ELECTRICAL ENGINEERING: SIGNAL PROCESSING AND MACHINE LEARNING, M.S.

This is a named option in the Electrical Engineering M.S. (http://guide.wisc.edu/graduate/electrical-computer-engineering/electrical-engineering-ms/#text)

The Signal Processing and Machine Learning (MLSP) program is intended for students looking for a jump-start on a career in data science, with a passion for quantitative thinking, practical problem solving, computer programming, and applications to a variety of domains. It is designed for motivated students ready for the rigors of a 12-month accelerated program.

The required coursework draws upon both classical and modern methods in MLSP, and is taught by faculty conducting cutting-edge MLSP research. Successful students will have some experience with linear algebra, statistics, and computer programming. The combined focus on the mathematical foundations of data science and their practical application to real-world problems will prepare graduates to be ready to immediately contribute in a variety of different MLSP jobs.

The focus of the MLSP program differs from the standard research-based MS program by the replacing the independent research that leads to a written thesis with an accelerated coursework plan, the summer practicum, and a focus on courses in the MLSP area. If you are interested in research and advanced concept development, you are better served pursuing a research-focused MS program. If you want to complete your degree in 12 months and be part of data science in the work force, then the MLSP program is right for you.

ADMISSIONS

An applicant must have a bachelor’s degree from a regionally accredited U.S. institution or a comparable degree from an international institution. International applicants can find specific information for their country on the Graduate School Admission Requirements (http://grad.wisc.edu/admissions/requirements) page. The department welcomes applications from scientific, engineering, and mathematical disciplines other than ECE.

Admission Requirements:

- It is preferred that applicants have a B.S. degree in Electrical and Computer Engineering or in a related area.
- A grade point average of 3.0 (4.0 basis) is the minimum requirement for admission consideration. Applicants from an international institution must demonstrate strong academic achievement comparable to a 3.0. The Graduate School will use your institution’s grading scale. Please do not convert your grades to a 4.0 scale.
- A submitted online application is required, consisting of:
  - your resume/CV;
  - a statement of purpose (see the guidelines (https://grad.wisc.edu/apply/prepare) provided by the Graduate School);
  - an uploaded transcript; and
  - payment of the one-time application fee of $75.
- This fee is non-refundable. It can be paid by credit card (MasterCard or Visa) or debit/ATM card. By Wisconsin state law, this fee can only be waived or deferred through the conditions outlined by the Graduate School (https://grad.wisc.edu/apply/fee-grant).
- Applicants must also obtain three letters of recommendation for consideration.
- Graduate Record Exam (GRE) general test scores are required for all applicants. Please send your scores electronically via ETS to institution code 1846. UW undergraduate students, specifically those who have a B.S. degree in Electrical Engineering or Computer Engineering, may be exempt from the GRE requirement. Please inquire with the ECE Graduate Admissions Team at ecegradadmission@engr.wisc.edu (ecegradadmission@engr.wisc.edu)
- Applicants whose native language is not English must provide an English proficiency score. There are a few situations in which applicants are exempt from this requirement. Please see the Graduate School’s English Proficiency Requirement (https://grad.wisc.edu/apply/requirements), which also lists the exemptions and required method of delivery.

The application deadline for Fall is March 15 of the year the student wishes to start the program (e.g., March 15, 2019 for Fall 2019). There are no Spring or Summer admission cycles. Only completed applications, including supportive materials, by the application deadline are guaranteed consideration. Please note that it is highly advised to take the GRE and TOEFL/IELTS tests well in advance of the deadline to ensure time for receiving and processing the scores.

- If you have any admissions questions, please contact the ECE Graduate Admissions team at ecegradadmission@engr.wisc.edu.

GRADUATE SCHOOL ADMISSIONS

Graduate admissions is a two-step process between academic degree programs and the Graduate School. Applicants must meet requirements of both the program(s) and the Graduate School. Once you have researched the graduate program(s) you are interested in, apply online (https://grad.wisc.edu/admissions).

FUNDING

GRADUATE SCHOOL RESOURCES

Resources to help you afford graduate study might include assistantships, fellowships, traineeships, and financial aid. Further funding information (https://grad.wisc.edu/funding) is available from the Graduate School. Be sure to check with your program for individual policies and processes related to funding.

Students in the Signal Processing and Machine Learning program are not permitted to accept tuition-waiving assistantships or seek double or dual degrees.
MINIMUM GRADUATE SCHOOL REQUIREMENTS

Review the Graduate School minimum academic progress and degree requirements (http://guide.wisc.edu/graduate/#policiesandrequierements), in addition to the program requirements listed below.

NAMED OPTION REQUIREMENTS

MODE OF INSTRUCTION

<table>
<thead>
<tr>
<th>Face to Face</th>
<th>Evening/Weekend</th>
<th>Online</th>
<th>Hybrid</th>
<th>Accelerated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Mode of Instruction Definitions

**Evening/Weekend:** These programs are offered in an evening and/or weekend format to accommodate working schedules. Enjoy the advantages of on-campus courses and personal connections, while keeping your day job. For more information about the meeting schedule of a specific program, contact the program.

**Online:** These programs are offered primarily online. Many available online programs can be completed almost entirely online with all online programs offering at least 50 percent or more of the program work online. Some online programs have an on-campus component that is often designed to accommodate working schedules. Take advantage of the convenience of online learning while participating in a rich, interactive learning environment. For more information about the online nature of a specific program, contact the program.

**Hybrid:** These programs have innovative curricula that combine on-campus and online formats. Most hybrid programs are completed on-campus with a partial or completely online semester. For more information about the hybrid schedule of a specific program, contact the program.

**Accelerated:** These on-campus programs are offered in an accelerated format that allows you to complete your program in a condensed time-frame. Enjoy the advantages of on-campus courses with minimal disruption to your career. For more information about the accelerated nature of a specific program, contact the program.

CURRICULAR REQUIREMENTS

Minimum Credit Requirement

| Minimum Residence Credit Requirement | 16 credits |
| Minimum Graduate Coursework Requirement | Half of degree coursework (15 credits out of 30 total credits) must be completed graduate-level coursework; courses with the Graduate Level Coursework attribute are identified and searchable in the university’s Course Guide (https://registrar.wisc.edu/course-guide/). |
| Overall Graduate GPA Requirement | 3.00 GPA required. |

Other Grade Requirements

1. A grade of B or better in any graduate course is acceptable.
2. A grade of BC in an ECE course is acceptable, provided the total cumulative GPA for graduate ECE courses is greater than or equal to 3.00.
3. A grade of BC or C in a non-ECE course is acceptable only if approved by the Graduate Committee.

Assessments and Examinations

Language Requirements
Non-native speakers of English who enroll in the M.S. program must take the ESLAT test on arrival at the university and then take any recommended courses based on the exam results. In addition, if a student's advisor believes that his or her technical writing ability needs improvement, the student may be required to undertake remedial work.

REQUIRED COURSES

Fall Semester (14 credits)—choose at the minimum four courses from the list below if wishing to graduate in one year.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ECE 431</td>
<td>Digital Signal Processing</td>
<td>3</td>
</tr>
<tr>
<td>ECE 436</td>
<td>Communication Systems I</td>
<td>3</td>
</tr>
<tr>
<td>ECE/COMP SCI/ISE 524</td>
<td>Introduction to Optimization</td>
<td>3</td>
</tr>
<tr>
<td>ECE/COMP SCI/ME 532</td>
<td>Matrix Methods in Machine Learning</td>
<td>3</td>
</tr>
<tr>
<td>ECE/COMP SCI 533</td>
<td>Image Processing</td>
<td>3</td>
</tr>
<tr>
<td>ECE/COMP SCI/ME 539</td>
<td>Introduction to Artificial Neural Network and Fuzzy Systems</td>
<td>3</td>
</tr>
<tr>
<td>ECE 717</td>
<td>Linear Systems</td>
<td>3</td>
</tr>
<tr>
<td>ECE 729</td>
<td>Theory of Information Processing and Transmission</td>
<td>3</td>
</tr>
<tr>
<td>ECE 730</td>
<td>Modern Probability Theory and Stochastic Processes</td>
<td>3</td>
</tr>
<tr>
<td>ECE/COMP SCI 761</td>
<td>Mathematical Foundations of Machine Learning</td>
<td>3</td>
</tr>
<tr>
<td>ECE 901</td>
<td>Special Topics in Electrical and Computer Engineering</td>
<td>1-3</td>
</tr>
<tr>
<td>EPD 611</td>
<td>Engineering Economics and Management</td>
<td>3</td>
</tr>
<tr>
<td>or EPD 612</td>
<td>Technical Project Management</td>
<td></td>
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</table>

Spring Semester (13 credits)—choose at the minimum four courses from the list below if wishing to graduate in one year.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 437</td>
<td>Communication Systems II</td>
<td>3</td>
</tr>
<tr>
<td>ECE/COMP SCI/ISE 524</td>
<td>Introduction to Optimization</td>
<td>3</td>
</tr>
<tr>
<td>ECE 719</td>
<td>Optimal Systems</td>
<td>3</td>
</tr>
<tr>
<td>ECE 735</td>
<td>Signal Synthesis and Recovery Techniques</td>
<td>3</td>
</tr>
<tr>
<td>ECE 736</td>
<td>Wireless Communications</td>
<td>3</td>
</tr>
<tr>
<td>ECE 738</td>
<td>Advanced Digital Image Processing</td>
<td>3</td>
</tr>
</tbody>
</table>
ECE 830  Estimation and Decision Theory  3
ECE/COMP SCI/ STAT 861  Theoretical Foundations of Machine Learning  3
ECE 901  Special Topics in Electrical and Computer Engineering  1-3
EPE 617  Communicating Technical Information  3

Summer (3 credits)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 699</td>
<td>Advanced Independent Study</td>
<td>3</td>
</tr>
<tr>
<td>ECE 702</td>
<td>Graduate Cooperative Education Program 1</td>
<td>1-2</td>
</tr>
</tbody>
</table>

1 Up to two credits of ECE 702 (Co-Op) may count towards this degree.

ECE 610 Seminar in Electrical and Computer Engineering requirement

All on-campus ECE graduate students must register for ECE 610 during their first semester of graduate studies. M.S.-degree-seeking students must take 1 credit of ECE 610 in the fall semester of which they are entering the program. Students with a course conflict with ECE 610 should discuss with their faculty advisor regarding an exception to the requirement.

The purpose of ECE 610 is to expose students in their first semester of graduate school to various areas within ECE and to areas outside of ECE to which ECE has or could have connections, e.g., biotechnology, physics, mathematics, business, software. Electrical and computer engineering is very interdisciplinary in nature, and so it is important that students be aware of state-of-the-art research in areas other than their own.

POLICIES

GRADUATE SCHOOL POLICIES

The Graduate School's Academic Policies and Procedures (https://grad.wisc.edu/acadpolicy) provide essential information regarding general university policies. Program authority to set degree policies beyond the minimum required by the Graduate School lies with the degree program faculty. Policies set by the academic degree program can be found below.

NAMED OPTION-SPECIFIC POLICIES

GRADUATE PROGRAM HANDBOOK

The Graduate Program Handbook (https://www.engr.wisc.edu/department/electrical-computer-engineering/academics/ece-graduate-student-handbooks) is the repository for all of the program's policies and requirements.

PRIOR COURSEWORK

Graduate Work from Other Institutions

With program approval, students may count graduate coursework from other institutions toward the minimum graduate degree credit requirement and the minimum graduate coursework (50%) requirement. No credits from other institutions may be counted toward the minimum graduate residence credit requirement. Coursework earned five or more years prior to admission to a master's degree is not allowed to satisfy requirements.

UW-Madison Undergraduate 1

With program approval, up to 7 credits from UW-Madison numbered 400 or above can be counted toward the minimum graduate degree credit requirement. Up to 7 credits of ECE courses numbered 700 or above can be counted toward the minimum graduate coursework (50%) requirement. No credits can be counted toward the minimum graduate residence credit requirement.

With program approval, students may count up to 7 credits of undergraduate coursework from a bachelor of science degree in Electrical Engineering, Computer Engineering, Electrical and Computer Engineering, Electrical Engineering and Computer Science, or Computer Science from an ABET-accredited program at other institutions (not UW-Madison) toward fulfillment of minimum degree requirements.

Courses numbered 300 or above may be counted towards the minimum graduate degree credit requirement and courses numbered 700 or above may be counted towards the minimum graduate coursework (50%) requirement. No credits from other institutions can be counted toward the minimum graduate residence credit requirement. Coursework earned five or more years prior to admission to a master's degree is not allowed to satisfy requirements.

1 The department also accepts undergraduate credit from non-UW ABET-accredited institutions. See policy language above for details.

UW-Madison University Special

With program approval, students are allowed to count up to 9 credits of coursework numbered 400 or above taken as a UW-Madison University Special student toward the minimum graduate residence credit requirement, and the minimum graduate degree credit requirement. Courses numbered 700 or above taken as a UW-Madison Special student toward the minimum graduate coursework (50%) requirement. Coursework earned five or more years prior to admission is not allowed to satisfy requirements.

PROBATION

Students must be in good academic standing with the Graduate School, their program, and their advisor. The Graduate School regularly reviews the record of any student who received grades of BC, C, D, F, or I in graduate-level courses (300 or above), or grades of U in research and thesis. This review could result in academic probation with a hold on future enrollment, and the student may be suspended from graduate studies.

The Graduate School may also put students on probation for incompletes not cleared within one term. All incomplete grades must be resolved before a degree is granted.

The status of a student can be one of three options:

1. Good standing (progressing according to standards; any funding guarantee remains in place).
2. Probation (not progressing according to standards but permitted to enroll; loss of funding guarantee; specific plan with dates and deadlines in place in regard to removal of probationary status.

3. Unsatisfactory progress (not progressing according to standards; not permitted to enroll, dismissal, leave of absence or change of advisor or program).

A semester GPA below 3.0 will result in the student being placed on academic probation. If a semester GPA of 3.0 is not attained during the subsequent semester of full time) the student may be dismissed from the program or allowed to continue for one additional semester based on advisor appeal to the Graduate School.

ADVISOR / COMMITTEE
New students must declare a course plan approved by an advisor by the end of the second week of classes in the first semester.

CREDITS PER TERM ALLOWED
15 credits

TIME CONSTRAINTS
Master’s degree students who have been absent for five or more consecutive years lose all credits that they have earned before their absence. Individual programs may count the coursework students completed prior to their absence for meeting program requirements; that coursework may not count toward Graduate School credit requirements.

OTHER
Students in the Signal Processing and Machine Learning program are not permitted to accept assistantships.

PROFESSIONAL DEVELOPMENT

GRADUATE SCHOOL RESOURCES
Take advantage of the Graduate School’s professional development resources (https://grad.wisc.edu/pd) to build skills, thrive academically, and launch your career.

PEOPLE

Faculty: Professors Booske (chair), Gubner (vice-chair), Anderson, Barmish, Behdad, Boston, Botez, Davoodi, DeMarco, Farrell, Fawaz, Hagness, Hitchon, Hu, Jahns, Jiang, Jog, Kats, Kim, Knezevic, Lesieutre, Lessard, Li, Lipasti, Ludois, Ma, Mawst, Milenkovic, Nowak, Papailiopoulos, Ramanathan, Roald, San Miguel, Sayeed, Sethares, Severson, Shohet, van der Weide, Van Veen, Velten, Venkataramanan, Wendt, Willett, Yu