WEST VIRGINIA UNIVERSITY
LANE DEPARTMENT OF COMPUTER SCIENCE
AND ELECTRICAL ENGINEERING (8/2003)

MASTER OF SCIENCE IN
ELECTRICAL ENGINEERING
DEGREE PROGRAMS

(for students beginning Fall 2003)

PART I

DEPARTMENTAL RESEARCH OVERVIEW

The department is enthusiastically and vigorously involved in research, technical publications, and graduate instruction at the forefront of the field. The areas of emphasis are:

- Communications and signal processing including computer networks and imaging processing systems.

- Computer systems engineering, including microprocessor applications, advanced computer architecture, neural networks, fuzzy logic, parallel processing, VLSI testing techniques, fault tolerant design, software metrics, and software engineering.

- Control system, including classical and modem control theory and applications-

- Electric power systems and power electronics, including stability, transients, and steady state analysis, real time control, protection, electric machines, drives, and advanced motion controllers

- Electronics, including integrated circuit devices, VLSI, optoelectronics, high performance packaging, and micro fabrication.

- Bioengineering and biometric systems, including biosignal processing, bioinstrumentation, telemedicine, biometric devices, and algorithms.

Communications & Signal Processing

Communications and signal processing, though distinct topics, share a strong overlap and form a joint thrust. Communications has evolved rapidly from the basic voice telephone service to a rich set of communications systems carrying voice, data, video, and other information. The integration of computers and communications systems has enabled powerful information systems for a wide range of applications. Advances in signal processing theory, physical technologies, and powerful digital signal processors (DSPs) have combined to dramatically expand the applications of signal processing. Research activities address three primary areas: theory technology, and applications. (1) Research in communications theory explores new principles for higher performance or improved analysis of communications systems. Signal processing theory research explores new principles for understanding and manipulation of analog and digital signals. These theoretical foundations drive a wide range of applied research. (2) Research on technologies extends from basic devices through full testbed systems. Projects include photonics and high-speed electronics for optical communications, advanced system packaging and interconnections for high performance communications and signal processing, and other DSP-based functions for communications and intelligent sensors. (3) Applications research includes cooperating software on opposite ends of the communications link used for distance education, distance collaborations and other information age applications. Image processing applications in areas such as medical imaging and inspection systems are also investigated.

Computer Systems Engineering

Computer engineering is a very broad area, covering hardware, firmware, and software engineering of complex digital systems and system components. Software and hardware systems design is the most technically intensive components of the Electrical and Computer Engineering curriculum. A broad spectrum of research topics of both applied and theoretical nature are undertaken in the department. Some examples are: software verification and validation, software process improvement, software development environments for signal processing applications, parallel processing of fingerprint image comparison systems, fast adaptive routing algorithms for processor arrays, communication switching systems, information systems, computational accelerator using digital signal processing arrays, an automated lumber processing system, neural network medical and industrial applications autonomous robots, computer controlled electric and hybrid vehicle instrumentation, a distributed microprocessor monitoring system, knowledge-based decision support system, and microprocessor-based instrumentation. A large selection of hardware and software graduate courses are offered in the department. These cover topics such as switching theory, digital communication systems, VLSI design and testing, fault-tolerant computing, computer architecture, neural networks, applied fuzzy logic, real-time software design and development, and C++ object-oriented programming. In addition, the Electrical Engineering and Computer Engineering faculty collaborate very closely with the Computer Science faculty. Graduate students in the computer engineering area are encouraged to include courses from Computer Science in their program. The department offers dedicated laboratories equipped with personal computers and workstations to support classroom instruction and research. A number of computer engineering faculty have close cooperation with several interdisciplinary research centers at WVU such as the Concurrent Engineering Research Center, the Alternate Fuels Research Center, and the Constructed Facilities Research Center.

Control Systems

The control systems area is an important part of the research program in electrical engineering. The topic has great breadth in applications ranging from electrical power systems and electrical machines to electrically energized transportation systems. (Applications of control theory in power are described in the Electric Power Systems program description as well as in this control program description). As a research area, control systems may be characterized as both modeling and control of complex systems of both deterministic and stochastic type. The department offers courses which provide the required background to prepare students for the design and analysis of control systems. Control theory, particularly as applied to large-scale systems is a topic emphasized in the department's research program. Current research is focused on the application of control to large dynamic systems, especially power systems, electrical machines and maglev transportation systems. The work is primarily on algorithm development. In recent years external funding for control systems research has come from the National Science Foundation, the Departments of Energy and Defense and electric utilities. Four faculty members in the Department of Computer Science and Electrical Engineering have significant research activities in control systems. Other faculty members in Mathematics and Mechanical Engineering also collaborate in the exciting on-going work at West Virginia University in the control area.

Electric Power Systems

Electrical power systems historically have been an area of emphasis in the electrical engineering curriculum, and the graduate program in power systems at WVU is quite mature. Four faculty members have interest in electric power, and the department has an endowed position for Electric Power Systems. Graduate courses are offered regularly in power system stability and control, real-time control of power systems, computer applications in power system analysis, advanced electric machines and HVDC systems. In addition, there are three senior elective/graduate courses on the subjects of distribution, power electronics, and power systems analysis. The power group works closely with the control area which offers graduate courses in linear and nonlinear control systems, optimal control, digital control. Recent and current research activities include control of power systems in a deregulated environment, energy balancing in a restructured market environment, modeling, controlling and dispatching distributed resources, electric transportation, modeling, stability analysis, optimal design, design of modulation controllers for multiterminal ac/dc power systems, electric drives, electric machines, advanced motion control systems, and power electronics. Externally funded projects include robust design of modulation controllers for flexible ac/dc transmission lines, optimal design of permanent magnet brushless machines, spacecraft power storage controllers, investigation of voltage/ current characteristics of MOS-controlled thyristors with static and dynamic loads, and identification and decentralized control of critical modes. These projects provide excellent support for both graduate student and faculty research. Extensive interaction with industry provides ample opportunity for direct contact with practitioners in the field. The department has enjoyed continuous support from local utilities.

Electronics and Photonics:

The field of electronics and photonics – initially microelectronics and now pushing well into nanoelectronics – is at a crossroads where further developments are forcing researchers to take a closer look at quantum mechanical processes to design and fabricate small dimensional devices. Students who chose to take the Electronics area at West Virginia University should obtain a deeper understanding of the physical basis for the design and fabrication of micro- and nano-electronic and photonic devices.

The suggested course work draws upon the expertise of the WVU faculty in EE, physics and chemical engineering – demonstrating the interdisciplinary characteristic of this field. These faculty have joined to form the Photonics and Microelectronics Working Group (http://msrc.wvu.edu/pmt/). The research areas that these faculty are involved in cover aspects of materials science, physics, and semiconductor electronics to design, grow, fabricate, and characterize novel electronic and photonic devices and small subsystems. Thus, the strength of the faculty is in experimental semiconductor physics and electronics. Present areas of research include wide bandgap semiconductor fabrication techniques, device design, and materials and device characterization; integration of photonics in microelectromechanical devices (MEMs) for active control and feedback; near-infrared and mid-infrared photonic materials and devices; nanoelectronic materials growth and device design; and the small scale integration of photonic and electronic devices for sensing applications.

These faculty are also involved in research on electronic applications that, by their very nature, require the integration of knowledge from other disciplines. One such example is the increasing activity in the design and characterization of sensors for biometric and information assurance applications. The Center for Identification Technology Research, CITeR, (http://www.csee.wvu.edu/citer/) was recently established to coordinate the research in this area at WVU and three other universities and several industrial and governmental partners. Thus, students are encouraged to take courses outside of the more standard Electrical Engineering coursework, in information technology and biotechnology, so that they can effectively participate in this multidisciplinary research programs.

Much of the research in photonics and micro/nanoelectronics is supported by the laboratory facilities of the Microelectronic Systems Research Center (http://msrc.wvu.edu/). The facilities include a micro/nanofabrication laboratory, a photonics laboratory, a CAD/CAE facility with SUN workstations/PCs and commercial/academic software tools, an electronic and photonics test facility (device through small scale systems testing), and a surface mount printed circuit board fabrication and assembly facility. Students also have access to a number of other facilities across the university to support specific research projects – in physics, chemistry, chemical engineering, and the Health Sciences Center as examples.

Bioengineering and Biometric Systems

A majority of the signal and image processing research in the department is centered in the bioengineering and biometrics areas. Bioengineering is the multidisciplinary application of engineering to medicine and biology. Biometrics is a specific area of bioengineering in which biological signatures (fingerprint, voice, face, DNA) are used for identification or authentication in criminal justice, e-commerce, and medical applications. Specific departmental projects in these areas include signal processing for prediction of sudden cardiac death in an animal model of heart failure, development of algorithms for arrhythmia detection in implanted medical devices, telemedicine for rural health care delivery in West Virginia, analysis of temporal fingerprint images for determination of vitality, neural network, and genetic algorithms for matching of fingerprint and dental images, 3-D crano-facial reconstruction, multimedia information systems (images, video, and audio), distributed multimedia systems, and multimedia data storage and compression. Sponsors for this work include the Department of Defense, National Science Foundation, the American Heart Association, the National Institute of Health, and industry. In addition, the department is working in collaboration with the forestry department to characterize the temporal and spectral characteristics of bird calls. Reserach entities in the department include the Center for Identification Technology, a developing NSF Industry/University Cooperative Research Center, the Biomedical Signal Analysis Laboratory, and the Software Architectures and High Performance Computer Research Lab.

Part II

MSEE Emphasis Areas and Tracks

A student is required to take 8 3-credit courses plus research for a thesis-based master degree or 10 3-credit courses plus research/independent study for a problem report-based master degree or 11 3-credit courses for a coursework-only master degree. Students who are supported as Research Assistants are required to pursue the thesis option. All students must also pass graduate seminar at least twice. The student is required to major in one emphasis area of electrical and computer engineering. There are six defined emphasis areas: **electronics, software engineering, communications and signal processing, control systems, digital systems, and power systems**. To **major** in an emphasis area, the student must take the required course plus courses from the "designated elective" list for a total of three courses. Students doing thesis must take the required course from one other area. Students doing the problem report must take the required courses from two other areas. The remaining courses are free electives, subject to approval by the student's Advisory and Examining Committee.

Emphasis Area Courses

Electronics and Photonics:

Required

EE 550 Adv. Semiconductor Electronics

Designated Electives

EE 437 Fiber Optic Communications
EE 455 Introduction to Microfabrication
EE 591C Introduction to Nanotechnology
EE 650 Optoelectronic Devices
EE 694 Electronics/Photonics Seminars
Phys 771 Intermediate Solid State Physics I
Phys 772 Intermediate Solid State Physics II
Phys 773 Advanced Solid State Physics
ChE 466 Thin Films

Software Engineering:

Required: Any 1 from:

CpE 585	Concurrent Prog. in Java
CpE 584	Adv. Real- Time Systems Development

Designated electives:

SENG 520	Software Analysis and design
SENG 591	ADTP:Object-Oriented Design
CpE 442	Introduction to Computer Architecture
CpE 560	Introduction to Information Systems
CpE 484	Intro to Real- Time System Development
CpE 620	Application of Neural Networks
CpE 643	Fault Tolerant Computing
CpE 572 /CS555	Advanced Computer Architecture
CS 450	Real-Time Operating Systems
CS 430	Advanced Software Engineering
CS 440	Database Design Theory
CS 557	Software Engng in Data Communication
CS 540	Theory of Database Systems
CS 535	Software Verification and Validation
CS 530	Formal Methods in Software Engineering
CS 570	Interactive Computer Graphics
CS 735	Advanced Software Verification
CS 734	Software Reuse
CS 770	Advanced Graphics and Multimedia
EE 461	Introduction to Communication Systems
EE 463	Digital Signal Processing Fundamentals
EE 465	Introduction to Digital Image Processing
EE 561	Communication Theory

Suggested Plan of Study :

CpE 585	Concurrent Prog. in Java (*Required)*
CpE 684	Adv. Real- Time Systems Development
CS 450	Real- Time Operating Systems *(Strongly Recommended)*
CpE 520	Application of Neural *Networks (Strongly Recommended)*
CpE 442	Introduction to Computer Architecture *(Recommended Minor)*
CpE 572 /CS555	Advanced Computer Architecture *(Recommended Minor)*

Communications and Signal Processing:

Required:

EE 513 Stochastic Systems Theory

Designated Electives:

EE 437 Fiber Optics Communications
EE 461 Intro. Communications Systems
EE 463 Digital Signal Processing Fundamentals
EE 465 Intro. Digital Image Processing
CS 453 Data and Computer Communications
CpE 493G Wireless Networking
EE 568CS 493/593 Intro. Information Theory
EE 561 Communication Theory
EE 591B Advanced Image Processing
EE 591X Coding Theory
EE 562 Wireless Communication Systems
EE 625 Advanced Signal Processing

Control Systems:

Required:

EE 515	State Variable Analysis of Systems

Designated electives:

EE 411	Fundamentals of Control Systems
EE 413	Introduction to Digital Control
EE 511	Applied Non-Linear Control
EE 513	Stochastic System Theory
EE 517	Optimal Control
EE 519	Digital Control
EE 535	Power System Control and Stability
EE 711	Non-Linear Control Systems Analysis
EE 713	Large Scale System Modeling
EE 715	Stochastic Estimation and Control
EE 731	Real Time Control of Electric Power System
CpE 520	Application of Neural Networks

Digital systems:

Required: Any 1 from:

CpE 670	Switching Circuit Theory I
CS 555	Advanced Computer Systems Architecture

Designated electives:

CpE 442	Intro to Digital Computer Architecture
CpE 454	Digital Systems Testing
CpE 484	Real-Time System Development
CpE 520	Application of Nellral Networks
CpE 521	Applied Fuzzy Logic
CpE 643	Fault Tolerant Computing
CpE 651	VLSI System Design
CpE 771	Switching Circuit Theory II
CpE 772	Advanced Digital Systems Design

Power Systems:

Required: Any 1 from:

EE 531	Advanced Electrical Machinery
EE 533	Appl. of Dig. Comp. to Power Sys. Analysis

Designated electives:

EE 435	Introduction to Power Electronics
EE 431	Electrical Power Distribution Systems
EE 436	Power Systems Analysis
EE 487	Electric Vehicle Design
EE 535	Power System Control And Stability
EE 537	Advanced Power Electronics and Drives
EE 731	Real- Time Control of Elec Pwr Systems
EE 735	HVDC Transmission

Part III

Master of Science in Electrical Engineering
With Emphasis in Biometrics and Information Assurance

An applicant with a baccalaureate degree, or its equivalent, from a program accredited by the Accreditation Board for Engineering and Technology (ABET), or an internationally recognized program in engineering will be admitted on the same basis as engineering graduates of WVU. Lacking these qualifications, an applicant must first fulfill any special requirements of the department in which the student is seeking an advanced degree.

All master's programs require applicants to satisfy the three items below in consideration for admission. Specific programs may have additional requirements.

- A GRE score on the general test of either the 80th percentile on the quantitative part or 80th percentile total (verbal + quantitative + analytical).
- A minimum cumulative grade point average of 3.0 or equivalent, based on 4.0 systems.
- Three letters of reference.
- Familiarity with the basic concepts of Information Assurance and Biometrics.

Admission as a graduate student is required of all applicants for admission to a program of study and research. Applicants for admission must hold or expect to receive a bachelor's degree in engineering or computer science from an accredited or an internationally recognized program in engineering or computer science

Regular, Provisional, and Non-Degree Admission

Students admitted into a program are designated as regular, provisional, or non-degree status. Regular status is given to students who are granted unconditional admission. Provisional status is given to students who have deficiencies to make up such as incomplete credentials or other reasons as identified by the graduate coordinator. In all cases, the student's letter of admission will state what must be done to attain regular status, and students must sign and date this letter no later than the first registration. Non-degree status is granted case-by-case by the graduate coordinator. Basically, a non-degree student is one who may take courses, but sometimes with no plan of study or any guarantee for attaining provisional status.

Masters Options

Three options are available to EE Masters students for degree completion:

Thesis Option: Total hours: 32. Eight 3-credit courses, at least two hours of graduate seminar, plus 6 credits of research leading to successful thesis defense.

Problem Report: Total Hours: 35. Ten 3-credit courses, at least two hours of graduate seminar, plus 3 credits of research/independent study leading to successful problem report completion.

Coursework: Total Hours: 35. Eleven 3-credit courses and at least two hours of graduate seminar.

To complete an MS EE with an Area of Emphasis in Biometrics and Information Assurance, A student must:

1.) Complete the five required courses (15 credits) of the Graduate Certificate in Biometrics and Information Assurance.

Required Courses for MSEE Emphasis and Grad Certificate in Biometrics and Information Assurance

No	Course Name	Course Number	Hrs
1	Forensic Statistics	STAT 591F	3
2	Concepts in Biometrics	BIOM426	3
3	Computing Security	CS 465	3
4	Advanced Biometrics	EE 526	3
5	Digital Image Processing	EE 465	3

2.) Depending on MS Option do the following:

a.) *Thesis Option:* Define and complete a Thesis (6 credits) in the area of Biometrics and/or Information Assurance plus successfully complete three, 3 credit hour courses,

b.) *Problem Report Option:* Define and complete a Problem Repot (3 credits) in the area of Biometrics and/or Information Assurance plus successfully complete five, 3 credit hour courses, two of which must be from the elective list below,

c.) *Coursework Option:* Complete a minimum of an additional six, 3 credit hour courses, three of which must be chosen from the elective list below.

In all cases, selection of elective courses is done in coordination with the student's faculty advisor and committee based upon student research direction and interest.

Recommended Electives

No	Course Name	Course Number	Hrs
1	**Advanced Image Processing**	EE5XX	3
2	Legal and Social Aspects of Biometrics	BE5XX	3
3	Concepts in IA Management	BE5XX	3
4	Data/Computer Communications	CS 453	3
5	Data Forensics	CpE5XX	3
6	Intrusions, Security Forensics	CSXXX	3
7	Advanced Topics – Biometric System Design	EEXXX	3

Part IV
Supplemental Plan of Study Form
(To be attached to College Plan of Study)

NAME: _____ SSN _____

Option (check one): [ ] Thesis [ ] Coursework [ ] Problem Report.

Major Emphasis Area:_____

Required Course: _____

Designated elective: _____

Designated elective: _____

Minor Emphasis Area: _____

Required Course: _____

Minor Emphasis Area (if problem report option): _____

Required Course: _____

Other Courses:

Free elective: _____
Free elective: _____
Free elective: _____
Free elective: _____

Free elective (or research): _____
Free elective (or research): _____
Graduate Seminar (twice): _____ _____

Research Advisor or Committee Chair: _____
signature/ date

* Only 3 courses at the 400 level can be taken for the master program.