

The University of Toledo

**Department of
Electrical Engineering and
Computer Science**

Graduate Student Handbook

2008-2009

Foreword

The Department of Electrical Engineering and Computer Science (EECS) at The University of Toledo offers graduate programs leading to the Master of Science in Electrical Engineering (M.S.E.E), the Master of Science in Engineering (M.S.E), and the Doctor of Philosophy (Ph.D) in Engineering degrees. Research focus of the Department is in the areas of:

Communication and Signal Processing (CSP)

High Performance Computing Systems (HPCS)

Intelligent Systems (IS)

Power Electronics and Energy Systems (PEES)

RF and Microwave Systems (RMS)

Sensors and Medical Devices (SMD)

Solid–State Devices (SSD)

This hand book describes the various programs in the Department. It also outlines a number of procedures for graduate students and states various departmental regulations.

Information provided in this handbook is intended as a supplement to, and not a substitute for, the Graduate School Catalog of The University of Toledo. The Graduate School Catalog contains general rules and regulations governing the University's graduate programs. The department web site is located at www.eecs.utoledo.edu, and the Graduate School home page is at www.utoledo.edu/grad-school/.

1 The policies and guidelines contained in this handbook are provided for general guidance and subject to change by the department. Students are encouraged to consult their academic advisors, or the Graduate Program Director for clarification of any issues. **(revised July, 2008)**

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1. ACADEMIC AND RESEARCH PROGRAMS

The new graduate program has gone through a major curriculum restructuring. The rationale for this restructuring were:

- **Align with the departmental strategic directions**
- **Prepare for anticipated enrollment caps in courses**
- **Increase both quality and number of PhD graduates**
- **Increase external research funding**
- **Develop multi-disciplinary research**
- **Effectively utilize limited departmental resources**
- **Align with the national research agenda**
- **Cater to local and global markets**

Faculty of the Electrical Engineering and Computer Science Department participate in seven academic and research focus groups. Research activities of faculty often overlap the focus groups, and therefore several faculty participate in more than one focus group. Each focus group has a set of required core courses (which every student in that focus group is required to take) and another set of recommended courses. Recommended courses are to be selected by the student in consultation with her/his advisor to complete the course requirements for the degree. The new graduate curriculum has been designed with a view to provide depth as well as breadth in the graduate plan of study for all graduate students both at the Master's and the Ph.D. levels.

For a more complete explanation, please see the sections addressing M.S. and Ph.D. academic requirements later in this handbook.

Students majoring in **Electrical Engineering (EE)** may choose from the following focus groups:

- **Communication and Signal Processing (CSP)**
- **Power Electronics and Energy Systems (PEES)**
- **RF and Microwave Systems (RMS)**
- **Sensor and Medical Devices (SMD)**
- **Solid State Devices (SSD)**

Students majoring in **Computer Science & Engineering (CSE)** may choose from the following focus groups:

- **High Performance Computing Systems (HPCS)**
- **Intelligent Systems (IS)**

*Please note that students pursuing EE areas will receive an M.S. degree in Electrical Engineering; those pursuing CSE areas will receive an M.S. degree in Engineering.

1.1 Communication and Signal Processing (CSP)

Members: **Mohsin M. Jamali (Group Leader), Junghwan Kim, Ezzatollah Salari**

The research in the Communication and Signal Processing focus group involve wide variety of topics such as data compression and image processing, satellite communication, sensor array processing and development of hardware for real time applications computation for digital receiver and passive radar systems.

The research in data compression and image processing mainly focuses on the development of efficient algorithms for video compression, packetization schemes for multimedia bitstreams, as well as neural network based image enhancement and restoration. A variety of advanced compression techniques including fast vector quantization, subband coding using wavelet transform, optimal packetization schemes for embedded bit-streams, and video motion estimation have been developed. In addition, projects are underway for the enhancement and compression of biomedical signals including electrocardiogram (ECG) data compression.

The research in communication systems involves modeling, simulation and performance analysis of communication systems, mobile/satellite system architecture, and network and payload design. Work also involves on tactical communication network, digital video/audio/multimedia broadcasting, turbo Coding, LDPC code and their Applications.

The signal processing area focuses on real time implementation of sensor array processing and radar signal processing algorithms using FPGA and cell processors.

Core Courses:

- ❖ **EECS 6/8300: Random Signals and Optimal Filters**
- ❖ **EECS 6/8110: Advanced Computer Architecture**
- ❖ **EECS 6/8xxx: Fundamentals of Intelligent Systems**

Recommended Courses from CSP Focus Group:

- ❖ **EECS 6/8340: Advances in Mobile and Satellite Communications**
- ❖ **EECS 6/8350: Design and Analysis of Advanced Mobile and Satellite Communication Systems (The above two courses were formerly titled Modern communications I and II)**
- ❖ **EECS 6/8xxx: Advanced Digital Signal Processing**
- ❖ **EECS 5/7330: Image Analysis and Computer Vision**
- ❖ **EECS 6/8320 Data Compression for Multimedia Communication**

Recommended Courses from Other Focus Groups:

- ❖ EECS 6/8980: Quantum Computing
- ❖ EECS 5/7180: Computer Networks
- ❖ EECS 6/8370 Pattern Recognition & Neural Nets

Faculty research interests:

Dr. Mohsin Jamali's research is in the areas of embedded sensor array processing, radar signal processing, beam-forming, adaptive control system and in-vehicle networks using Cell processors and FPGA based system.

Dr. Junghwan Kim's research is in the areas of modeling and performance analysis of satellite system, its architecture and network, mobile ad-hoc network, advanced channel coding and modem, multimedia broadcasting.

Dr. Ezzatollah Salari's research is in the areas of data compression-multimedia communication, image/video/signal processing, applied neural networks for industrial and medical applications.

1.2 HIGH PERFORMANCE COMPUTING SYSTEMS (HPCS)

Members: Mansoor Alam (Group Leader), Mohsin Jamali (Associate), Devinder Kaur, Kami Maki, Mohammed Niamat, Hilda Standley

High performance computing and visualization, Information security, High performance scalable software, Information systems and services, System software for parallel computing, Numerical computing and applications, Hypermedia & multimedia environments, Reliable computing, FPGAs, VLSI Testing and Fault Tolerance.

Computing from both the programming language and the computer architecture viewpoints. Computational complexity. Quantum computing. Unified intermediate language with well-defined semantics in the design of both software and hardware. Distributed systems, databases, mobile & wireless networks. Fault tolerance and reliability. Performance modeling of computer and communication networks. Adaptive scheduling and resource reservation protocols. Routing protocols and security in wireless internet and mobile ad hoc networks. Algorithms, complexity, power connectivity and coverage in wireless sensor networks. Bio-molecular networks, information systems, cellular and high-performance computing. Theoretic foundations and advanced analysis for real-time, hybrid and embedded systems. Adaptation, design and implementation of dynamic models for wireless and mobile networks. Radio resource allocations, channel schemes and handoff strategies in wireless multimedia networks.

Core Courses:

- ❖ **EECS 6110/8110: Advanced Computer Architecture**
- ❖ **EECS 6/8550: Software Specification and Design**
- ❖ **EECS 6/8xxx: Fundamentals of Intelligent Systems**

Recommended Courses from HPCS Focus Group:

- ❖ **EECS 6/8xxx: Virtual Reality and Computer Vision**
- ❖ **EECS 6/8980: Quantum Computing**
- ❖ **EECS5/7560: Data Base System II**
- ❖ **EECS5/7140: Fault Tolerant Digital Systems**
- ❖ **EECS 5/7180: Computer Networks**
- ❖ **EECS5/7390: Wireless and Mobile Networks**
- ❖ **EECS 6/8390: Modeling and Performance evaluation of Communication Networks**

Recommended Courses from Other Focus Groups:

- ❖ **EECS 6/8xxx: Advanced Digital Signal Processing**
- ❖ **EECS 5/7330: Image Analysis and Computer Vision**
- ❖ **EECS 6/8320 Data Compression for Multimedia Communication**

Faculty Research Interest:

Dr. Hilda Standley's research is in the areas of computational complexity, quantum computing, unified intermediate language with well-defined semantics in the design of both software and hardware.

Dr. Mohammed Niamat's research is in the area of reconfigurable processors including field programmable gate arrays; testing of digital, reconfigurable, system on chip (SOC) and VLSI circuits; built in self test (BIST); fault modeling; modeling and testing of nano electronic devices using quantum dot cellular automata (QCA); parallel processing; systolic array architectures; hardware implementation of algorithms

Dr. Mansoor Alam's research is in the areas of fault tolerance and reliability, software reliability, performance modeling of network protocols.

Dr. Mohsin Jamali's research is in the areas of hardware implementation of sensor array processing algorithms, FPGA based systems.

Dr. Devinder Kaur's research is in the areas of computer architecture, parallel and distributed processing, software scalable systems on CHIP architecture, intelligent systems based on fuzzy logic, neural networks and genetic algorithms.

The research in this group is supported in part by NSF and AFOSR and Chrysler.

1.3 INTELLIGENT SYSTEMS (IS)

Members: Gursel Serpen (Group Leader), Devinder Kaur, and Krishna Shenai.

Intelligent systems embody inquiries into artificial and computational intelligence fields. The Intelligent Systems (IS) faculty conducts research in several areas. Faculty research interests span fields of artificial intelligence, machine learning, artificial neural networks, data-mining, fuzzy logic and reasoning, and hybrid algorithms.

Research on Intelligent Systems focuses on design and development of software applications for optimization, bio-medical informatics, computer security, image interpretation, intrusion detection and access control in computing systems, medical image interpretation and hybrid reasoning systems for diagnosis, development of novel neural network algorithms for optimization, data mining in databases for knowledge modeling and extraction, development of novel ensemble machine learning algorithms, evolutionary computation based hybrid techniques for knowledge extraction, empirical process intelligent control and databases, logic reasoning with applications in cognitive wireless sensor networks, and development of cognitive software for management and control of various aspects of wireless sensor networks.

Core Courses:

- ❖ **EECS 6/8xxx: Fundamentals of Intelligent Systems**
- ❖ **EECS 6/8550: Software Specification and Design**
- ❖ **EECS 6/8110: Advanced Computer Architecture**

Recommended Courses from IS Focus Group:

- ❖ **EECS 5/7xxx Sensor Networks**
- ❖ **EECS 6/8360 Knowledge Based Systems**
- ❖ **EECS 6/8370 Pattern Recognition & Neural Nets**

Recommended Courses from Other Focus Groups:

- ❖ **EECS 6/8xxx: Virtual Reality and Computer Visualization**
- ❖ **EECS 6/8980: Quantum Computing**
- ❖ **EECS 5/7560: Data Base System II**
- ❖ **EECS 5/7180: Computer Networks**

Faculty Research Interests:

Dr. Devinder Kaur's research is in the areas of computer architecture, parallel and distributed processing, intelligent systems based on fuzzy logic, neural networks and genetic algorithms

Dr. Gursel Serpen's research is in the areas of artificial intelligence, machine learning, neural nets, knowledge based systems, data mining, applications in optimization, computer security, bio-medical informatics, legal reasoning

Dr. Krishna Shenai's research is in the areas of cognitive wireless sensors and networks, semiconductor materials, devices, circuits, and systems; low-power mixed-signal and RF systems; power management

The research in this focus group has been funded by the NSF, AFOSR, and Industry.

1.4 POWER ELECTRONICS AND ENERGY SYSTEMS (PEES)

Members: Thomas Stuart (Group Leader), Roger King, and Krishna Shenai

Electrical Engineering basically consists of two primary functions: processing information and processing energy. The research in this focus group is primarily concerned with processing energy in electrical form, but to accomplish this it is necessary to also utilize many techniques from the information sector. Therefore the research in this area depends on fields such as power electronics, electro-mechanical machines, energy storage devices, control systems, computer analysis methods and modelling, and real time embedded systems.

The search for new sources of alternative energy has intensified the importance of this field since new techniques are needed to improve the methods of processing all of these energy forms such as wind, solar and geo-thermal. This group conducts research in a variety of areas that support this field, such as power semiconductor devices, electronic power converters, and energy storage devices. Current and recent externally funded research includes projects dealing with power converters and various forms of energy storage systems including high energy batteries, ultracapacitors, and fuel cell vehicles.

Core Courses:

- ❖ **EECS 5/7480: Electronic Energy Processing I**
- ❖ **EECS 6/8xxx: Power Semiconductor Devices**
- ❖ **EECS6/8xxx: Advanced Electro Magnetic Components**

Recommended Courses from PEES Focus Group:

- ❖ **EECS 5/7170: Real Time Embedded Systems**
- ❖ **EECS 5/7490: Electronic Energy Processing II**
- ❖ **EECS 4/5/6460: Power Systems Design and Modeling**

Recommended Courses from Other Focus Groups:

- ❖ **EECS 5/6460: Power Systems Analysis**
- ❖ **EECS 6/8xxx: Advanced Analog Integrated Circuits**
- ❖ **EECS 6/8xxx: MEMS Devices and Applications**

- ❖ **EECS 6/8xxx: Compound Semiconductor Devices**
- ❖ **EECS 6/8xxx: Power Management Integrated Circuits**

Faculty Research Interests:

Dr. Thomas Stuart's research is in the areas of Power Electronics and Alternative Energy.

Dr. Roger King's research is in the areas of Power Electronic Circuit Design and Modeling.

Dr. Krishna Shenai's research is in the areas of Electronic Power Devices.

1.5 SOLID-STATE DEVICES (SSD)

Members: Rashmi Jha (Group Leader), Robert Collins, Alvin Compaan, Xunming Deng, Vijay Devabhaktuni, Daniel Georgiev, Sanjay Khare, Sylvan Marsillac, Anthony Johnson, and Krishna Shenai

The main objective of the group is to exploit atomic scale phenomena in developing next generation of solid-state materials and devices targeted for electrical energy generation, electrical power conversion, and electronic sensing applications. The strategy is to develop research that carefully blends physics and electrical engineering disciplines to address growing demand for renewable/alternative energy, electrical energy conversion and storage, photovoltaics, solid-state lighting, low-power sensors and electronics, and harsh environmental electronics.

Graduate students working in the group will have full access to several state-of-the-art research laboratories listed below, which are being developed in collaboration with industry:

- **Semiconductor Design Laboratory (NE-2033)**
This laboratory will have high-power computers and advanced simulation capability.
- **Semiconductor Test and Measurement Laboratory (NE-1035)**
This laboratory will have state-of-the-art semiconductor test and measurement equipment.
- **Nanoelectronic Device Laboratory (NE-2047)**
This laboratory will be capable of the electrical characterization of nanoelectronic, optoelectronic, and photovoltaic devices.
- **Electronics Materials Laboratory (NE-2010)**
This laboratory has capability of LASER based advanced processing and thin film deposition.
- **PVIC**
The Center for Photovoltaics Innovation and Commercialization (**PVIC**) consists of a world class science and technology platform in the State of Ohio employing second and third generation Photovoltaics materials tailored primarily for applications in

clean electricity generation. Three primary locations of the Center are: The University of Toledo, The Ohio State University, and Bowling Green State University.

- **Center for Materials Science and Engineering**

The purpose of the CMSE is to provide a vehicle for enhancing materials research and education at the University of Toledo. To accomplish this, the CMSE facilitates collaborative research and educational activity on the University of Toledo campus, with Bowling Green State University, other educational institutions, and regional industry.

The current research conducted by the group is expected to result in important outcomes (in various forms) with strategic applications including but not limited to:

- Thin film and Third generation solar photovoltaics materials and devices
- New light emitting diodes (LED's)
- Breakthrough high-frequency solid-state power switching devices
- Rugged sensors
- Low-power CMOS devices

Core Courses:

- ❖ **EECS 6/8xxx: Power Semiconductor Devices**
- ❖ **EECS 5/7480: Electronics Energy Processing I**
- ❖ **EECS 6/8xxx: Principles of CMOS Devices**

Recommended Courses from RMS Focus Group:

- ❖ **EECS 6/8xxx: MEMS Devices and Applications**
- ❖ **EECS 6/8xxx: Compound Semiconductor Devices**

Recommended Courses from Other Focus Groups:

- ❖ **EECS 5/6460: Power Systems Design and Modeling**
- ❖ **EECS 5/7490: Electronics Energy Processing II**
- ❖ **EECS 6/8xxx: Advanced Analog Integrated Circuits**
- ❖ **EECS 6/8xxx: Power Management Integrated Circuits**
- ❖ **EECS 6/8xxx: Advanced Electromagnetic Components**
- ❖ **EECS 6/8xxx: Computer Aided Modeling & Design of RF/Microwave Systems**
- ❖ **EECS 6/8xxx: RF Integrated Circuits**

Faculty Research Interests:

Dr. Vijay Devabhaktuni's research is in the areas of applied electromagnetics, neural networks, computer aided modeling, low-noise amplifiers, RF/microwave design and optimization, space mapping, biomedical signal analysis and processing, PV power management.

Dr. Daniel Georgiev's research is in the areas of device fabrication and novel materials for high-frequency components.

Dr. Krishna Shenai's research is in the areas of physics and technology of semiconductor materials and devices; low-power RF CMOS and sensors; power semiconductor devices and integrated circuits; solid-state lighting; renewable/sustainable energy technologies and systems; and, wireless communication. The research in this group is currently supported federal agencies, the State of Ohio, and industry.

Dr. Rashmi Jha's research lies in the areas of fabrication, characterization, and modeling of nanomaterials, interfaces, and nanoelectronic devices for applications in photovoltaics, advanced logic and memory devices, sensors, and nanobiosciences.

Dr. Alvin Compaan's research focuses on the deposition of semiconductor thin films for solar cells, is supported by the National Renewable Energy Laboratory (NREL). Complete CdS/CdTe thin film solar cells are being fabricated at Toledo with the CdS, CdTe, and CdCl₂ deposited by pulsed laser deposition and radio frequency (rf) planar magnetron sputtering. The research emphasizes techniques scalable to large-area, thin-film modules for applications of photovoltaic power generation. Most of our research effort involves the use of glass substrates which are coated with fluorine-doped tin oxide which serves as the transparent conductor. However, some research is directed to the development of CdS/CdTe cells on flexible substrates such as molybdenum foil and high temperature polymers.

Dr. Sylvan Marsillac's research lies in the areas of high efficiency CIGS film solar cells, ultra-lightweight flexible GIGS solar cells for space and defense applications, generation of hydrogen fuels from water and sunlight.

Dr. Robert Collins's research range from achieving a basic understanding of thin film growth and optical properties to improving industrial processes for photovoltaic thin films and other coatings. The instrumentation development in Prof. Collins's laboratory focuses on multichannel spectroscopic and imaging techniques that can be performed in real time during the fabrication and processing of materials.

Dr. Sanjay Khare's research focuses on the application of appropriate theoretical techniques to explain and predict interfacial and materials phenomenon of direct experimental relevance. A strong connection with experimental measurements such as scanning tunneling microscopy (STM), scanning tunneling spectroscopy (STS), low energy electron microscopy (LEEM), and transmission electron microscopy (TEM) is made. A wide range of theoretical and computational techniques are employed including analytical solutions to stochastic differential equations with noise, equations of elasticity, numerical solutions to algebraic equations, Monte Carlo simulations, molecular dynamics, and ab initio density functional theory calculations.

Dr. Xunming Deng's research interests are in the areas of amorphous silicon photovoltaic materials and devices, thin film depositions, and photo-electrochemical production of hydrogen.

1.6 SENSORS AND MEDICAL DEVICES (SMD)

Members: Krishna Shenai (Group Leader), Mansoor Alam, Vijay Devabhaktuni, Daniel Georgiev, Rashmi Jha, Sanjay Khare, Richard Molyet, Mohammed Niamat, and Gursel Serpen

Minimum feature of a semiconductor device is reduced to below 50 nm in logic and mixed-signal applications. New opportunities are emerging that functionally integrate micro/nano technologies with bio-technology to create new sensing and electronics devices for a wide range of applications. The main objective of this research group is to develop next generation of miniaturized intelligent sensors with duplex communication capability for agricultural manufacturing, environmental sensing and monitoring, energy and water management, medical implants, non-invasive diagnosis and treatment, fermentation process control and optimization, robotics and mechatronics, and defense and space applications. Another objective is to develop intelligent wireless networking technology for large scale low-cost deployment of sensors.

Graduate students working in the group will have full access to several state-of-the-art research laboratories listed below, which are being developed in collaboration with industry:

- **Electronics Materials Laboratory (NE-2010)**
This laboratory has capability of LASER based advanced processing and thin film deposition.
- **Semiconductor Design Laboratory (NE-2033)**
This laboratory will have high-power computers and advanced simulation capability.
- **Nanoelectronic Device Laboratory (NE-2047)**
This laboratory will be capable of the electrical characterization of nanoelectronic, optoelectronic, and photovoltaic devices.
- **Semiconductor Test and Measurement Laboratory (NE-1035)**
This laboratory will have state-of-the-art semiconductor test and measurement equipment.
- **Wireless Sensor Testbed (TBD)**
This laboratory will have capability to test large-scale functional and communication properties of sensor devices.

The current research conducted by the group is expected to result in important outcomes (in various forms) with strategic applications including but not limited to:

- Wireless communication technology through soil and water
- Multifunction soil and environmental sensors
- Low-power Ion-Sensitive Field-Effect Transistors (ISFET's)
- Non-invasive thermal monitoring device
- System-on-a-Chip for DNA analysis
- On-chip electrical power generation devices
- Portable ultrasound

Core courses:

- ❖ EECS 6/8xxx: Principles of CMOS Devices (3 credit hours)
- ❖ EECS 6/8xxx: Power Semiconductor Devices
- ❖ EECS 6/8xxx: Advanced Electro Magnetic Components

Recommended courses from SMD focus group:

- ❖ EECS 6/8600: Analog Integrated Circuits
- ❖ EECS 6/8xxx: Power Management Integrated Circuits

Recommended Courses from Other Focus Groups:

- ❖ EECS 6/8xxx: MEMS Devices and Applications
- ❖ EECS 6/8xxx: Compound Semiconductor Devices

Faculty Research Interests:

Dr. Krishna Shenai's research is in the areas of physics and technology of semiconductor materials and devices; low-power RF CMOS and sensors; power semiconductor devices and integrated circuits; solid-state lighting; renewable/sustainable energy technologies and systems; and, wireless communication. The research in this group is currently supported federal agencies, the State of Ohio, and industry.

Dr. Mansoor Alam's research is in the areas of Fault tolerance and reliability, software reliability, performance modeling of network protocols.

Dr. Vijay Devabhaktuni's research is in the areas of applied electromagnetics, neural networks, computer aided modeling, low-noise amplifiers, RF/microwave design and optimization, space mapping, biomedical signal analysis and processing, PV power management.

Dr. Daniel Georgiev's research is in the areas of device fabrication and novel materials for high-frequency components.

Dr. Rashmi Jha's research lies in the areas of fabrication, characterization, and modeling of nanomaterials, interfaces, and nanoelectronic devices for applications in photovoltaics, advanced logic and memory devices, sensors, and nanobiosciences.

Dr. Sanjay Khare's research focuses on the application of appropriate theoretical techniques to explain and predict interfacial and materials phenomenon of direct experimental relevance. A strong connection with experimental measurements such as scanning tunneling microscopy (STM), scanning tunneling spectroscopy (STS), low energy electron microscopy (LEEM), and transmission electron microscopy (TEM) is made. A wide range of theoretical and computational techniques are employed including analytical solutions to stochastic differential

equations with noise, equations of elasticity, numerical solutions to algebraic equations, Monte Carlo simulations, molecular dynamics, and ab initio density functional theory calculations.

Dr. Richard Molyet's research is in the area of the development of sensors capable of noninvasive monitoring of physiological processes and their incorporation into automatic control loops.

Dr. Mohammed Niamat's research is in the area of reconfigurable processors including field programmable gate arrays; testing of digital, reconfigurable, system on chip (SOC) and VLSI circuits; built in self test (BIST); fault modeling; modeling and testing of nano electronic devices using quantum dot cellular automata (QCA); parallel processing; systolic array architectures; hardware implementation of algorithms; and implantable medical devices including defibrillators and pace makers.

Dr. Gursel Serpen's relevant research expertise entails applications of intelligent systems concepts to problems in the domain of sensors and medical devices. In particular applications of algorithms from artificial intelligence, machine learning, cognitive science, knowledge based systems, and data mining are prominent.

1.7 RF and Microwave Systems (RMS)

Members: Vijay Devabhaktuni (Group Leader), Daniel Georgiev, and Krishna Shenai

The objective of the group is to exploit electromagnetic (EM) fundamentals and radio-frequency (RF) and microwave concepts for engineering new high-frequency components, circuits, materials, and systems. The underlying strategy is to foster research leading to development of commercially viable products, patents, user-friendly CAD tools, publications in top-ranked international conferences and journals, and to secure external research funding from federal, state and industry sources.

Graduate students working in the group will have full access to two state-of-the-art research laboratories listed below, which are being developed in collaboration with industry:

- **EM Simulation and Design Facility (NE-2033)**
This laboratory will have high-power computers and circuit/EM solvers.
- **RF/Microwave Test and Measurement Facility (NE-1035)**
This laboratory will have state-of-the-art GHz measurement equipment.

The current research conducted by the group is expected to result in important outcomes (in various forms) with strategic applications including but not limited to:

- Filters and low-noise amplifiers
- High-performance power amplifiers for wireless communication

- Intelligent energy and water management systems
- Intelligent monolithic adaptable low-power wideband antenna
- Miniaturized medical devices
- Next-generation EM-CAD packages
- Next-generation input devices for games and virtual reality
- Power and RF magnetic components
- RF modules for environmental and healthcare monitoring and control
- RFI and EMI measurement, analysis and modeling
- RFIDs for commercial and defense applications
- Signal integrity optimization techniques
- Wireless human interface devices
- Wireless agricultural manufacturing systems

Core Courses:

- ❖ **EECS 6/8xxx: Advanced Electromagnetic Components**
- ❖ **EECS 6/8xxx: Power Semiconductor Devices**
- ❖ **EECS 6/8xxx: Principles of CMOS Devices**

Recommended Courses from RMS Focus Group:

- ❖ **EECS 6/8xxx: Computer Aided Modeling & Design of RF/Microwave Systems**
- ❖ **EECS 6/8xxx: RF Integrated Circuits**

Recommended Courses from Other Focus Groups:

- ❖ **EECS 5/6460: Power Systems Design and Modeling**
- ❖ **EECS 5/7480: Electronics Energy Processing I**
- ❖ **EECS 5/7490: Electronics Energy Processing II**
- ❖ **EECS 6/8xxx: Advanced Analog Integrated Circuits**
- ❖ **EECS 6/8xxx: MEMS Devices and Applications**
- ❖ **EECS 6/8xxx: Compound Semiconductor Devices**
- ❖ **EECS 6/8xxx: Power Management Integrated Circuits**

Faculty Research Interests:

Dr. Vijay Devabhaktuni's research is in the areas of applied electromagnetics, neural networks, computer aided modeling, low-noise amplifiers, RF/microwave design and optimization, space mapping, biomedical signal analysis and processing, PV power management.

Dr. Daniel Georgiev's research is in the areas of device fabrication and novel materials for high-frequency components.

Dr. Krishna Shenai's research is in the areas of RF/Microwave semiconductor and magnetic materials, devices and integrated circuits; RF antennas; low-power RF CMOS and sensors;

RFID's; power electronics; renewable/sustainable energy technologies and systems; and, wireless communication.

The research in this group is currently supported (either cash or in-kind) by Agilent Technologies, Ansoft Corporation, Cadence, Silvaco International, Synopsys, and The University of Toledo.

Changing focus groups is not recommended; however, those students wishing to change their focus group to another within their major must complete a "Request for Change of Focus Group" form, available from the Academic Program Coordinators. Students wishing to change their focus group to one within another major must re-apply for that major with the Graduate School.

2. REGISTRATION

The registration procedure begins in the EECS Department. The Graduate Program Director (or the focus group representative) will serve as the student's temporary faculty advisor until a permanent advisor is chosen. A Plan of Study should be prepared and submitted as soon as possible after selection of the permanent advisor.

Changes in the student's program of study may be requested by submitting a Plan of Study Course Substitution Form. It is the responsibility of the student to ensure that required courses in the program are taken.

2.1 FINANCIAL SUPPORT

Students with Research Assistantships (RA) and Graduate Assistantships (GA) expected to meet certain research objectives. RAs are supported by faculty research grants and are expected to work with the respective faculty and to help meet their research goals and expectations. GAs are supported by the department and they are assigned twenty hours of teaching/grading duties every semester. GAs are expected to meet the goals set by the department and faculty in terms of research output and submission of research proposals.

2.2 FULL-TIME STATUS

Full-time graduate students supported by the Department must register for a minimum of 9 graduate credit hours each semester including projects, independent study, research and thesis. Self-supporting full-time international students must complete a minimum of 9 hours each term. Courses taken on an audit basis are excluded from this number.

Students with Research Assistantships (RA), Graduate Assistantships (GA), University Fellowships (UF), Tuition Assistantship (TA) and any other financial assistance from general funds must maintain full-time status, exclusive of audit hours. If a supported student falls below the required minimum (9 credits) registration through course withdrawals during any term, he or she will be liable for tuition for that term. Students with any form of financial assistance will also be assessed for any registration exceeding 16 credits, including audit hours.

First-year students receiving financial support from the Department must register for three regular courses (a minimum of 9 hours total) per semester during each semester of the first year plus research or other hours to meet full-time registration requirements. The three-course/9-credit load requirement is exclusive of independent study, research, thesis, etc.

2.3 PART-TIME STATUS

To maintain an active degree program status, students are required to register for at least one credit each term. However, it is expected that every part-time student will take at least one course per term or register for thesis or dissertation work so as to complete the degree program within a reasonable time. Exceptions may be granted for such reasons as illness, maternity leave or travel requirements imposed by employers.

2.4 EXCESSIVE CREDIT HOURS

The Ohio Board of Regents denies state subsidy for graduate students who have earned more than 174 graduate credit hours. Graduate students whose graduate credit hours at The University of Toledo exceed 174 are not eligible for financial aid from general funds.

2.5 COURSE REGISTRATION REGULATIONS

Changes in registration can be made using a Course Request Form. Every Course Request Form for a graduate student must be signed by the student's faculty advisor and by the instructor for the course. Courses cannot be added after the 15th calendar day of the semester.

Permission to audit a course is at the discretion of the instructor of the course, who is not obligated to accept a student for audit. Audit course credits do not count towards degree requirements. Audit hours also do not count toward the 174 credit limit for university funded financial assistance and they do not count toward full-time status. They do, however, require payment of tuition. Hence, a student on a GA/RA/TA will be assessed for any registration exceeding 126 hours, including audit hours. No more than three courses can be taken on an audit basis.

2.6 RESEARCH COURSES

- **EECS 6900(M.S)/8900(Ph.D): Independent Research**

Both Masters (6900) and Doctoral (8900) students may register for research hours up to the maximum allowable for each semester. Such research hours may be used to explore research topics for a thesis or dissertation. An example for a master's degree student would be EECS 6900:0XY - 3 hours, where 0XY is the identification number of the advisor. For a doctoral student an example is EECS 8900:0XY - 2 hours.

- **EECS 6960 through 6969: Master's Graduate Research and Thesis**

A total of 9 hours of the 30 required for a master's degree may be used for the thesis. The number 6960 is used for the first term of thesis registration and for each successive term

the next larger number is used. For example, for the third term, it is EECS 6962:OXY - 4 hours.

- **EECS 8960 (Ph.D): Dissertation**

An example dissertation registration for a Ph.D. candidate would be EECS 8960:OXY - 3 hours, where OXY is the identification number of the advisor. Registration for the dissertation is not permitted until the doctoral student has passed the Qualifying Examination.

- **EECS 6990(M.S)/8990 (Ph.D): Independent Study**

Independent study is defined as individualized study under the direction of an EECS faculty member, and is distinct from thesis or dissertation research. A maximum of 3 credits of independent study may be counted toward the M.S. degree course work requirements; an additional 6 credits may be counted toward the doctoral degree course work requirement. This course number is not to be used for thesis.

- **EECS 5920: M.S Projects**

6 hours of the 30 required for a master's degree may be used for the project.

Registration in any of these courses is done using a Seminar Request Form. The form may be obtained from the EECS Academic Program Coordinator and requires the approval of the supervising EECS faculty member and the Graduate Program Director. A self-supporting student working only on thesis or dissertation and using University resources must register for a minimum of 1 credit hour each term.

3. GENERAL INFORMATION

3.1 RESPONSIBILITIES OF GRADUATE STUDENTS

- Maintain a 3.0 cumulative GPA.
- Comply with University, College, and Departmental regulations.
- Complete and submit the appropriate forms.
- Keep the EECS department office updated regarding current address, phone number, and e-mail addresses.

3.2 COMPLETION OF STUDENT RESEARCH

It is expected that the research and resulting thesis or dissertation will be completed while the student is in full-time residence. This is especially to be expected of those students who have received financial aid. Departure before final acceptance of the thesis or dissertation generally results in long delays before completion, in some cases so long that the work has been superseded by the work of others and may no longer be acceptable to meet the requirements. International students must, of course, maintain full-time status and remain in residence until all requirements for the degree are met.

In those instances where unusual circumstances exist and the student wishes to complete his or her degree while no longer in residence, the student must provide adequate justification and secure written concurrence in advance by both the advisor and Graduate Program Director. The student and the advisor must also agree on a time table to complete the degree. Failure to do so can result in resignation of the advisor and/or the student being considered as withdrawn from the program.

3.3 GRADE REQUIREMENTS FOR GRADUATION

All course work to be counted towards the M.S. or Ph.D. degree must be taken for a letter grade (A, A-, B+, etc.), and cannot be taken on a pass/fail or audit basis. A letter grade of C- or below is not acceptable for graduate credit, although such grades are included in computation of the grade point average.

In order to be awarded the masters or doctoral degree, the student must have a grade point average (GPA) of at least 3.00/4.00 (B average) for all credits (course work and thesis research) in his or her program of study. Grades earned in courses which are repeated are included in the computation of the GPA.

If a grade of incomplete (IN) or progress (PR) is received, the student must remove the IN or the PR grade from the record as soon as possible. After one semester, the IN grade automatically changes to an F (failure). No student may graduate with an IN or PR on his/her record.

3.4 CONTINUATION AND DISMISSAL

A student may continue in the EECS Department as long as reasonable progress is being made toward the degree. From an academic viewpoint, this means that the student's record in graduate course work, exclusive of thesis or dissertation research, continues to exhibit an average of B or better with an appropriate distribution of A, B, and C grades, and that IN and PR grades appear only infrequently and for a good cause.

In accordance with University policy, academic dishonesty will be dealt with by the course instructor.

3.5 FACILITIES

The University has an excellent facility in the Carlson Library. Graduate students may reserve a carrel in the library, if available, for study purposes.

Graduate students may obtain a computer account number for academic use on any of the servers or mainframe computers operated by the University Computer Center or Engineering College Computing office if approved by the department chair. All students in the EECS department are provided an account, including access to the Internet, on the departmental server at the time of their matriculation.

Keys or cards for access to departmental areas are assigned on a discretionary, as-needed basis. All keys must be returned to the Key Control Office at the end of each academic year and prior to leaving the University. A \$25 deposit is required by the department for each key authorized. Deposits are returned when the Key Control Office confirms that a key has been returned. In addition, grades, transcripts, and final paychecks will be withheld from individuals who have not returned keys.

Computer disks, laser printing, copying, and similar items are the students' responsibility and will not be furnished by the department.

3.6 STUDENT ORIENTED SERVICES

The Graduate Student Association (GSA) is available to assist and serve graduate students in many ways. Their offices are located in the Student Union. For a list of the services or assistance GSA has available, please contact the GSA office.

4. MASTER OF SCIENCE DEGREE REQUIREMENTS

4.1 BASIC REQUIREMENTS

The Master of Science Degree is offered with the following options.

1. **Master of Science Degree with Thesis Option:** A minimum of 30 credit hours of approved graduate study including 9 credit hours of Master of Science Thesis under the supervision of an EECS faculty member is required. Students are required to successfully complete the oral defense of the thesis work, submit typed copies of their thesis to the Graduate School and the department (see Section 4.6).
2. **Master of Science Degree with Non-Thesis Options:** The degree requirements for Master of Science with Non-Thesis option are available with the approval of the Department Chair or the Department Graduate Program Director:
 - a. **Master of Science Degree with Project Option:** Students are required to complete 30 credit hours of approved graduate study including 6 hours of Master of Science Project as specified by individual department guidelines and requirements. Students are required to submit a bound, typed Project Report to the department (**needs two members**).
 - b. **Master of Science Degree with Coursework-only Option:** Students are required to complete 36 credit hours of approved graduate-level course work.

All students must complete the following additional requirements:

- ❖ **Must take the three required core courses in the focus group.**
- ❖ **Must take recommended courses in that focus group or other focus groups with approval of his/her advisor.**

- ❖ an approved Plan of Study.
- ❖ a minimum of 18 hours of EECS courses (including thesis/project and independent study).
- ❖ at least 6 hours of EECS courses at 6000 level excluding thesis and independent study.
- ❖ 1 credit hour (included in the required 30 hours for the program) of the EECS graduate seminar course EECS 5930 with a maximum of two excused absences in the semester.
- ❖ The student must be enrolled in a minimum of one credit hour in the semester of graduation.
- ❖ Must submit at least one journal paper if pursuing project or thesis option.

Note: All M.S. graduate students in the EECS Department are encouraged to pursue a thesis option; however, students with Teaching/Research Assistantships will normally be required to write a thesis.

Students are encouraged to include higher level math courses in their program, subject to approval of their advisors. Courses taken on an audit basis do not count toward the degree. Courses outside the College of Engineering require prior approval by the faculty advisor, EECS Graduate Program Director, and the EECS Department Chair.

In order to be awarded the Master of Science degree, the student must have at least a B average (GPA of 3.0/4.0) for all graduate course credits in his or her program of study as well as for his or her entire graduate transcript.

4.2 PLAN OF STUDY

The student must, in conjunction with his/her faculty advisor, prepare a coherent Plan of Study related to courses in at least one of the departmental focus areas. The Plan of Study must be approved by the faculty advisor, EECS Graduate Program Director, the Associate Dean of Graduate Studies, and the Graduate School. Courses will be selected by the student in consultation with the faculty advisor.

Any changes in the student's Plan of Study must be submitted on a Course Substitution Form and approved by the EECS Graduate Program Director, the Associate Dean of Graduate Studies, and the Graduate School.

4.3 TIME LIMIT

The M.S. degree may be pursued on a full or part-time basis. However, each student must complete all requirements for the M.S. degree no later than 6 years from the date of first graduate registration in the EECS Department, unless a petition for extension has been approved by the faculty advisor, EECS Graduate Director, and the Graduate School.

4.4 FORMATION OF THESIS COMMITTEE

After the student has chosen his or her permanent advisor, a thesis committee is formed (for those students pursuing thesis option) and approved by the EECS Graduate Program Director in consultation with the thesis advisor and the student. The M.S. thesis committee shall be composed of a minimum of three members (having a majority of EECS faculty), one of whom should be from the student's focus area. The thesis advisor or co-advisor must be a full-time member of the EECS faculty as well as a full member of the UT Graduate Faculty.

4.5 THESIS PROPOSAL

The student must prepare a thesis proposal soon after formation of the thesis committee with approval by the committee members. It is the responsibility of the advisor to circulate or give copies of the proposal to each faculty member in the student's focus group. Then, using a form available from the EECS Academic Program Coordinator, the thesis advisor notifies the Graduate Program Director in order to obtain final approval of the thesis proposal.

After the thesis topic and title have been selected and approved, the student must submit two forms to an EECS Academic Program Coordinator: *Notice of Thesis* and *Assurances of Compliance*.

4.6 THESIS SUBMISSION, DEFENSE, AND ACCEPTANCE

A final draft of the M.S. thesis is prepared by the student when research is completed to the satisfaction of the faculty advisor. The student should obtain directions regarding thesis preparation from the UT Graduate School. The draft thesis should be submitted to the advisor for critical review and evaluation. This should be done in a timely manner, giving the advisor sufficient time to review the final draft. After the thesis advisor has reviewed the thesis draft, recommended changes, and approved the final text and form of the document, the student should submit copies to the thesis committee for evaluation. The thesis committee members should have at least one week for review of the document before the defense. All members of the thesis committee are expected to be present at the thesis defense.

The student, in consultation with the thesis advisor and committee, schedules the thesis defense. The thesis advisor will counsel the student regarding specific topics to be addressed at the defense. The defense is presented in an open, announced meeting presided over by the thesis advisor. The student is allowed approximately 35 minutes for a formal oral presentation. Following the oral presentation, the thesis committee, other faculty, students, and guests are allowed to ask questions concerning the student's thesis work. After the question and discussion period is concluded, all those present, other than the faculty members constituting the committee, will be excused.

The thesis committee holds a private discussion of the student's thesis and makes a final decision by a majority vote whether the student's defense has been successful. If the student does not pass the thesis defense, then the thesis committee, in consultation with the Graduate Program Director, will decide a course of action to correct deficiencies, weaknesses, or other problems.

Even if the student passes the thesis defense, there are usually changes or additions/deletions required as a result of the defense. These are made by the student in consultation with the faculty advisor and any concerned committee members. The student should also be aware that the Graduate School requires final corrected copies to be submitted by a specified date, if a student is to graduate that term.

After successful defense and corrections have been completed, the committee will sign a thesis approval page and forward it to the Graduate Program Director.

At least two permanently bound copies of the thesis must be prepared in accordance with the University regulations. One copy is to be provided to the faculty advisor and the other will be retained in the files of the EECS Department. Two unbound copies (original plus one copy) are submitted to the Graduate School for archival storage in the University library. It is the student's responsibility to pay costs associated with copying and binding of the thesis.

4.7 GRADUATION

Students must formally apply for graduation for the semester they will complete their degree requirements. Applications are available in Rocket Hall. Application deadlines for graduate students are listed below:

- September 22, 2006 for Fall graduation (December)
- February 9, 2007 for Spring graduation (May)

There is no formal ceremony for Summer graduates. Students who will be completing their degrees in the Summer will be recognized if they apply for the Spring commencement. Otherwise, they will be recognized in the Fall commencement ceremony.

4.8 PART-TIME GRADUATE STUDIES

Admission to the program and requirements for the M.S. degree are identical to that for admission to the regular full-time program.

5. DOCTOR OF PHILOSOPHY DEGREE REQUIREMENTS

The Doctor of Philosophy degree is conferred on the basis of extended study and high scholarly attainment in the field of electrical engineering, computer engineering or computer science. The general requirements for the Ph.D. degree are:

- ❖ **A minimum of 60 semester credits beyond the M.S. degree or a minimum of 90 semester credits beyond the B.S. degree.**
- ❖ **At least 45 semester credits of graduate-level course work beyond the B.S. degree of which the credit allowance for the masters degree will not exceed 30 semester credit hours.**
- ❖ **Must take the three required courses in the focus group.**

- ❖ **Must take recommended courses in that focus group or other focus groups with approval of his/her advisor.**
- ❖ **No more than 3 semester credits of Independent Study for students with M.S. degree and no more than 15 semester credits of Independent Study for direct admittees with a B.S. degree may be counted toward the Ph.D. course requirement.**
- ❖ **The student must pursue, complete and publish a research study which is demonstrated to be an original contribution to her/his field of study.**
- ❖ **The dissertation must be written and successfully defended publicly before the Ph.D. degree is conferred.**
- ❖ **The student must submit a minimum of 2 journal papers based on the dissertation research. Copies of the official letters of acknowledgments for the submitted papers should be given to the Graduate Director. Every Ph.D. student must register and complete the seminar course EECS 7930 with no more than two excused absences in the course.**

It is the responsibility of both the student and faculty advisor to formulate a program of study to meet the objectives and needs of the student and to satisfy requirements for the Ph.D. degree. The student's program of study should contain both breadth of knowledge and depth of specialization in one of the focus areas outlined earlier. The program of study must be approved by the faculty advisor, advisory committee, the Graduate Program Director, and the Graduate School.

Note: The doctoral program is normally a full-time program throughout both course work and the dissertation. The department does not encourage part-time students in the Ph.D. program.

5.1 FORMATION OF THE ADVISORY COMMITTEE

After a student has selected his or her advisor, a Ph.D. advisory committee is selected by the advisor in consultation with the Graduate Program Director and the student. The Ph.D. committee is composed of a minimum of five graduate faculty members, at least one of whom must be outside the focus area and another outside the EECS Department.

The advisor chairs the committee. The chairperson or co-chairperson must be a full-time faculty member with appointment in the EECS Department and a full member of the UT Graduate Faculty. Responsibilities of the committee include the following:

- ❖ **Assist the student in developing a Doctoral Program Proposal**
- ❖ **Prepare and administer the qualifying examination and the dissertation proposal defense**
- ❖ **Evaluate the student's dissertation research proposal, its presentation, and the student's defense of the proposal**
- ❖ **Advise and assist the student in dissertation research**
- ❖ **Evaluate the Ph.D. written dissertation**
- ❖ **Approve the final defense of the dissertation**

5.2 DOCTORAL QUALIFYING EXAMINATION

Objective: The intent of the Ph.D. Qualifying Examination (QE) is to assess the student's potential for successfully completing doctoral level studies and research in the department.

Qualifying Examination Format:

- ❖ **The student will be tested on five areas: three based on the required core courses of the focus group; and two areas based on the recommended list in the student's focus group chosen in consultation with the student's advisor. The courses will all be at the graduate level (5000 or higher level), with at least 3 courses at the 6000/8000 level. These courses are enumerated solely for the purpose of defining the scope and coverage of the exam. The test will be open book.**
- ❖ **The examination will be given in two written parts. The first part of the examination will be in the morning on the required core of 3-hour duration. The second part of the examination will be in the afternoon same day on the recommended courses of 3-hour duration.**
- ❖ **The student's advisory committee will prepare the examination with the approval of the Graduate Committee.**
- ❖ **The Graduate Committee will coordinate the exam.**

Timing

All Ph.D. students must take the QE at the end of their first year of the Ph.D. program. The students starting in the Fall (Spring) must take the QE in the beginning of the next Fall (Spring). The Graduate Director will announce the dates for the QE in the prior semester. A student in the Ph.D. program can take the exam up to two times and must pass it within the first two years after entering the Ph. D. Program. Direct admittees (those admitted directly to Ph. D. program with B. S. degrees) must complete the qualifying exam within the first two years into the graduate program. Exceptions to this time schedule must be approved by the Graduate Committee.

Evaluation

The student's advisory committee will review the results of the CE and based on the student's performance makes one of the following recommendations to the Graduate Committee:

- ❖ **Student passes the QE unconditionally and proceeds onto the dissertation.**
- ❖ **Student fails the exam and is found lacking the potential for doctoral study. The student will not be allowed to continue the Ph. D. program.**

- ❖ **Student passes the examination with some deficiencies. The student is directed to complete an additional work prescribed by the advisory committee.**
- ❖ **Student fails the examination but is still believed to have the potential for doctoral work. The student is directed to retake the entire exam for a second time. This is only an option on the first attempt at the qualifying examination.**

Based on the recommendation of the student's advisory committee and the result of the examination, the Graduate Committee will make the final decision and the Graduate Director will inform the student about the status of his/her examination.

Appeals

A student may request a review of the graded Ph. D. Qualifying Examination in writing to the Graduate Director. The student should specify the reasons for the appeal. The student's advisory committee will then review the grading and provide a recommendation to the Graduate Committee for a final decision.

5.3 ADMISSION TO DOCTORAL CANDIDACY

Doctoral students are admitted to doctoral candidacy upon meeting the following requirements:

- ❖ **Satisfactory performance on the Doctoral Qualifying Examination**
- ❖ **Successful formation of a dissertation committee and selection of a dissertation advisor.**
- ❖ **Student initiation of "Application for Candidacy" on a form available from an Academic Program Coordinator or the Graduate School.**

The Graduate School formally notifies the successful student of admission to candidacy in writing on recommendation of the student's advisory committee.

5.4 DISSERTATION PROPOSAL DEFENSE

Objective: The intent of the Ph.D. proposal defense is to review and evaluate the content and style of the dissertation proposal and the student's ability to present the ideas orally.

Schedule: The doctoral student must present his/her dissertation proposal within six months of passing the Qualifying Examination.

Format: A doctoral student's proposal defense consists of the following components:

- ❖ **A written dissertation proposal that is prepared by the student and presented to the Advisory Committee for review and evaluation.**
- ❖ **An oral presentation of the dissertation proposal, which occurs at least two weeks after the written proposal is submitted to the Advisory Committee.**

- ❖ **An oral and/or written examination(s) to assess the student's preparation in the major and related field(s) of study for conducting the proposed research.**

The Advisory Committee will decide whether or not the third portion of the proposal defense will be written or oral. Passing the proposal defense shall require:

- ❖ **Satisfactory performance on the oral dissertation proposal presentation.**
- ❖ **Satisfactory performance on the formal examination.**
- ❖ **A satisfactory written dissertation proposal, a copy of which will be placed in the student's file.**

Evaluation Criteria: The Advisory Committee will consider all of the information available to it, including an interview with the student to clarify unresolved issues, and render one of the following decisions:

- ❖ **The student passes the proposal defense and he/she is encouraged to finish all remaining requirements at the earliest possible time.**
- ❖ **The student passes the defense and, except for identified deficiencies for which the Committee will prescribe a remedy, the student is encouraged to finish all remaining requirements at the earliest possible time.**
- ❖ **The student fails the defense but is given permission to repeat it after certain conditions are met.**
- ❖ **The student fails the defense and is asked to withdraw from the program at the end of the term.**

Passing the defense requires approval of at least two thirds of the students advisory committee.

Appeals: A student may appeal the Advisory Committee's decision. Such an appeal must be made in writing to the Graduate Director. The written appeal must contain explicit reasons for requesting that the review be conducted. The appeal must be filed within two weeks from the date the student is notified in writing by the Graduate Director of the Advisory Committee's decision. The Graduate Director will then present his case to the Graduate Committee for a final decision.

5.5 TIME LIMIT

Candidacy for the doctorate automatically terminates seven years after beginning of study for the degree.

5.6 DISSERTATION SUBMISSION, FINAL DEFENSE, AND ACCEPTANCE

Dissertation research is to be done while the student is in full-time residence. The research must be completed and the dissertation must be written and successfully defended before the Ph.D. is conferred. The primary requirement of a dissertation is that it shows evidence of high

scholarly attainment through original and independent research work and creation of new knowledge. The acceptability of a dissertation depends upon its quality rather than the time and credit hours spent on the research work.

When the dissertation research is completed to the satisfaction of the dissertation advisor, the student will prepare a final draft of the Ph.D. dissertation. This draft is submitted to the dissertation advisor for critical review and evaluation before scheduling a final defense of the dissertation. After receiving advisor approval, the student prepares the dissertation in final form and submits a copy of the completed dissertation to each committee member for critical evaluation at least two weeks before the defense. Information concerning the required dissertation format, reproduction, and other regulations for preparing a dissertation is available from the EECS office and the UT Graduate School.

Final public defense of the dissertation is required of every doctoral candidate after he or she has fulfilled all other requirements of the doctoral program. This examination is administered by the student's dissertation committee and is restricted to the content of the dissertation and closely related subject matter. The dissertation advisor is the chairperson of the committee. All members of the dissertation committee are expected to be present at the dissertation defense. The dissertation defense is presided over by the student's faculty advisor and must be publicized and posted at least two weeks before the defense date.

The dissertation defense includes an oral presentation of approximately 45 minutes. This is followed by questions and comments from members of the dissertation committee and others. At the conclusion of the question and discussion period, all attendees present other than the dissertation committee members shall be excused. The dissertation committee may ask additional questions and will make a decision regarding acceptability of the dissertation and its defense and report these findings to the candidate. At least a 3/4 majority of the committee must concur in the final decision.

Major or minor changes and additions or deletions to the dissertation may be recommended by the dissertation committee. These must be made by the student and approved by the dissertation advisor before the student can be certified as having completed requirements for the dissertation.

After successful defense and corrections have been completed, the committee will complete and sign a dissertation approval page and forward it to the Graduate Program Director. Should the student not pass the final dissertation defense, the committee, in consultation with the Graduate Program Director, will decide upon a future course of action.

The doctoral candidate must submit a minimum of two journal papers based on the dissertation research.

The original signed dissertation manuscript and two copies (all unbound) must be submitted to the UT Graduate School.

Hard bound copies of the dissertation must also be provided to the advisor and the EECS Department. The student should prepare and bind additional copies for committee members, if requested. The student is expected to bear all costs associated with copying and binding.

5.7 GRADUATION

Students should follow the same procedure as specified in Section 4.7.

6. PRACTICAL TRAINING

Students may apply for optional (post-completion of study) practical training with the Office of International Student Services. To request a letter from the department, students must:

- ❖ **Have a 3.0 cumulative grade point average**
- ❖ **Have all PRs and INs removed from their transcripts, excluding project, thesis, dissertation, and independent study**
- ❖ **Have an approved and current plan of study on file**
- ❖ **Be completing their degree requirements by the end of the semester.**

Upon meeting the above requirements, students may fill out a "Request for Practical Training" form, available from the Academic Program Coordinator. Once the faculty advisor has signed the form, it may be submitted to the Program Coordinator, who will provide a letter to be taken to International Student Services.

7. DEPARTMENT FACULTY



Dr. Mansoor Alam, Professor and Graduate Director
Ph.D, Indian Institute of Science, 1974
Research Areas: Networking, Simulation, Performance Evaluation, Fault-Tolerance



Dr. Jackson Carvalho, Assistant Professor
Research Areas: Document Processing, Human-Computer Interaction and User



Dr. Robert W. Collins, Prestige Faculty of EECS, Ph.D., 1982, Harvard University
Professor of Physics and NEG Chair in Silicate and Materials Science



Dr. Alvin Compaan, Prestige Faculty of EECS, Professor and Chair, Department of Physics
Research Areas: Thin-film Photovoltaics, Photoluminescence and Raman Spectroscopy, Laser



Dr. Xuming Deng, Honorary Professor of EECS, Professor of Physics
Ph.D, University of Chicago, 1990
Research Areas: Photovoltaics, Semiconductor Devices, Thin Films



Dr. Vijay Devabhaktuni, Associate Professor
Ph.D, Carleton University, 2003
Research Areas: Applied Electromagnetics, Computer Aided Design, Neural Networks, RF/Microwaves



Dr. Gerald R. Heuring, Assistant Professor
Ph.D, Univ. of Illinois at Urbana-Champaign, 1993
Research Areas: Operating Systems, Computer Graphics Co-Director, Product Development Laboratory



Dr. Mohsin M. Jamali, Professor
Ph.D, University of Windsor, 1984
Research Areas: Computer Architecture, Computer Networks, Signal Processing



Dr. Rashmi Jha, Assistant Professor
Ph.D, North Carolina State University, 2006
Research Areas: Semiconductors, Photovoltaics, Sensors, Nanoelectronic device fabrication



Dr. Anthony D. Johnson, Associate Professor
Ph.D, University of Belgrade, 1975
VLSI and ASIC System Design
Director, VLSI Design Tool Laboratory



Dr. Devinder Kaur, Associate Professor
Ph.D, Wayne State University, 1989
Research Areas: Computer Architecture, Parallel and Distributed Processing



Dr. Sanjay V. Khare, Prestige Faculty of EECS, Assistant Professor of Physics
Ph.D., 1996, University of Maryland at College Park
Research Areas: Molecular dynamics, LEEM, TEM, STS techniques



Dr. Junghwan Kim, Professor
Ph.D, Virginia Polytechnic Institute and State University, 1988,
Research Areas: Digital Communications and Networking, Mobile/Satellite



Dr. Roger J. King, Professor
Ph.D, University of Toledo, 1983
Research Areas: Electronic Circuits, Power Electronics Co-director, Power Electronics Laboratory



Dr. Henry F. Ledgard, Professor
Ph.D, Massachusetts Institute of Technology, 1969
Research Areas: Human Aspects of Computers, Programming Languages



Dr. Kami Makk, Professor
Ph.D, The University of Queensland, 1997
Research Areas: Distributed, Mobile, Web, Multimedia & Bioinformatics Databases, Real-Time Applications, Intelligent Web



Dr. Sylvain Marsillac, Prestige Faculty of EECS, Assistant Professor of Physics
Ph.D. 1996, University of Nantes
Research Areas: High-Efficiency CIGS Thin Films Solar Cells



Dr. Lawrence Miller, Assistant Professor
Ph.D, University of Houston, 2001
Research Areas: Computer Networks, B-ISDN, ATM, Real-Time Communications, Simulation, Fault-Tolerance



Dr. Ezzatollah Salari, Professor
Ph.D, Wayne State University, 1982
Research Areas: Data Compression and Coding, Image/Video/Signal Processing, Applied Neural Networks



Dr. Gursel Serpen, Associate Professor
Ph.D, Old Dominion University, 1992
Research Areas: Artificial Intelligence/Neural Networks Theory and Applications in Medical Image



Dr. Krishna Shenai, Professor and Chair
Ph.D, Stanford University, 1986
Research Areas: Semiconductor Materials, Device, Circuits and Systems, Low-Power Mixed-Signal and RF Electronics, Power Electronics, Wireless Sensors and Networks



Dr. Hilda M. Standley, Associate Professor
Ph.D, University of Toledo, 1983
Research Areas: Compiler Design, High Performance Architecture



Dr. Thomas A. Stuart, Professor
Ph.D, Iowa State University, 1972
Research Areas: Electrical Power Systems, Power Electronics Co-Director, Power Electronics Laboratory



Dr. Daniel Georgiev, Assistant Professor
Ph.D, University of Cincinnati, 2003
Research Areas: Optical and optoelectronic materials and devices, laser processing of materials, vacuum microelectronics, materials characterization, glasses, thin films, sensors



Dr. Richard Molyet, Professor and Under Graduate Director
Ph.D, University of Toledo, 1981
Research Areas: Automatic Control, Robotics



Dr. Mohammed Y. Niamat, Professor
Ph.D., Electrical Engineering, The University of Toledo, 1989
Research Interests: Computer Engineering, Computer Architecture, Systolic Arrays, Digital Electronics, and Microprocessors.

8. OFFICES OF INTEREST

8.1 ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Department Chair	Dr. Krishna Shenai	(419) 530-8196 kshenai@utnet.utoledo.edu
Graduate Program Director	Dr. Mansoor Alam	(419) 530-8148 malam2@utnet.utoledo.edu
Academic Program Coordinator	Christie Hennen	(419) 530-3853 christina.hennen@utoledo.edu

8.2 FOCUS GROU REPRESENTATIVES

Communications and Signal Processing	Dr. Mohsin Jamali	(419) 530-8162 mjamali@utnet.utoledo.eduHugh
High Performance Computing Systems	Dr. Mansoor Alam	(419) 530-8161 mansoor.alam2@utoledo.edu
Intelligent Systems	Dr. Gursel Serpen	(419) 530-8158 gserpen@eecs.utoledo.edu
Power Electronics and Energy Systems	Dr. Tom Stuart	(419) 530-8189 Tstuart@utnet.utoledo.edu
RF and Microwave Systems	Dr. Vijay Devabhaktuni	(419) 530-8172 vdevabh@utnet.utoledo.edu
Sensor and Medical Devices	Dr. Krishna Shenai	(419) 530-8196 kshenai@utnet.utoledo.edu
Solid State Devices	Dr. Rashmi Jha	(419) 530-8145 rjha@utnet.utoledo.edu

Department Mailing Address Electrical Engineering and Computer Science Department
Mai Stop 308, Nitschke Hall, Room 2008
The University of Toledo
2801 West Bancroft St, Toledo, OH 43606-3390

TEL (419) 530-8140
FAX (419) 530-8146

8.3 COLLEGE OF ENGINEERING

Dean of Engineering

Dr. Nagi Naganathan

(419) 530-8000
nagi.naganathan@utoledo.edu

Assoc. Dean of Graduate Studies and Research

Dr. Samir M. Hefzy

(419) 530-6086
mhefzy@eng.utoledo.edu

8.4 UT GRADUATE SCHOOL

3240 University Hall

(419) 530-4723
grdsch@utnet.utoledo.edu
www.utoledo.edu/grad-school

Appendix A: Mathematics Courses

Following is a list of engineering courses that may be acceptable as math courses. A student in consultation with his/her advisor may select appropriate courses from this list as well as courses offered by the math department. Certain math courses may not be acceptable to a focus area. Please check with your advisor regarding this list.

MIME 5100 Applications of Engineering Analysis	3 cr.
MIME 5600/7600 Engineering Statistics I.....	3 cr.
MIME 5610/7610 Engineering Statistics II.....	3 cr.
MIME 5640/7640 Random Processes.....	3 cr.
MIME 5730/7730 Forecasting	3 cr.
MIME 6000/8000 Advanced Engineering Mathematics I.....	3 cr.
MIME 6100/8100 Advanced Engineering Mathematics II.....	3 cr.
MIME 6150/8150 Applied Numerical Methods I.....	3 cr.
MIME 6170/8170 Applied Numerical Methods II.....	3 cr.
MIME 6630//8630 Applied Statistical Methods.....	3 cr.
MIME 6670/8670 Queuing Theory	3 cr.
MIME 6700/8700 Linear Statistical Models.....	3 cr.
MIME 6720/8720 Experimental Design.....	3 cr.
MIME 6740/8740 Optimization Theory and Applications.....	3 cr.
MIME 6760/8760 Applied Math Programming.....	3 cr.

Appendix B: Frequently Used Forms (Available on the Web)

M.S. Plan of Study - to be completed in consultation with your faculty advisor. For full-time students, this form is due in the department office before registering for the second term. Changes to the plan of study are acceptable and should be indicated on the **Course Substitution Form**.

Graduate Advisor Selection Form - to be signed by your faculty advisor. This form is also due in the department office before registering for the second semester. Should you decide to change your advisor, you must obtain the signatures of both faculty members and have the change approved by the Graduate Program Director.

Request for Seminar Form - to be completed and approved before you may register for independent study, project, or thesis hours

Approval of M.S. Thesis Proposal - to be completed after your thesis proposal has been approved by your committee.

Notice of Thesis and Assurances of Compliance* - to be completed in the semester before graduation. The Assurances of Compliance form is required of all students doing research.

Approval of M.S. Thesis - to be signed by your committee after your thesis has been successfully defended. You need two forms, both with their original signatures.

Doctoral Program Proposal - to be completed within the first year of doctoral work.

Application for Qualifying Examination - to be completed at the beginning of the semester in which you plan to take the QE.

Application for Ph.D. Candidacy - to be completed after passing the QE.

Approval of Ph.D. Dissertation Proposal* - to be completed after your dissertation proposal has been approved by your committee.

Approval of Ph.D. Dissertation - to be signed by your committee after your dissertation has been successfully defended. You need two forms, both with their original signatures.

Intellectual Properties Form – to be completed and submitted to the Graduate Dean’s office along with your final project, thesis or dissertation.

Request for Academic Status Letter – to be completed and submitted to the Academic Program Coordinator, who will provide you with a letter to be taken to International Student Services

Request for Practical Training - to be completed and submitted to the Academic Program Coordinator, who will provide you with a letter to be taken to International Student Services.

Notice of Research (M.S and Ph.D.)- to be completed and submitted to the Academic Program Coordinator along with M.S Plan of Study or Doctoral Program Proposal

- ❖ **An announcement of your thesis or dissertation defense must be posted 2 weeks in advance.**
- ❖ **For M.S Project Option, minimum two faculty members must be included for the Committee and be shown in the Notice of Research Form.**
- ❖ **For Independent Study (EECS 6990/8990), M.S. Project (EECS 5920), M.S Thesis (EECS 6960), Request for Independent Study/Project/Thesis Form must be submitted at the time of registration and should be approved by Graduate Director before registration. If not, registration may be denied.**
- ❖ **Note that some forms can be replaced with new forms from time to time. Check with College of Engineering website or Graduate school website regularly for the newest update.**