of course work taken in a non-degree status can be considered for application toward the MS degree. The certificate may be pursued concurrently with any of the graduate degree programs in the School of Information Technology and Engineering.

Admission Requirements: The certificate program in Communications and Networking is open to all students who hold a B.S. degree in any scientific or engineering discipline from an accredited university and are in graduate status (either Degree or Non-Degree) in the School of Information Technology and Engineering. Interested persons not already in a George Mason graduate degree program should apply for admission in either degree or non-degree status. Non-degree students pursuing a certificate must submit a standard Graduate Application form, annotated with "Certificate program" before they can be awarded the certificate.

Program Requirements: The certificate is awarded upon completion of 15 credit hours of graduate course work in the area of communications. A cumulative GPA of 3.0 is required and at most one course with a grade of C may be applied towards the certificate. A maximum of three credits of graduate course work completed at another institution may be considered for application to the certificate. The certificate is comprised of six credit hours of required foundation courses, and nine credit hours of elective courses.

Foundation Courses:

- ECE 528, Introduction to Random Processes in Electrical and Computer Engineering, and
- ECE 542, Computer Network Architectures and Protocols or CS 656, Computer Communications and Networking.

Elective Courses: After completing the foundation courses, students can choose three elective courses from the following list:

ECE 535 Digital Signal Processing
ECE 565 Introduction to Optical Electronics
ECE 567 Optical Fiber Communications
ECE 630 Statistical Communication Theory
ECE 633 Coding Theory
ECE 642 Design and Analysis of Computer Communication Networks
ECE 643 Telecommunication Switching Systems
ECE 646 Cryptography and Computer-Network Security
ECE 665 Fourier Optics and Holography
ECE 731 Digital Communications
ECE 732 Mobile Communications Systems

ECE 734 Detection and Estimation Theory
ECE 735 Data Compression
ECE 737 Spread Spectrum Communications
ECE 738 Advanced Digital Signal Processing
ECE 739 Satellite Communications
ECE 741 Wireless Networks
ECE 742/IT 834 High Speed Networks/Telecommunications Networks
ECE 743 Multimedia Networking and Communications Software
ECE 746 Secure Telecommunication Systems
ECE 751/IT 886 Information Theory
OR 635 Discrete System Simulation
OR 643 Network Modeling
OR 647 Queueing Theory

CERTIFICATE PROGRAM in SIGNAL PROCESSING

The Department of Electrical and Computer Engineering offers the Certificate in Signal Processing which provides graduate students with a concise sequence of courses and laboratory experiences within the wide field of signal processing. Course-work towards the graduate certificate can be used for credit towards the M.S. degree in Electrical Engineering, Computer Engineering or Statistical Science. However, the primary purpose of the certificate is to provide a well-defined target for students who want to advance or update their knowledge in this fast moving field but do not necessarily wish to complete all requirements for the M.S. degree. The certificate may be pursued concurrently with any of the graduate degree programs in the School of Information Technology and Engineering. While all 15 credit hours required for the Certificate may be taken in Non-degree status, only 12 hours of course work taken in a non-degree status can be considered for application toward the MS degree.

Admission Requirements: The certificate program in Signal Processing is open to all students who hold a B.S. degree in any scientific or engineering discipline from an accredited university and are in graduate status (either Degree or Non-degree) in the School or Information Technology and Engineering. Interested persons not already in a George Mason graduate degree program should apply for admission in either Degree or Non-degree status. Non-degree students pursuing a certificate must submit a standard Graduate Application form, annotated with "Certificate program" before they can be awarded the certificate.

Program Requirements: The certificate is awarded upon completion of 15 credit hours of graduate course work in the area of signal processing. A cumulative GPA of 3.0 is required and at most one course with a grade of C may be applied towards the certificate. A maximum of three credits of graduate course work completed at another institution may be considered for application to the certificate. The certificate is comprised of six credit hours of foundation courses taken by all students and nine credit hours of elective courses.

Foundation Courses:

- ECE 528, Introduction to Random Processes in Electrical and Computer Engineering, or STAT 544, Applied Probability, and
- ECE 535, Digital Signal Processing.

Elective Courses: After completing the two foundation courses, students can choose elective courses by taking three courses from the list below.

ECE 537, Introduction to Digital Image Processing
ECE 635, Adaptive Signal Processing
ECE 638/IT 838, Fast Algorithms and Architectures for Digital Signal Processing/Signal Processing Algorithms and Architectures
ECE 644, Algorithms and Architectures for Image Processing
ECE 665, Fourier Optics and Holography
ECE 722/IT 841, Kalman Filtering with Applications
ECE 728, Random Processes in Electrical and Computer Engineering
ECE 734/IT 830, Detection and Estimation Theory
ECE 735/IT 832, Data Compression
ECE 738, Advanced Digital Signal Processing
ECE 749/IT 844, Neural Networks for Control/Pattern Recognition
ECE 751/IT 886, Information Theory

ECE 752/IT 885, Spectral Estimation
ECE 754/IT 837, Optimum Array Processing I
ECE 755/IT 937, Optimum Array Processing II
STAT 652, Statistical Inference
STAT 658, Time Series Analysis and Forecasting
STAT 662, Multivariate Statistical Methods
IT 746, Calculus of Random Signals
IT 930, Multichannel Statistical Signal Processing (Proposed)
IT 934, Advanced Topics in Detection and Estimation (Proposed)
IT 941, System Identification and Adaptive Control
IT 978, Statistical Analysis of Signals

CERTIFICATE PROGRAM in VLSI DESIGN/MANUFACTURING

The ECE Department offers the Certificate in VLSI Design/Manufacturing which provides a well targeted graduate level continuing education possibility for professionals working in Northern Virginia's semiconductor industry. This certificate is intended for the students who want to advance their knowledge of very large scale integration (VLSI) design or VLSI manufacturing but do not necessarily wish to complete all requirements for the M.S. degree in Electrical Engineering or Computer Engineering. The course work is designed so that graduate students can reach a demonstrated level of competence either in VLSI design or VLSI manufacturing. Course work towards the graduate certificate can be used for credit towards the M.S. degree in Electrical Engineering or Computer Engineering. While all 15 credit hours required for the Certificate may be taken in Non-degree status, only 12 hours of course work taken in a non-degree status can be considered for application toward the MS degree. The certificate may be pursued concurrently with any of the graduate degree programs in the School of Information Technology and Engineering.

Admission Requirements: The certificate program in VLSI design/manufacturing is open to all students who hold a B.S. degree in any scientific and engineering discipline and are currently holding a graduate student status (degree or non-degree) in the School of Information Technology and Engineering. Students with non-scientific and non-engineering degrees are required to take remedial courses before being admitted into the certificate program.

Program Requirements: The certificate is awarded upon completion of 15 credit hours of graduate course work. These fifteen credit hours include a required foundation course, a concentration core course, and three or more elective courses out of which at least two courses are in the selected concentration area. A cumulative GPA of 3.0 is required and, at most, one course with a grade of C may be applied toward the certificate. A maximum of three credits of graduate course work completed at another institution may be considered for application to the certificate.

After completing the foundation course (ECE 684), students can choose one of the two areas of concentration (VLSI Design or VLSI Manufacturing) described below by taking four courses in that area, one of which is to be the core course in that area.

Foundation Course:

- ECE 684 MOS Device Electronics

VLSI Design Concentration:

- Core Course: ECE 586 Digital Integrated Circuits

Electives: ECE 545 Introduction to VHDL, ECE 587 Design of Analog Integrated Circuits, ECE 645 Computer Arithmetic: Hardware and Software Implementations, ECE 680 Physical VLSI Design, ECE 681 VLSI Design Automation, ECE 682 VLSI Test Concepts.

VLSI Manufacturing Concentration:

- Core Course: ECE 689 VLSI Processing

Electives: ECE 586 Digital Integrated Circuits, ECE 680 Physical VLSI Design, ECE 745 ULSI Microelectronics.

Intentionally left blank (for doodling!)

Department of Electrical and Computer Engineering

Master's Degree Plan of Study

Last Name: _____ First Name: _____ Initial: ____

Student G-number: _____

Date Admitted: _____ _____ _____

Degree Provisional Non-Degree

Home Phone: _____

Home Address: _____

_____

GMU email Address: _____

Advisor: _____ Degree: Electrical Engineering Computer Engineering

Concentration/Specialization Area: _____

Research Interests: _____

Expected Date of Graduation: _____

Highest Degree Earned

School: _____

Degree: _____ Discipline: _____ Year: _____ GPA: _____

This plan should be kept up to date based on consultation with student's advisor. Consequent changes should be appropriately annotated on the student's and the ECE file copy. A final, signed, version must be submitted by the student with the graduation application.

	COURSE	TITLE	SEMESTER	GRADE
Core:				
Core:				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Remarks: Remediation Required/Substitutions/Waivers/Justifications

Approved by

Advisor: _____ _____ Date: _____

Signature Printed name

June 1999

SEMINAR ATTENDANCE RECORD

Student Name: _____

1. _____ _____
   Date/Time Title
   _____ _____
   Location (Building/Room) Speaker
2. _____ _____
   Date/Time Title
   _____ _____
   Location (Building/Room) Speaker
3. _____ _____
   Date/Time Title
   _____ _____
   Location (Building/Room) Speaker
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9. _____ _____
   Date/Time Title
   _____ _____
   Location (Building/Room) Speaker
10. _____ _____
    Date/Time Title
    _____ _____
    Location (Building/Room) Speaker

Acknowledging my responsibilities as a professional and recognizing my obligation to meet the requirements of the George Mason University Honor Code, I hereby affirm that I did attend the seminars listed above.

_____ _____
Signature Date

June, 12, 1999

ELECTRICAL AND COMPUTER ENGINEERING FACULTY

ALLNUTT, J.E., Professor, Ph.D. Salford University, 1970. Satellite communications; radiowave propagation impairments, uplink power control for Internet satellites, and the impact of fade durations. jallnutt@gmu.edu

BARANIECKI, A.Z., Associate Professor, Ph.D. University of Windsor, 1980. Digital signal processing algorithms; application of digital signal processing to speech, image processing, and telecommunications. abaranie@gmu.edu

BARNES, R., Assistant Professor, Ph.D. University of Illinois, 2005. Complexity- and power-efficient computer architectures, compiler managed microarchitectures, ILP compilation, embedded computing. rbarnes1@gmu.edu

BEALE, G.O., Associate Professor, Ph.D. University of Virginia, 1977. Applications of advanced control techniques; digital simulation, robotics and automation; intelligent systems. gbeale@gmu.edu

BERRY, A.K., Associate Professor, Ph.D. University of Missouri, 1985. Growth and characterization of semiconductor materials, thin films, and photovoltaics. aberr1@gmu.edu

BLACK, W.M., Professor, Ph.D. Pennsylvania State University, 1971. Plasma physics; microwave engineering; generation and amplification of high-power microwaves. mblack@gmu.edu

CEPERLEY, P.H., Associate Professor, Ph.D. Stanford University, 1973. Physical acoustics; thermoacoustics; waves; electromagnetic fields. pceperle@gmu.edu

CHANG, S.C., Associate Professor, Ph.D. University of Hawaii, 1977. Information theory; computer communications networks; error-correcting codes. schang@gmu.edu

COOK, G., Earle C. Williams Professor, Sc.D. Massachusetts Institute of Technology, 1965. Image analysis and processing; control systems; robotics; signal processing; digital simulation. gcook@gmu.edu

EPHRAIM, Y., Professor, D.Sc. Technion-Israel Institute of Technology, 1984. Statistical signal processing; array signal processing; speech processing. yephraim@gmu.edu

GAJ, K., Associate Professor, Ph.D., Warsaw University of Technology, 1992. Cryptography; computer arithmetic; VLSI design and testing; reconfigurable computing; hardware/software co-design; computer network security. kgaj@gmu.edu

GERTLER, J.J., Professor, Ph.D., 1967, Sc.D. 1980, Hungarian Academy of Sciences. System identification; fault detection and diagnosis; real-time programming. jgertler@gmu.edu

GRIFFITHS, L.J., Dean, School of Information Technology and Engineering, and Professor, Ph.D., 1970, Stanford University. Signal Processing. griffiths@gmu.edu

HINTZ, K.J., Associate Professor, Ph.D. University of Virginia, 1981. Microprocessors; self-organizing machines; sensor management and scheduling; pattern recognition; signal processing. khintz@gmu.edu

IOANNOU, D.E., Professor, Ph.D. University of Manchester, England, 1978. Devices and materials for microelectronics. dioannou@gmu.edu

JABBARI, B., Professor, Ph.D. Stanford University, 1981. Digital communications; computer communication networks; switched telecommunications networks. bjabbari@gmu.edu

LEVIS, A.H., University Professor, Sc.D. Massachusetts Institute of Technology, 1968. Distributed intelligence systems; variable structure distributed architectures; Petri nets. alevis@gmu.edu

MANITIUS, A.Z., Chairman and Professor, Ph.D. Technological University of Warsaw, 1968. Control of time-delay; distributed parameter systems; adaptive control; adaptive signal processing; computational methods in control. amanitiu@gmu.edu

MARK, B., Associate Professor, Ph.D. Princeton University, 1995. Architecture, design and performance evaluation of computer/communication systems and networks. bmark@gmu.edu

MULPURI, V.R., Professor, Ph.D. Oregon State University, 1985. Large bandgap semiconductor (SiC, GaN, etc) materials, and devices (ion-implantation doping, ohmic contacts, device fabrication, material and device characterization); semiconducting opto-electronic materials; microwave devices. rmulpuri@gmu.edu

NELSON, J. K., Assistant Professor, Ph.D. University of Illinois, 2005. Equalization techniques for communications in the presence of inter-symbol interference, low-complexity equalizers in a high-SNR regime, universal equalizers, digital signal processing. jnelsond@gmu.edu

PACHOWICZ, P., Associate Professor, Ph.D. Stanislaw Staszic Technical University, Poland, 1984. Machine vision/perception, automatic target recognition, machine learning, knowledge-based systems, autonomous agents, intelligent robotics. ppach@gmu.edu

PARIS, B-P., Associate Professor, Ph.D. Rice University, 1990. Multiuser communications systems, including multiple-access control strategies and code-division multiple-access; statistical signal processing; mobile radio systems, including fading multi-path channels and traffic control. pparis@gmu.edu

SUTTON, W.G., Associate Chair and Associate Professor, Ph.D. Air Force Institute of Technology, 1981. Semiconductor device physics; VLSI design. wsutton@gmu.edu

WAGE, K., Assistant Professor, Ph.D. Massachusetts Institute of Technology, 2000. Signal processing and array antennas for underwater acoustic wave propagation. kwage@gmu.edu

FOR YOUR NOTES