INFORMATION ON GRADUATE PROGRAMS IN ELECTRICAL ENGINEERING AND
COMPUTER ENGINEERING
(Revised 2012)

ADMISSION

Admission to the graduate programs of the College of Engineering is based on an individual
assessment of the applicant’s ability to successfully complete the program. Many factors, including
undergraduate performance and relevant professional experience, enter into this assessment. Applicants
who meet the minimum requirements, explained below, may still be denied admission if, in the opinion of the
Department Graduate Committee, such denial is in the best interest of the applicant and/or the departmental
graduate program.

MASTER OF SCIENCE DEGREE ADMISSION CRITERIA:

Applicants for either a Master of Science in Electrical Engineering or a Master of Science in
Computer Engineering will be admitted on either a regular or qualified basis depending on their
undergraduate G.P.A.s and background.

1. **Regular Master’s admission** requires a minimum 3.0 (C=2.0) GPA, with undergraduate degree in
Electrical and/or Computer Engineering from an ABET (Accreditation Board for Engineering and
Technology) accredited program. Students with lower GPA are required to submit other pertinent
information including the results of the general test of Graduate Record Examination (GRE),
publications, and/or inventions.

2. Student admitted to **Regular Master’s program** with any previous or current WSU financial support
(GTA, GRA, and Rumble Fellow) must select the Plan A option, with eight-credit thesis.

3. All applicants whose BS degree is not from an ABET accredited university are required to submit
other pertinent information including the results of the general test of Graduate Record Examination
(GRE), publications, and/or inventions. An applicant is expected to have a GRE Quantitative Score
of 156 or higher in the revised scores or 720 or higher in the old scores.

Non-ECE Undergraduate Majors

Qualified admission may be granted to applicants who do not have bachelor’s degrees in either
Electrical or Computer Engineering but with undergraduate degrees from regionally accredited institutions in
engineering, physics, chemistry, mathematics, and computer science who meet the equivalent of the above
minimum standard. Students must take five prerequisite undergraduate courses as specified by the
Graduate Advisor before they are permitted to take graduate courses. The prerequisite courses can not be
taken by examination. Students must have a “B” grade or better in each of the five prerequisite courses. In
some cases, prerequisite courses may be part of the program undertaken while holding Qualified Admission
(this will be indicated on the “ADMISSIONS ACTION” and on the plan of work and will increase the credit
hour requirements). These students must have their M.S. Program and prerequisites approved by the
Department Graduate Committee.

Ph.D. ADMISSION CRITERIA:

Applicants are admitted on a regular basis depending on their Master’s G.P.A.s and background.
Doctoral applicants must present higher entrance qualifications than those required for the master’s degree
applicants. The same conditions relative to graduate from ABET-accredited institutions hold as specified for
the Master’s degree, furthermore:

1. Regular Ph.D. admission requires a 3.6 GPA, or better with a Master’s degree in Electrical or
Computer Engineering.

2. Post-master’s admission requires a 3.3 GPA, or better with a Master’s degree in Electrical or
Computer Engineering. Applicants are required to take four ECE courses assigned by the
Graduate advisor with a 3.6 G.P.A. or better and no grades below B. On the successful completion
of the Post-Master’s program applicants may be granted regular admission to the Ph.D. program.

3. Applicant with master’s degrees from other fields can be admitted on a regular basis if
recommended and supervised by a Ph.D. advisor.

4. All applicants whose BS degree is not from an ABET accredited university are required to submit
other pertinent information including the results of the general test of Graduate Record Examination
(GRE), publications, and inventions. An applicant is expected to have a GRE Quantitative Score of
156 or higher in the revised scores or 720 or higher in the old scores.
CHANGE OF STATUS:
A change of status from the Master’s to the Ph.D. program is normally allowed only if the applicant
has completed 24 or 32 credit requirements of the master’s degree. Exceptional students are allowed to go
from Bachelor’s to the Ph.D. programs if recommended and supervised by a Ph.D. advisor.

ECE Combined BS/MS ‘A GRADE’ (Accelerated Graduate Enrollment) PROGRAM

AGRADE applicants must have:

1. Complete approximately 90 credit hours towards the undergraduate degree.
2. An overall Honor Point Average (HPA) of at least 3.4 in Engineering.
3. Not less than 3.6 honor point average in the department of specialization as computed by the rules
   of the Division of Engineering in the courses already completed.

GRADUATE NON-DEGREE ADMISSION:
A student who is entering the Graduate Division with objectives not related to the pursuit of graduate
degree may request admission on a non-degree basis. An Application for Graduate Admission must be
filled, but a major is not recorded. The student may usually register for any course for which he/she is
prepared. Qualified graduate applicants may apply for the following categories:

1. PRE-MASTER’S: For students with an acceptable grade point average and an earned bachelor’s
degree from an accredited institution. Applicants must submit an Application for Graduate Admission
and request official transcripts to be sent to the University Office for Graduate Admissions.
2. POST-MASTER’S: For students who hold an earned master’s degree. Students with Wayne State’s
master’s degree should contact the Engineering Graduate Office. Others must submit a graduate
application and transcripts to the University Office for Graduate Admissions.
3. POST-DOCTORAL: For those holding an earned doctoral degree.

A maximum of nine credit hours is normally permitted in the above classifications. Beyond that, registration
as a non-degree student requires approval of the Engineering Graduate Office. Not more than nine
credits, subject to the approval of the graduate officer, may be applied at a later date toward the
residence and credit-hour requirements for either the master’s or Ph.D. degrees. If the student
decides to seek admission to a graduate degree program, he/she should apply to the ECE department for a
change of status before completing nine credit hours.

INTERNATIONAL STUDENTS:
Students from other countries desiring admission to the Graduate Division must contact the
University Office for Graduate Admissions for material and deadline dates. To be considered for graduate
admission, applicants must have completed an appropriate university-level program comparable in subject
matter and credits to a program for which a bachelor’s degree is awarded at Wayne State University. All
graduate applicants MUST (1) present an acceptable scholastic record (see section on admission); (2) make
financial arrangements which allow for approximately $18,000 per academic year for tuition, supplies, living
expenses, and medical insurance; (3) have a sufficient proficiency in the Test of English as a Foreign
Language (TOEFL) to be able to study in classes conducted entirely in the English language (a minimum
TOEFL score of).

The University Office of Graduate Admissions prefers results from the TOEFL. However, other
standard examinations, which measure English proficiency, may be substituted if conditions prohibit taking
the TOEFL. Any examination must be administered by qualified persons in American Consulates, USIS
Offices, universities or binational centers.

Applications educated in countries where English is not native language and who are now
permanent residents or U.S. citizens can be tested by the University’s Director of the English Language
Institute. Procedures for such testing must be initiated through the University Office for Graduate
Admissions.
FINANCIAL ASSISTANCE:
Although financial assistance for graduate students is limited, the department currently awards approximately 20 Graduate Teaching Assistantships. Furthermore, research funding in the department allows individual professors to award Graduate Research Assistantships.

MASTER'S DEGREE PROGRAMS
After receiving his/her credentials from the University Office of Graduate Admissions, and before registration, the student should contact the graduate advisor for details of program planning and to discuss course requirements and work. A preliminary plan of work must be prepared at this time in accordance with the master's degree requirement work-sheet.

A master's thesis may be elected by those students wishing to pursue independent research. An oral presentation must be delivered upon completion of the thesis.

Graduate Courses
Graduate work is classified either as course work, in which students meet as a group, or as research. A student registered for eight or more credits is considered full time.

Directed Study
Directed study may be authorized provided the area of interest for the study is an integral part of the student's graduate program and is not covered by courses available while he/she is completing the degree requirements. Normally, no credits of ECE 5990 and no credits of ECE 7990 are allowed in the master's program without a thesis. Before master's student can register in direct study (or research), he/she must prepare an outline of the study and obtain the approval of the advisor and the Graduate Director.

English Proficiency
It is expected that all graduate students should be able to write at a level of English surpassing that of an undergraduate student. Therefore, all papers and examinations will be graded on the basis of content and use of the English language.

Grades and Probation
No less than a “B” average overall (3.0) is required for graduation. A “B” average must also be attained in all ECE courses attempted. Only courses with grades of B- or higher can be counted towards the 32 credit hour requirement. A “C” grade in a core course must be repeated. The department will only permit one course to be repeated. A student is put on probation if two C grades are received or if his/her Honor Point Average (H.P.A.) falls below 3.0. Probation student will be permitted the next eight credits to restore their cumulative H.P.A. to at least a 3.0; failure to do so will result in immediate termination from the program. A grade below C means termination from the program.

Plan of Work
A Plan of Work must be completed, signed by the Graduate Director; and placed in the student’s folder on or before the student has accumulated eight credits, but before he/she is permitted to register for additional courses. Approval of the Plan of Work advances the M.S. Student from “applicant” status to that of “candidate”.

Candidacy
Candidacy is an advanced rank, which is recommended by the departmental advisor and authorized by the Engineering Graduate Officer upon evidence of the applicant’s superior scholarship, appropriate personal qualities and promise of the professional competence. The applicant must exercise primary responsibility for advancing his rank to candidate. The student must have completed the specified prerequisites and have filed his Plan of Work. Approval of candidacy is a necessary but not sufficient requirement for a graduate degree.

Course Overrides
To obtain overrides for registering graduate courses that you have not taken their listed prerequisite courses, you must e-mail the Instructor with the course number and providing evidence that you have already taken courses similar to the prerequisite courses.
MASTER'S DEGREE REQUIREMENTS – TOTAL 32 CREDIT HOURS (MINIMUM)

NOTE: unless otherwise stated, the following courses are 4 credit hours.

The Master of Science degree in Electrical or Computer Engineering is offered under the following options:

Master’s Degree Requirements – Total 32 Degree Credit hours (minimum)
The Master of Science degree in Electrical or Computer Engineering is offered under the following options:

Plan A: Thesis Option
- ECE8999 – 8 Cr Hrs
- Four courses in one Major Area, at least one 7000 level courses – 16 Cr Hrs (B- or better)
- Any ECE graduate course and may include 4 Cr Hrs of ECE5990 (directed study) – 4 Cr Hrs
- Any graduate course (except CSC5050) from any Engineering or Science Departments at WSU or transferred from any ABET accredited institution with grade of B or better – 4 Cr Hrs

Plan C: Course work only Option
- Five courses in one Major Area, at least two 7000 level courses – 20 Cr Hrs (B- or better)
- One course must be from ECE Mathematics list – 4 Cr hrs
- Any ECE graduate course (except ECE5990) – 4 Cr Hrs
- Any graduate course (except CSC5050) from pre-approved Engineering or Science Departments at WSU or transferred from any ABET accredited institution with grade of B or better – 4 Cr Hrs

The department will only permit one course to be repeated. Only courses with grades of B- or higher can be counted towards the 32 credit hour requirement. A student whose GPA falls below 3.0 must bring up their GPA to 3.0 within the next two semesters. Failure to do so can result in termination from the program. Overall 3.0 GPA in all the graduate courses taken at WSU is required for graduation. Any university supported student must follow Plan A only.

Note: Only one Major Area must be selected.

Major Areas for M.S. in Computer Engineering Degree

- Computer Systems and Applications
  7000/8000 level courses: ECE 7120, 7530, 7610, 7650, 7660, 7665, 7670, 7680, 7690, 7995, 8120.
  5000/6000 level courses: ECE 5120, 5325, 5610, 5620, 5630(2), 5640, 5650, 5670, 5680, 5690, 6600, 6640, 6660

Major Areas for M.S. in Electrical Engineering Degree

- Electrical Systems
  7000 level courses: ECE 7030, 7100, 7120, 7160, 7420, 7430, 7440, 7450, 7460, 7480, 7680, 7690, 7700, 7850.
  5000/6000 level courses: ECE 5100, 5120, 5170, 5325, 5370, 5380, 5410, 5420, 5430, 5440, 5470, 5480(2), 5690, 5700, 5770, 5870, 6100, 6180, 6660, 6690

- Electrical Devices
  7000/8000 level courses: ECE 7030, 7530, 7540, 7550, 7570, 7680, 7830, 7850, 8550, 8570(1)
  5000/6000 level courses: ECE 5325, 5330, 5550, 5575, 5690, 5870, 6550, 6570

- Electric Vehicles and Vehicle Electronics
  7000/8000 level courses: ECE 7030, 7430, 7440, 7420, 7650, 7655, 7730
  5000/6000 level courses: ECE 5330, 5410, 5430, 5440, 5470, 5575, 5620, 5650, 5700, 5770

ECE Mathematics Courses: ECE5020, 5040, and 7030
ECE AGRADE PROGRAM 32 Credit Hour Plan of Work:

Up to 12 Credit Hours out of the 134-credit BSEE requirement represent the AGRADE portion of the AGRADE undergraduate BS curriculum:

ECE5002 (4 Cr. Hr)*  Special AGRADE section – to replace another ECE 4000-level course.
8 Cr. Hr. elective    - Additional two 5000 or higher –level courses selected from the student chosen ECE MS Core Curriculum.
*Other 5000 level course may be used with Advisor's approval

Minimum 20 Credit Hours MS Graduate component in addition to 136 credit BSEE requirement.

8 Cr. Hr.                        - Two 7000-level ECE courses selected from the student chosen MS ECE Core Curriculum.
12 Cr. Hr.                      - Three 5000-level or higher ECE courses selected in consultation and with the approval of the AGRADE Faculty Advisor.

STUDENT ADVISING

Each graduate student enrolled in ECE will have a faculty advisor. New students should meet with the graduate advisor to choose their faculty advisor. Each faculty member had posted office hours. A student's faculty advisor will generally be the only faculty member signing registration forms, plans of work, etc. for them. Due to this, student should be prepared to complete all paper work for the next semester in a timely manner.

Core Advisors
Biomedical:                      Dr. Robert Erlandson, Dr. A. Basu, Dr. M. Cheng, Dr. A. Pandya
Computer:                       Dr. Mohamad Hassoun, Dr. Song Jiang, Dr. Syed Mahmud, Dr. A. Pandya, Dr. N Sarhan, Dr. Harpreet Singh, Dr. Pepe Siy, and Dr. Cheng-Zhong Xu.
Communication and Circuits:     Dr. A. Basu, Dr. Mohamad Hassoun, Dr. John Liu, Dr. Le Yi Wang, and Dr. Yang Zhao
Control and Power Systems:      Dr. Feng Lin, Dr. Le Yi Wang, and Dr. Hao Ying
Solid State Devices:             Dr. Gregory Auner, Dr. A. Basu, Dr. M. Cheng, Dr. James Woodyard, and Dr. Y. Xu
Optical Engineering:             Dr. Ivan Avrutsky, Dr. Mohamad Hassoun, and Dr. Yang Zhao
The general purpose of the Ph.D. program is to provide an educational experience, which will enable its graduates to develop new knowledge in the discipline. Thus, research training is an important component of each student’s program. The faculty of the department recognizes that for engineering research to be relevant to the solution of problems encountered by those engaged in professional practices, a broad background in the profession is essential. Thus, an acceptable level of competence in each of the major areas of the discipline is a requirement of the program.

It is important for students entering the Ph.D. program to become familiar with the research interests of all the faculty as soon as possible. This allows a better match between student and faculty advisor in terms of selecting a research area and appropriate research assistantships and fellowships, particularly for sponsored research programs.

**Credit-Hour Requirements**

A minimum of 90 graduate credits (semester) beyond the baccalaureate degree is required for the completion of the Ph.D. program. The division of these credits will be basically as follows:

1. At least twelve credits of coursework in the major (not including directed study or research credit).
2. At least one minor composed of six or more credits elected within or outside the major department (no minor is required for students entering the PhD Program in Fall 2012 or after).
3. Two credits of Doctoral Seminar (ECE 9997).
4. Thirty additional credits of coursework, pre-dissertation research and directed study.
5. Thirty credits earned in four consecutive Candidate Status semesters after candidacy has been approved.

The total Ph.D. program must include thirty credits, excluding Candidate Status semesters, in courses open only to graduate students (i.e. 7000 level or above). At least 30 hours must be elected at Wayne State University. Only courses with grades of B- or higher can be counted towards the degree. At the discretion of the advisor, up to 30 credit hours of graduate courses may be transferred from the Master’s program. A student wishing to transfer graduate credit toward a Ph.D. degree should file a Transfer of Credit form along with the doctoral Plan of Work. A minimum grade of B is necessary to transfer credits; B- credits and credits graded “P” or “S” (Pass or Satisfactory) are not transferable. Transfer credit must be appropriate to the student’s degree program and may not be used to reduce the minimum requirement of thirty credits, which must be carried at WSU.

**Directed Study**

Twelve credits of ECE 7990 are normally allowed in the Ph.D. program. The student must have the proper forms signed before registering for directed study. Before a student can register in directed study, he/she must prepare an outline of the study and obtain the approval of the advisor and the Graduate Director.

**Research Course**

Eight credits of ECE 7996 are normally allowed in the Ph.D. program. The student must have the proper form signed before registering for the course. Before a student can register in the course, he/she must prepare an outline of the study and obtain the approval of the advisor and the Graduate Director.

**Dissertation Research and Direction**

To register in ECE 999X courses, the student must send an e-mail to phdstudents@wayne.edu, including his/her student number (PID) and semester of the course.

**Plan of Work**

The Doctor of Philosophy Plan of Work approved by the advisor and the departmental graduate committee chairperson should be submitted to the Graduate School for approval before the student has completed 40 graduate credits (this includes the Master’s degree work). Any subsequent changes in the Plan of Work must be approved by the advisor and submitted to the Graduate School for approval.

**Course Overrides**
To obtain overrides for registering graduate courses that you have not taken their listed prerequisite courses, you must e-mail the Graduate Director or the Department Chair with the course number and providing evidence that you have already taken courses similar to the prerequisite courses.

**Ph.D. Examinations**

There are two Electrical and Computer Engineering Ph.D. Examinations.

**A. The Ph.D. Preliminary Examination**

The purpose of this examination is to determine whether a student is well prepared for the pursuing Ph.D. study in the Department of Electrical & Computer Engineering. Specifically, the purpose of this written preliminary examination is to determine if the student has sufficient background knowledge in basic general areas of electrical and computer engineering. The examination consists of three areas chosen from the approved list. One of the three area exams should be in the area in which the student plans to do a dissertation. A student should attempt the written preliminary examination within the first two semesters (not including the Spring/Summer semester) enrolled as a Ph.D. student. An extension may be arranged in exceptional circumstances during the first year of residence in the Ph.D. program. Each student is encouraged to consult his/her PhD advisor or the Graduate Committee Chair regarding the preliminary exam.

**B. Ph.D. Qualifying Examination**

All students must pass the qualifying examination before earning 64 credits toward the Ph.D. degree. As soon as possible after passing the preliminary examination, student should find a dissertation advisor, and under the advisor's direction, choose a dissertation topic and form a dissertation committee. It is the responsibility of the student's dissertation committee to give the Ph.D. qualifying examination.

The Ph.D. qualifying examination consists of written and an oral part.

**Written Part:** The purpose of this part of the exam is to test the student's comprehensive background in the chosen dissertation area. The student will prepare a comprehensive report consisting of background (theoretical and/or experimental), literature survey, definition of the problem, and description of the proposed research. The report must also address any other issues related to the student's major and minor area that the dissertation committee deems appropriate. This report will be presented to the student's dissertation committee and serve as a written part of the qualifying examination. This is meant to be writing experience as well as a technical experience. In addition to the technical content, the dissertation committee will evaluate the report for its organization, clarity, and conciseness. The department graduate committee will be notified of the outcome of the written part. If the dissertation committee does not recommend that the student proceed to the oral part, the graduate committee will require that the student redo the written part. The resubmission of the written part to the dissertation committee must be down within one semester of the first attempt.

Within the time period specified by the Graduate school following successful completion of the Written Ph.D. qualifying examination as specific above, the applicant must pass the Oral Ph.D. qualifying examination.

**Oral Part:** The purpose of this part of the exam is to test the student's comprehensive background in the chosen dissertation area and to give the student the opportunity to defend the written part of the exam. The oral exam will be conducted by the dissertation committee and a graduate examiner appointed by the Graduate School. At this examination the applicant is expected to present in detail the proposed dissertation topic and to be prepared to show that all necessary preparation has been done to maximize the likelihood of successful scholarly contribution in the proposed area of research. Upon successfully passing oral examination the student will become Ph.D. Candidate by completing the Ph.D. Candidacy form and submitting to graduate school.

Information on the oral and written required examinations, as well as other requirements, are outlined in the **HANDBOOK FOR DOCTORAL STUDENTS AND ADVISORS** available in Graduate School website in this link:


**Areas of Research**

| Bioengineering and Bioelectromagnetics | Neural Networks (Soft Computing) |
| Computer Engineering                  | Optical Engineering             |
| Control Theory                        | Power Systems                   |
| Information and Communication Theory  | Software Engineering            |
Ph.D. Degree Requirements

1. A minimum of 90 graduate credits (semester) beyond the baccalaureate degree is required for the completion of the Ph.D. program. Detailed requirements were discussed earlier in this bulletin.

2. Students must take the Ph.D. written preliminary exam during the first two semesters (excluding Spring/Summer session) of doctoral study. Failure to take the exam in the 2\textsuperscript{nd} semester constitutes a failed attempt. Failure to take the exam in the third semester constitutes a failed 2\textsuperscript{nd} attempt and will result in dismissal from the Ph.D. program.

3. A student must find a dissertation advisor within two semesters of passing the preliminary exam; failure to find an advisor will result in dismissal from the Ph.D. program.

4. Complete a Ph.D. Plan of Work form and present to dissertation advisor and departmental graduate officer for approval. The plan must be submitted to the Graduate School before completion of 40 graduate credits which includes the approved transfer of a maximum of thirty credits from other universities.

5. Form a doctoral dissertation committee with the membership specified in “The Graduate School Handbook for Doctoral Students and Advisors” (available on the ECE Graduate School Website).

6. Advance to the rank of Ph.D. Candidate upon completing the Ph.D. Candidacy Status form, obtaining the recommendation of the department and the approval of the Graduate School.

7. Complete the Doctoral Dissertation: Prospectus and Record of Approval form and pass the prospectus exam administered by the doctoral dissertation committee.

8. Register for Doctoral Dissertation and Direction I, II, III and IV (ECE 9991, 9992, 9993 and 9994) for a total of thirty credits.


10. Receive approval of the dissertation manuscript from the Graduate School.

Note: All forms are available on the ECE Graduate School Website.
DESCRIPTIONS OF GRADUATE COURSES

5020 (CSC 6620) Matrix Computation I. Cr. 4 (LCT: 4)
Prereq: CSC 2110 or equiv.; and B E 2550 for engineering students. Background matrix algebra; linear
system sensitivity; basic transformations; Gaussian elimination; symmetric systems; positive definite
systems; Householder method for least squares problems; unsymmetric eigenvalue problems; the QR
algorithm. (I)

5100 (BME 5010) Engineering Physiology. (CHE 5100) (I E 5100) (M E 5100) Cr. 4 (LCT: 4)
Prereq: BME 5005 or consent of instructor. The basic principles of human physiology presented from the
engineering viewpoint. Bodily functions, their regulation and control discussed in quantitative terms and
illustrated by simple mathematical models when feasible. (F,W)

5120 Artificial Neural Systems I. Cr. 4
Prereq: ECE 4330. Introduction to the theory, architecture, and application of artificial neural systems.
Supervised, unsupervised, and reinforcement learning in single and multiple layer neural networks.
Associative neural memory recording, and retrieval dynamics. Self-organizing maps. Learning capacity and
generalization. (F)

5170 (BME 5570) Design of Human Rehabilitation Systems. (I E 5170) (M E 5170) Cr. 4
Prereq: senior standing. Design, fabrication and testing of customized hardware to aid handicapped
patients. (F)

5310 Active Filters. Cr. 4 (LCT: 4)
and applications. Active-RC filter synthesis. Multiloop feedback design. Computer-aided design and
sensitivity optimization. (Y)

5325 Smart Sensors and Fuel Cells. (AET 5325) Cr. 4
Prereq: senior standing in a B.S. program. Study of multi-domain simulation platform that will enable
engineers to study complex systems such as fuel cells, mems, and automotive power distribution systems.
(F)

5330 (EVE 5430) Modelling and Control of Renewable Power Sources and Power Electronics. (AET 5330)
Cr. 4
Prereq: senior standing in science or engineering discipline. Basic methodologies for modeling, control
system design, system coordination, and optimization of renewable power sources and power electronics
systems. (B)

5370 Mechatronic System Design I. (BME 5530) Cr. 4
Prereq: ECE 4600 or equiv.; written consent of instructor. Students work in small groups to design and build
"smart" devices or systems. These products will integrate sensors, digital logic and/or microprocessors, and
user interfacing. The products will be requested by "client" and the students will work as part of a cross-
disciplinary team. (F)

5380 Mechatronic System Design II. (BME 5540) Cr. 4
Prereq: ECE 4600 or equiv.; written consent of instructor. Students work in small groups to design and build
"smart" devices or systems. These products will integrate sensors, digital logic and/or microprocessors, and
user interfacing. The products will be requested by a "client" and the students will work as part of a cross-
disciplinary team. (W)

5410 Power Electronics and Control (EVE 5410). Cr. 4 (LCT: 3)
Prereq: ECE 4330. Control of electric energy using solid-state devices, diodes, thyristors, triacs;
mathematical analysis of circuits containing these devices; power converters and control; solid-state drives
for motor control. (I)

5430 Electric Energy Systems Engineering. Cr. 4 (LCT: 4)
Prereq: ECE 4330. Transmission capacity, load characteristics, power frequency control. Energy system
component analysis and modeling. Steady-state analysis, load-flow problem and algorithms, optimal
dispatch. Transient stability by simulation and direct methods. (I)
5440 Computer-Controlled Systems. Cr. 4
Prereq: ECE 4470 or CHE 4600 or ME 4420 or former 5540. Introduction to z-transform and sampling theory. Digital controller design using both transfer function techniques and state space methods. Implementation aspects of computer-controlled systems. (Y)

5450 (EVE 5450) Control and Optimization for Integrated Electric-drive Vehicle Systems. Cr. 4
Prereq: EVE 5430; open only to Engineering graduate students and undergraduates with senior standing, others by consent of instructor. Understanding of how to control a system using modern control theory, how to optimize the performance of a system using various optimization technologies, and how to apply the control and optimization technologies to EDV systems. (W)

5470 Control Systems II. Cr. 4 (LCT: 4)
Prereq: ECE 4470. State space representation of systems; stability and Liapunov methods, controllability and observability, pole placement design using state feedback, observer design, optimal control, linear quadratic regulators, Kalman filter. (Y)

5500 Current Electronic and Photonic Materials Technology. Cr. 4
Prereq: ECE 4570, BE 1300 and BE 1310, or consent of instructor. Introduction to new and innovative technologies for electronic and photonic materials synthesis and processing. New semiconducting materials. Growth of single crystals of semiconducting materials. Semiconducting material processing techniques. (F)

5510 Electronic and Photonic Materials Laboratory. Cr. 2
Prereq: ECE 5500 and written consent of instructor. Laboratory experience in state-of-the-art techniques for electronic and photonic materials synthesis, processing, and characterization. (W)

5550 Solid State Electronics. Cr. 4 (LCT: 4)
Prereq: ECE 4570, ECE 4800 or consent of instructor. Physical basis for the opto-electronic properties of solids with particular emphasis on semiconductors. Basic principles associated with solid-state devices. Behavior of P-N junctions, bi-polar and field-effect transistors. PC-based simulation of device characteristics using the PC1D simulator. (Y)

5575 Introduction to Micro and Nano Electro Mechanical Systems. Cr. 4
Prereq: senior or graduate student in engineering or written consent of instructor. Introduction of fabrication technologies and designs of fundamental Micro/Nano Electro Mechanical Systems (MEMS/NEMS). (W)

5610 Introduction to Parallel and Distributed Systems. Cr. 4

5620 Embedded System Design. Cr. 4 (LCT: 4)
Prereq: ECE 4600 or consent of instructor. Microcontroller architecture and its subsystems. Wired and wireless protocols for vehicular networking applications. Design and implementation of real-time embedded systems. (F,S)

5630 Microcomputer Laboratory. Cr. 2 (LAB: 2)
Prereq: ECE 4340, ECE 4600. Study of interrupt structures, interfacing with teletypes, floppy disks, cassettes, keyboards and displays, testing and evaluation of microprocessors. Design and development of complete digital systems using a microprocessor development system. Material Fee as indicated in the Schedule of Classes (T)

5640 (CSC 6280) Real-Time and Embedded Operating Systems. Cr. 3
Prereq: CSC 4420 and CSC 4421. Operating system design for real-time and embedded systems. Focus on scheduling, synchronization, communication, and process and memory management for time-critical and resource-constrained applications. (I)

5650 Computer Networks and Programming. Cr. 4
5680 Computer Aided Logical Design and FPGAs. Cr. 4 (LCT: 4)
Complex sequential machine realization. State equivalence and minimization. Automata and linear
machines. State identification and fault detection. (T)

5690 Introduction to Digital Image Processing. Cr. 4
Prereq: B E 2500, ECE 4330, ECE 4050, or equiv. Concepts of digital image processing from an operational
perspective, with good exposure to theory. Accessibility of DIP to engineering. Detailed review of current
techniques. (F)

5700 Analog and Digital Communication Circuits. Cr. 4 (LCT: 4)
Prereq: ECE 4570 and ECE 4700. Amplitude, frequency, pulse modulation and digital modulation.
Detection, operational amplifiers; introduction to linear integrated circuits. Digital modulation. (I)

5730 Communications Laboratory. Cr. 2 (LAB: 2)
Prereq: ECE 4700; coreq: ECE 5700. Analog and digital modulation techniques, pulse code modulation,
delta modulation, FSK, PSK and ASK, data communication, signal processing. Material Fee as indicated in
the Schedule of Classes (Y)

5760 Fiber Optics Engineering Laboratory. Cr. 2
Prereq: ECE 4850. Laboratory study of basic components of fiber optic systems: fibers, semiconductor
lasers and light emitting diodes, photodetectors, digital and analog receivers and transmitters, filters, and
couplers. (Y)

5770 Digital Signal Processing. Cr. 4 (LCT: 4)
Prereq: ECE 4700. Analysis of discrete signals and systems. Applications to digital filtering, active filters,
digital communication and encoding. (Y)

5870 Optical Communication Networks. Cr. 4 (LCT: 4)
Prereq: ECE 4700; 4850. Laser and detectors; modulation and demodulation; optical transmitters and
receivers; optical filters; optical amplifiers; architecture and network control; multiaccess networks; FDDI
networks, SONET/SDH, ATM, system performance. (Y)

5885 Security and Electronic Commerce. Cr. 4
Prereq: ECE 4050. Basic principles of computer security and cryptography; focus on electronic commerce
applications. (W)

5990 Directed Study. Cr. 1-4 (Max. 4) (IND: 1)
Prereq: admission to M.S. program, written approval of proposed study outline by adviser and chairperson
prior to registration. Supervised study and instruction in the field selected by the student. (T)

5995 Special Topics in Electrical and Computer Engineering I. Cr. 1-4 (Max. 8) (LCT: 1)
Prereq: written consent of instructor. Maximum of eight credits in Special Topics may be elected in any one
degree program. Special subject matter in electrical and computer engineering. Topics to be announced in
Schedule of Classes . (T)

6100 Enabling Technology. (BME 6500) (O T 6620) Cr. 3-4
Prereq: consent of instructor. Principles of application of enabling technology: across life stages, for differing
ethnic and cultural backgrounds, for individuals with varying functional abilities. (W)

6180 (BME 6480) Biomedical Instrumentation. (I E 6180) (M E 6180) Cr. 4 (LCT: 4)
Prereq: ECE 3300, BME 5010 or BMS 6550 or former BMS 5550, and BME 5020. Engineering principles of
physiological measurements, signal conditioning equipment, amplifiers, recorders and transducers. Recent
advances in instrumentation. (F)

6550 Solid State Devices for Wireless Communications. Cr. 4 (LCT: 4)
Undergrad. prereq: consent of instructor; grad. prereq: admission to master's program. High-speed
semiconductor devices with emphasis on application for wireless communications. Si-Ge heterostructures
and devices as alternative for the conventional Si technology. Advanced concepts on electronic properties
and fabrication of heterostructures. Solid state devices in the microwave region. (Y)
6570 Smart Sensor Technology I: Design. (BME 6470) (PHY 6570) Cr. 4
Prereq: B.S. degree in engineering or science. Introduction to various types of sensors and the design of
basic analog VLSI circuit building blocks. (F)

6600 Engineering Software Design. Cr. 4 (LCT: 4)
Prereq: CSC 2220 or ECE 5620. Software engineering principles developed and integrated to identify,
modify, extend, and apply computational and information-processing methods in a variety of systems
applications. Structural analysis, design and programming is assumed and integrated into an engineering
systems design context. (F)

6640 Database Machines. Cr. 4 (LCT: 4)
Prereq: ECE 5620. Theory, design, and applications of database machines. Hardware implementation of
database functions; search, sort, relation operations, and the like. (Y)

6660 Introduction to VLSI Systems. Cr. 4 (LCT: 4)
Prereq: ECE 4680. Survey of very large scale integrated circuit components and design procedures. MOS
fabrication, MOS gates, circuit architecture, device design, manufacturing and interface techniques. Material
Fee as given in Schedule of Classes. (F)

6991 Industrial Internship. Cr. 1-4 (Max. 4)
Offered for S and U grades only. Prereq: graduate standing. Internship experience that satisfies the
curricular practical training requirements. (T)

7030 Mathematical Methods in Engineering I. Cr. 4
Prereq: ECE 4330. Introduction to functional analysis. Banach and Hilbert spaces. Fixed-point and
projection theorem techniques. Approximation, estimation, and optimization theory. Applications to
numerical and error analysis, non-linear equations, and modeling system identification. (Y)

7100 (BME 7100) Mathematical Modeling in Impact Biomechanics. (I E 7100) (M E 7100) Cr. 3-4 (LCT: 4)
Prereq: M E 3400, and ECE 5100 or BMS 6550 or former BMS 5550; consent of instructor. Review of
models created for impact simulations. Regional impact simulation models. Human and dummy models
subject to various restraint systems. (W)

7120 Artificial Neural Systems II. Cr. 4
Prereq: ECE 5120. Select current topics. Capabilities of neural networks to carry general computations.
Learning theory and information storage in ANSs. Generalization of a system's map from examples.
Collective computations in search and optimization. Statistical neurodynamics. Applications to
computationally complex problems. (Y)

7160 (BME 7160) Impact Biomechanics. (I E 7160) (M E 7160) Cr. 4 (LCT: 4)
Prereq: M E 2400, and BME 5010 or BMS 6550 or former BMS 5550. Biomechanical response of the body
regions and the whole body to impact. Mechanisms of injury in blunt impact. Effects of restraints on injury
reduction. Development of test surrogates such as dummies. (Y)

7225 (SCP 7100) Scientific Systems Programming. (CSC 5000) Cr. 3
Not for CSC or ECE major credit. Prereq: working knowledge of Fortran or C or C++. Introduction to basic
programming tools required for scientific computing, including advanced programming concepts, code
optimizations, mathematical prototyping language, and basic system administration. (F)

7400 Medical Robotics and Systems. (BME 7400) Cr. 4
Prereq: ECE 5020 or MAT 2250. Technology that interfaces computer engineering and electronics with
surgery; introduction to key topics, including medical robotics, image-guided surgery, segmentation/3D
modeling, medical simulation, and medical sensors. (W)

7420 (M E 7590) Nonlinear Control Systems. Cr. 4
Prereq: M E 5550 or ECE 5470 or ECE 5440. Review of nonlinear control problems in industries, analysis of
nonlinear systems using phase plane, Lyapunov describing function methods, design of nonlinear
controllers, applications to the control of robots, aircrafts and automobiles. (W)
7430 Control of Discrete Event Systems. Cr. 4
Prereq: ECE 5440 or ECE 5470 or M E 5550. Automation model of discrete event systems; logical model of processes; permissive and forceful control; communicating sequential processes (CSP); calculus of communicating systems (CCS); timed discrete event systems; performance analysis. (B)

7440 Dynamic Systems and Optimal Control. Cr. 4 (LCT: 4)
Prereq: ECE 5440 or ECE 5470 or M E 5550. Formulation of optimal control problems. Pontryagin's maximum principle and necessary conditions for optimality, with applications. Dynamic programming; Hamilton-Jacobi equation; optimal feedback control; stochastic systems. (I)

7450 System Identification and Adaptive Control. Cr. 4
Prereq: ECE 5440 or ECE 5470 or M E 5550. Problem formulations for system identification and adaptive control. Identification for nonparametric models and parametric models. Online identification controls. Design of self-tuning and model reference adaptive control schemes. Stability, robustness and performance analysis of adaptive control systems. (Y)

7455 (EVE 7450) Embedded Systems for Vehicles. Cr. 4
Prereq: EVE 5430; B.S. degree in an engineering or math-based science program. Advanced embedded processors and operating systems, power modules, auxiliary execution engine, display interface, memory controller, USB controller, DMA, I/O, initialization and configuration, programmable serial controller, serial audio interface, and video input. (F)

7530 Advanced Digital VLSI Design Using VHDL. Cr. 4
Prereq: ECE 6660. Behavioral, data flow, and structure VHDL modelling. CADENCE CAD tools used to simulate and generate the schematic and layout of the synthesized VHDL code. (Y)

7550 Advanced Solid State Electronics I. Cr. 4 (LCT: 4)
Prereq: ECE 5550 or 6550. Review of solid state theories. Electrical conductivity, relaxation times and the Boltzmann equation. Mobility, Hall effect, contacts and application to negative differential conductivity devices such as the Gunn diode. (Y)

7570 Smart Sensor Technology II: Characterization and Fabrication. (BME 7470) (PHY 7580) Cr. 4
Prereq: ECE 6570. Integration of ongoing research in integrated technology of smart sensors. Design of smart sensor devices using computer simulation. Fabrication of smart sensor. Material Fee as given in Schedule of Classes. (W)

7610 Advanced Parallel and Distributed Systems. Cr. 4 (LCT: 4)
Prereq: ECE 5610 or ECE 5650. Advanced topics in parallel and distributed computing, multicore and parallel architecture, communication, synchronization, parallel algorithms and programming, load balancing and scheduling, security. (W)

7650 Scalable and Secure Internet Services and Architecture. Cr. 4
Prereq: graduate standing; ECE 5610 or ECE 5650. Advanced principles of networks and distributed computing systems, the Internet, Internet server and data center, content delivery networks, performance scalability, energy-aware resource management, security and privacy, cost-effective engineering design. (W)

7655 Multimedia Computing and Networking. Cr. 4
Prereq: ECE 5650. Research-oriented course. Emphasis on network and server support for multimedia streaming over the Internet and wireless networks, video conferencing, and other emerging multimedia applications. (W)

7660 Parallel Computer Architecture. Cr. 4 (LCT: 4)
Prereq: ECE 5610, ECE 5620. Review of parallel computer architectures, including symmetric multiprocessors and scalable machines. Parallel software basics for various architectures. Fundamental issues including cache coherence, interconnection network, and synchronization; influence of these on performance of applications. (Y)

7670 Pattern Recognition. Cr. 4 (LCT: 4)
7680 Advanced Digital Image Processing and Applications. Cr. 4
Prereq: ECE 5690 or equiv. Advanced aspects, algorithms, methods in digital image processing and their corresponding applications in different fields. Students will develop a comprehensive skills and knowledge in Digital Image processing. (Y)

7690 Fuzzy Systems. Cr. 4
Prereq: ECE 4330 or consent of instructor. From basic fuzzy set theory to advanced topics such as neuro-fuzzy systems. (Y)

7700 Statistical Communication Theory. Cr. 4 (LCT: 4)
Prereq: ECE 5700. Decision theory, binary decisions with single and multiple observations, signals in additive Gaussian noise, sequential decision theory, estimation theory, Kalman filtering. (Y)

7730 Telematics. Cr. 4
Prereq: ECE 5700 or consent of instructor. Introduction to fundamental principles in mobile communications to support automotive telematics. Topics include introduction to telematics, mobile communication channels, advanced modulation methods, error correction, intra-vehicle and inter-vehicle communications, vehicle to infrastructure communications, automotive radar, and GPS. (W)

7830 Information Optics. Cr. 4
Prereq: ECE 5870 or 4850 and 4700. Wave theory, optical signal processing, nonlinear optical interactions, optical switching, optical interconnection, information storage, optical sensing and optical information display. (Y)

7850 Fiber and Integrated Optics. Cr. 4

7990 Directed Study. Cr. 1-8 (Max. 12) (IND: 1)
Prereq: written consent of adviser, chairperson and graduate officer for master's students; written consent of adviser, chairperson and Dean of Graduate Studies for Ph.D. students. Outline of proposed study and petition must be submitted to graduate committee in advance of registration. Supervised study and instruction in an advanced topic. (T)

7995 Special Topics in Electrical and Computer Engineering II. Cr. 1-4 (Max. 12) (LCT: 1)
Prereq: written consent of instructor. Maximum 12 credits in Special Topics may be elected in any one degree program. A consideration of special subject matter in electrical and computer engineering. Topics to be announced in Schedule of Classes . (T)

7996 Research. Cr. 1-8 (Max. 8)
Prereq: written consent of adviser and chairperson. Design, investigation and experimental work on some phase of electrical and computer engineering. Written report required. (T)

7999 Master's Essay Direction. Cr. 2 (IND: 2)
Prereq: consent of adviser. (T)

8550 Advanced Solid State Electronics II. Cr. 4 (LCT: 4)
Prereq: ECE 7550. Current topics in solid state phenomena, devices, and technology such as heterojunctions, metal-semiconductor barriers and junctions, photoemissive cathodes and amorphous devices used in electrical and optical memory units and solar cells. (I)

8570 Smart Sensor Technology Seminar. (BME 8470) (PHY 8570) Cr. 1
Prereq: ECE 6570, 7570. Technological advances. Interaction of research experience in smart sensors and integrated devices. (W)

8999 Master's Thesis Research and Direction. Cr. 1-8 (req.) (IND: 1)
Prereq: written consent of graduate adviser. (T)
9990 Pre-Doctoral Candidacy Research. Cr. 1-8 (Max. 10)
Prereq: consent of department. For Ph.D. program applicants. Offered for S and U grades only. Research in preparation for doctoral dissertation. (T)

9991 Doctoral Candidate Status I: Dissertation Research and Direction. Cr. 7.5
Prereq: consent of dissertation adviser; Ph.D. candidate in department. Required in academic-year semester following advancement to Ph.D. candidacy. Offered for S and U grades only. (T)

9992 Doctoral Candidate Status II: Dissertation Research and Direction. Cr. 7.5
Prereq: consent of dissertation adviser; ECE 9991. Required in academic-year semester following 9991. Offered for S and U grades only. (T)

9993 Doctoral Candidate Status III: Dissertation Research and Direction. Cr. 7.5
Prereq: consent of dissertation adviser; ECE 9992. Required in academic-year semester following 9992. Offered for S and U grades only. (T)

9994 Doctoral Candidate Status IV: Dissertation Research and Direction. Cr. 7.5
Prereq: consent of dissertation adviser; ECE 9993. Required in academic-year semester following 9993. Offered for S and U grades only. (T)

9995 Candidate Maintenance Status: Doctoral Dissertation Research and Direction. Cr. 0
Prereq: consent of dissertation adviser; completion of 30 credits in ECE 9991-9994. Offered for S and U grades only. (T)

9997 Doctoral Seminar. Cr. 1-4 (Max. 4)
Prereq: written consent of doctoral adviser. (T)
FACULTY SPECIALIZATIONS

Gregory Auner, Professor (313-577-3904; e-mail: gauner@eng.wayne.edu) is interested in wide bandgap semiconductors, graded pyroelectric materials, magnetic materials for sensors and device development, smart sensors.

Ivan Avrutsky, Associate Professor (313-577-4801; e-mail: avrutsky@ece.eng.wayne.edu) is interested in optoelectronics, theory and technology of optical waveguides and gratings, fiber and integrated optics, optics of nanostructures, semiconductor lasers.

Amar S. Basu, Assistant Professor (313-577-3990; email: abasu@ece.eng.wayne.edu) Research areas: Microfluidics, bioMEMS, bionanotechnology, and scanning probes for medical applications.

Ming-Cheng Mark Cheng, Assistant Professor (313-577-5462; email: mcheng@ece.eng.wayne.edu) Research areas: BioMEMS, Nanotechnology, Nanomedicine.

Robert Erlandson, Professor, (313-577-3990; e-mail: rerlands@eng.wayne.edu) works on systems methodologies suitable for analysis and evaluation of large complex systems, particularly physiological structures; development of decision-making methodologies utilizing multivalued logic and nonparametric techniques.

Xiaoyan Han, Professor, (313-577-3646; e-mail: xhan@eng.wayne.edu) Research areas: infrared imaging, nondestructive evaluations.

Mohamad Hassoun, Professor (313-577-3966; e-mail: hassoun@brain.eng.wayne.edu) research interest includes artificial neural systems; associative memories; machine learning; pattern recognition; application of artificial neural networks to physiologic signal processing, optimization, and control.

Song Jiang, Associate Professor, (313-577-8944; email: sjiang@eng.wayne.edu) Research areas: operating system, file and storage system, and high-performance computing.

Feng Lin, Professor, (313-577-3428; e-mail: flin@eng.wayne.edu) has a background in systems and control, hierarchical structure of discrete event systems, decision analysis for complex processes, control and optimization of flexible manufacturing systems.

John Liu, Associate Professor, (313-577-3428; email: jliu@eng.wayne.edu)

Syed M. Mahmud, Associate Professor, (313-577-3855; e-mail: smahmud@eng.wayne.edu) has been working in the area of microprocessor-based systems design, digital system design, special purpose computer architectures, cache-based multiprocessor system design and performance analysis.

Abhilash Pandya, Associate Professor, (313-577-9921; e-mail: apandya@eng.wayne.edu) Research areas: Medical, NASA and Military Robotics, Image Guided Surgery, Biosensors, Augmented Reality, Virtual Reality, Image Processing.

Nabil J. Sarhan, Associate Professor, (313-577-7526, e-mail: nabil@ece.eng.wayne.edu) is interested in multimedia systems, multimedia networking, storage subsystems, multiprocessor systems, computer architecture, performance evaluation.

Harpreet Singh, Professor (313-577-3917; e-mail: hsingh@eng.wayne.edu) is involved in problems of state-variables and system theoretic and Petri New approach to computer hardware and software, vehicle guidance, software engineering, expert systems, VLSI design.

Pepe Siy, Professor, (313-577-3841; e-mail: psiy@ece.eng.wayne.edu) is interested in pattern recognition, image processing, parallel discrete computational problems, analog and digital VLSI, smart sensor technology.

Le Yi Wang, Professor, (313-577-4715; e-mail: lywang@eng.wayne.edu) research interests concentrate on H-infinity optimization, stabilization of time-varying systems, frequency-domain systems identification hybrid control systems, automotive control systems, nonlinear and adaptive control.
James Woodyard, Associate Professor, (313-577-3758; e-mail: woodyard@eng.wayne.edu) works on ion beam analysis and modification of thin-film devices and device materials; hydrogenation, dehydrogenation, and radiation resistance of amorphous semiconductor materials; optical and electrical characterization of device materials and device fabrication.

Chengzhong Xu, Professor, (313-577-3856; e-mail: czxu@eng.wayne.edu) is interested in parallel computing, particularly run-time and operating system support for irregularly structured applications; distributed shared memory systems; multiprocessor server technologies.

Yong Xu, Associate Professor, (313-577-3850; e-mail: yxu@ece.eng.wayne.edu) works on MEMS sensors (flow sensors, pressure sensors, inertial sensors, tactile sensors, etc), MEMS flexible skin technology, intelligent textile technology, and micro/nanofluidics.

Hao Ying, Professor, (313-577-3738; e-mail: hying@ece.eng.wayne.edu) research interest includes fuzzy control and systems, control, modeling, expert systems, image/single processing, neural networks, and ultrasonics, all with biomedical applications.

Yang Zhao, Professor and Chair, (313-577-3404; e-mail: yzhao@eng.wayne.edu) research interests relate to optics, in particular nonlinear optical devices for communications, novel optical materials, optical sensing, lasers.
ECE GRADUATE COURSES

Course descriptions, etc. may be found in the Graduate Bulletin of the University given in this link:

http://www.bulletins.wayne.edu/gbk-Output/gbk-index.html

Contacts:

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University Graduate Admissions Office
Office of University Admissions
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Detroit MI 48202
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College of Engineering Home Page:
http://www.eng.wayne.edu/

ECE Home Page:
http://www.ece.eng.wayne.edu/

ECE Graduate Home Page:
http://www.eng.wayne.edu/page.php?id=442

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