ELECTRICAL ENGINEERING

GRADUATE MANUAL

MASTERS & Ph.D. REQUIREMENTS

ELECTRICAL ENGINEERING AND COMPUTER SCIENCE DEPARTMENT
ELECTRICAL AND COMPUTER ENGINEERING

June 2014 Revision
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1. THE EE MASTER’S PROGRAM

The Department of Electrical Engineering and Computer Science has three Graduate Programs: Electrical Engineering (EE), Electrical Engineering: Systems (EE:S) and Computer Science and Engineering (CSE). Each has a Master's Program comprised of several technical areas and each offers two degrees: Master of Science in Engineering (MSE) and Master of Science (MS). The three Master's Programs are governed by similar rules and guidelines. This document describes the rules and guidelines that apply to the EE Master's Programs.

Each program is administered by a Graduate Committee and a Graduate Chair.

1.1 Admissions

Admission to the MSE Program in EE requires the satisfactory completion of an undergraduate engineering degree or the equivalent of the undergraduate Electrical Engineering program at The University of Michigan.

Admission to the MS Program in EE requires the satisfactory completion of an undergraduate degree in a relevant or related area such as engineering, mathematics, or the physical sciences. (A student with an engineering background in the relevant discipline is also eligible for the MS degree if he/she wishes).

1.2 Requirements

1. 30 credits in graduate level courses. Must be approved by the Graduate Chair or designate.

2. At least 24 credits in technical courses. All courses must be graduate level.

3. At least 12 credits in EECS course work at the 500 level or higher; not including seminar, independent research studies or courses from other departments or universities.

4. At least 9 credits from an EE major area; including at least 6 at the 500 level. The selection of courses to meet this requirement must be approved by the Graduate Chair or designate. A list of EE major topics and associated courses is provided in the Approved List of Courses at the end of this manual.

5. At least 6 credits in courses outside one’s own field (subject to Graduate Chair approval).

6. Credits transferred from another university to the Rackham Graduate School transcript may be counted towards any requirement except item 3 above (12 EECS 500 level). UM students can transfer up to 15 credits, non-UM students can transfer up to 6.

7. Equivalent courses taken from another department or university may be counted towards meeting the major area coursework requirement, whether or not they are transferred. This does not reduce the requirements in items 1, 2, or 3. Equivalency must be granted by the Graduate Chair.

8. A Master’s thesis option is available (6 credits must be completed in EECS 698). Students selecting this option can count at most an additional 3 credits of research, seminar, or directed study.

9. A student who does not complete a Master’s thesis can count at most 4 credits in research, seminar and directed study courses toward degree requirements.

10. Students must obtain at least B- for any graded course to be counted towards any Master’s requirement. At least a 3.0 GPA must be maintained overall and in EECS courses.

11. Courses with insufficiently advanced content and level, or which substantially duplicate in content and level courses already completed by the student may not be counted as meeting any Master's requirement.
12. A student must satisfy both the General Master's Degree Requirements of the Rackham Graduate School as specified in Section 7 of the Rackham Student Handbook and the College of Engineering Regulations as specified in the College of Engineering Bulletin.

13. Students must submit a plan of study for approval by the Graduate Chair or designate at the beginning of the first term of enrollment. Any departure must be explicitly submitted for approval by written petition.
### 2. Master’s Degree Plan of Study Template
**Electrical Engineering**

Name (print) ___________________________ Signature ___________________________ Date ________

Email ________________________________ UMID#___________________________________

Admission Date ___________ Advisor’s Signature ___________________________ Date ________

<table>
<thead>
<tr>
<th>Category</th>
<th>Requirements</th>
<th>Level</th>
<th>Course #</th>
<th>Credit Hours</th>
<th>Terms</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Topic of Study</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Check one:</td>
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<td></td>
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<td></td>
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</tr>
<tr>
<td>Applied Electromagnetics</td>
<td>≥ 9 credits total; include ≥ 6 credits at ≥ 500 level</td>
<td>400</td>
<td></td>
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<tr>
<td>&amp; RF Circuits</td>
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<tr>
<td>Integrated Circuits &amp; VLSI</td>
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<td>MEMS &amp; Microsystems</td>
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<td>Optics &amp; Photonics</td>
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<tr>
<td>Solid-State</td>
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</tr>
<tr>
<td><strong>Other EECS courses:</strong></td>
<td>≥ 12 credits total; EECS courses at ≥ 500 level (include above)</td>
<td>400</td>
<td></td>
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<tr>
<td><strong>Directed study, seminar or research</strong></td>
<td>≤ 4 hours (≤ 3 hrs. if thesis elected)</td>
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<tr>
<td><strong>Master’s Thesis</strong></td>
<td>6 credits</td>
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<tr>
<td><strong>Cognate courses, those outside one’s own field.</strong></td>
<td>2 courses; 6 Credits total</td>
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<tr>
<td>See Master’s requirements for definition and instructions</td>
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<tr>
<td><strong>Other technical courses</strong></td>
<td>≥ 24 credits for all technical courses, including above</td>
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<tr>
<td><strong>Non-technical courses</strong></td>
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</tbody>
</table>

**ALL courses must be graduate level**

Total credits (≥ 30 ) _____________

ALL COURSES MUST BE GRADUATE LEVEL
3. The EE Ph.D. Program

The Doctoral degree (Ph.D.) is conferred by the Rackham Graduate School in recognition of marked ability and scholarship in some relatively broad field of knowledge, plus the demonstrated ability to carry out independent research yielding significant original results.

The Doctoral Program proceeds in four stages:

1. Qualification, including doctoral qualification coursework and Doctoral Qualification Exam (Preliminary Exam: Part I).
2. Candidacy, marked by completion of coursework and preliminary research (Preliminary Exam: Part II).

3.1. QUALIFICATION

To qualify for the EE Doctoral Program a student must do the following:

(a) Satisfactorily complete the Doctoral Qualification Coursework, which consists of 4 courses/12 credits minimum of 400-level or higher EECS courses, of which 6 hours must be 500-level or above. In consultation with his/her research advisor the student will submit the list of courses proposed to meet this requirement for approval by the Graduate Chair or designate.

The qualification coursework requirements may be satisfied by transferred credits or “equivalency”. However, at least 9 credits in graded graduate courses must be taken at UM.

(b) Initiate and make satisfactory progress (as determined by the Graduate Chair) in a Research-Oriented Directed Study project or Master's Thesis.

(c) Take the Doctoral Qualification Exam (Preliminary Examination: Part I).

(d) Be accepted by the Doctoral Qualification Committee as qualified for doctoral study. Students who enter the graduate program in the EECS Department with a Bachelor’s degree and who are planning to work toward the Ph.D. are encouraged to plan their Doctoral Qualification coursework in concert with their Master’s degree coursework.

Major Areas

For the Electrical Engineering Program there are five major topics of study:

- Applied Electromagnetics and RF Circuits
- Integrated Circuits and VLSI
- MEMS and Microsystems
- Optics and Photonics
- Solid State

Plan of Study

At the beginning of the first term of enrollment as a pre-candidate, in consultation with his/her advisor, the student will select a Major Topics of study and submit a Plan of Study for qualification and candidacy for approval by the Graduate Chair or designate. The plan of study can be changed. However, any modifications must be submitted for approval.
GPA Requirement

"Satisfactory" performance in the Doctoral Qualification Coursework means that the student must achieve at least a B grade in each course of the Doctoral Qualification Coursework and at least a 3.57 grade point average in the courses he or she selects to satisfy the major topic of study requirement.

The student may take more courses than are necessary and is free to select from the subsets of major topic courses to satisfy the major topic grade requirements for Preliminary Exams Part I and II.

3.2. CANDIDACY

A student will be admitted to Candidacy when the following requirements have been met:

(a) The student has completed all 36 credits of Doctoral Candidacy Coursework; at least 36 credits of relevant graduate coursework beyond the Bachelor's Degree. At least 18 credits must have been earned in EECS courses at the University of Michigan, Ann Arbor; including at least 12 in 500 level courses or above. Credit for individual study, research and seminar courses may not be counted toward the 18 or 36 credit hour requirement. No more than 6 credits of the 36 can be in courses graded with pass/fail.

At least 6 graduate credits must be in areas outside one’s own field (cognates). These courses can be included in the Candidacy credit hour requirement unless an “S” grade was used or the course is non-technical.

Students who enter the Ph.D. with a relevant Master's degree from another school will generally have transferred approximately 18 hours of relevant graded coursework which gives a total of 36 hours when combined with the required 18 hours at UM.

(b) The student has completed a Directed Study (Research) or Master’s Thesis Project.

(c) The student has satisfied all other Rackham Candidacy requirements. These concern items such as residence requirements and cognate coursework outside one’s own field.

3.3. SATISFACTORY PROGRESS

All Ph.D. graduate students must maintain satisfactory progress towards degree, as determined by the Graduate Chair in consultation with the research advisor. The Department may terminate the enrollment of any student who does not maintain satisfactory progress.

3.4 DISSERTATION

3.4.1 The Thesis Proposal Presentation and Dissertation Committee

After admission to Candidacy, it is the responsibility of the student to find an eligible faculty member willing to serve as Dissertation Chair and to propose him/her to the Graduate Committee for approval. In most cases the Dissertation Chair will be the same person who supervised the Directed Study/Master’s Thesis project.

After appointment of the Dissertation Chair, the student will write a dissertation research proposal under the guidance of the Dissertation Chair and give a Thesis Proposal Presentation.

Upon satisfactory completion of the proposal, the student, in consultation with the Dissertation Chair, will recommend a tentative Dissertation Committee to the Graduate Committee. See the Graduate Coordinator for the form that you must complete and submit. The Dissertation Chair (or Co-Chair) will be the Chair (or Co-Chair) of the committee, which shall include at least three other members. The Dissertation Chair, or at least one of the Co-Chairs, must be from the EECS Department. In accordance with Rackham rules, at least one member must be outside EECS Department. Eligibility for service as a Dissertation Chair or as a Dissertation Committee member must be consistent with Rackham
rules. The tentative Dissertation Committee may be changed completely or in part after the Thesis Proposal Presentation if so desired by the student, Dissertation Chair, or the Graduate Committee. The final decision on Dissertation Committee membership is made by the Graduate Committee, which must recommend the Committee to the Rackham Graduate School.

See the Graduate Coordinator for the thesis proposal form that you must complete and have approved by the Graduate Committee. When the Dissertation Committee is formed, the student will submit the dissertation research proposal to the Committee at least two weeks in advance of the Thesis Proposal Presentation.

The student will make an oral presentation of the proposed dissertation research, including relevant background material. During and after the presentation, the Committee will explore the research project with the student in order to provide guidance and make an evaluation of its suitability. They will report to the Graduate Committee one of two results:

(1) The student has presented an acceptable thesis proposal.
(2) The student does not have an acceptable proposal.

In the second case, the student is to take immediate steps to refine the proposal in consultation with the Chair and other Committee members. It is the responsibility of the student to work with the committee, possibly augmented by other faculty members, to obtain an acceptable proposal within the time period given in the Timetable (Section 4).

The Thesis Proposal Presentation requirement is completed when the Dissertation Committee Chair reports a successful proposal presentation to the Graduate Office.

Following acceptance of the Thesis Proposal, the Dissertation Committee is finalized. This must be done within the timetable given in Section 4 for the Thesis Proposal Presentation. The student submits a written request to the Graduate Committee with a proposed committee. Upon approval by the Graduate Committee, its membership is submitted to Rackham for approval. It is expected that the Dissertation Committee will regularly review the student’s progress. Waiting to finalize this committee until just before the Final Oral Defense may result in serious delays of the defense.

A person who is not a member of the graduate faculty of the University of Michigan may serve on the Dissertation Committee with prior approval of the Graduate Committee and the Rackham Graduate School. Such a person must have an earned doctorate or the equivalent. See the Rackham Student Handbook for details about eligibility for the Dissertation Committee.

It is expected that work on the thesis proposal will be done concurrently with the completion of coursework for Candidacy.

3.4.2 FINAL ORAL DEFENSE

Upon completion, the dissertation must receive a written evaluation from each member of the Dissertation Committee and must be defended orally in an open examination before the Committee in accordance with Rackham rules. Following the successful Final Oral Defense, the student must consult with the Dissertation Chair(s) about any changes required by the Committee, and must make these changes before final submission of the thesis to Rackham.
4. TIMETABLE FOR THE Ph.D. PROGRAM

The following time periods include Fall, Winter and Spring/Summer terms. They apply to all students regardless of the term (Fall, Winter or Spring/Summer) in which they begin graduate studies at the University of Michigan. Any departure from the timetable must be explicitly requested by petition to the Graduate Chair.

Students entering the Ph.D. Program with a Bachelor’s degree must

1. Qualify for the Doctoral Program within twenty-five (25) months of entry. (For satisfactory progress students are strongly encouraged to take the Qualification Exam (Preliminary Exam: Part I) within seventeen (17) months.)

2. Complete Preliminary Exam: Part II and achieve Candidacy within 36 months of entry. (For satisfactory progress, Candidacy should be achieved within 32 months.)

3. Complete the Thesis Proposal Presentation within 40 months of entry. (For satisfactory progress, the proposal should be completed within 36 months.)

4. Complete the dissertation and Final Oral Defense within six years of entry. (Under normal conditions the dissertation should take an average of five years from entry to complete.)

Students entering the Ph.D. Program with a relevant Master’s degree must

1. Qualify for the Doctoral Program within seventeen (17) months of entry. (For satisfactory progress, students are strongly encouraged to take the Qualification Exam (Preliminary Exam: Part I) within thirteen (13) months.)

2. Complete Preliminary Exam: Part II and achieve Candidacy within 28 months of entry. (For satisfactory progress, Candidacy should be achieved within 24 months.)

3. Complete the Thesis Proposal Presentation within 32 months of entry. (For satisfactory progress, the proposal should be completed within 28 months).

4. Complete the dissertation and Final Oral Defense within five years of entry. (Under normal conditions the dissertation should take an average of four years from entry to complete.)

Experience has shown that successful doctoral students devote a majority of their time to their academic program. Consequently, this Timetable applies to all students, including those with GSI or GSRA appointments, as well as to students carrying outside obligations. Any departure from the Timetable must be explicitly requested by written petition. Each petition will be reviewed by the Graduate Chair or the Graduate Committee of the EE Program and each decision will be made on the individual merits of the petition. The Department may terminate the enrollment of any student who fails to follow these procedures and the timetable or fails to maintain satisfactory progress.

Students entering the Ph.D. Program who were originally admitted to Masters Program must

1. Qualify for the Doctoral Program within 24 months of entry by passing the Qualification Exam (Preliminary Exam: Part I). Furthermore, he/she must find a research advisor willing to guarantee four years of funding and obtain approval of the program change by the Graduate chair.

2. Complete Preliminary Exam: Part II and achieve Candidacy within 28 months of entry into the Ph.D. Program. (For satisfactory progress, Candidacy should be achieved within 24 months.)

3. Complete the Thesis Proposal Presentation within 32 months of entry. (For satisfactory progress, the proposal should be completed within 28 months.)
4. Complete the dissertation and Final Oral Defense within five years of entry. (Under normal conditions the dissertation should take an average of four years from entry to complete.)

It is strongly recommended that students changing from the Master’s Program to the Ph.D. Program take the Qualification Exam (Preliminary Exam: Part I) during their final semester prior to completing the Master’s Program because students must be currently registered in order to take the Preliminary Exam: Part 1. If the student was registered full-time Fall and Winter semesters for example, he/she should take the exam in January or May.

International students should apply for Optional Practical Training (OPT) if they choose to take the exam in May. This is necessary to ensure continuation of F-1 status in the event that the student fails the exam. Students who pass the January or May exam must apply for admission to the Rackham Ph.D. program before June 1. All students originally admitted to the Master’s Program who pass the Qualifying exam must apply for admission to the Rackham Graduate School as Ph.D. applicants. By applying to the program and finding a practical training job (paid or unpaid), an OPT student who failed the Qualifying Exam in May can stay in the U.S., work during the summer and take the exam a second time in September. In such a case, the applicant must apply for “Non-Candidate For Degree” (NCFD) for one term. Once registered, OPT is terminated but the student can then take the Qualifying Exam. If the student passes the September exam, Rackham Graduate School will issue a new I-20 to start the Ph.D. Program in January. If the student does not pass the exam, he/she must return home at the end of the semester OPT status cannot be continued or renewed.
4.1 Request for Equivalency Form:

REQUEST FOR EQUIVALENCY EVALUATION

Students entering with a Master’s degree must submit a petition for equivalency as part of the planning and counseling process at the beginning of their first term in the graduate program.

Date: ______________

Please complete the information requested below for equivalency evaluation. Use a separate form for each course that you are submitting for evaluation.

Name: ___________________________________ Major: ____________________________
Email: ___________________________ UMID#________________________

1. University where course was taken: _____________________________________________
2. Year & term taken: ____________ 3. Letter grade earned: ______________________
4. Course title: ______________________________________________________________
5. Course number: ______________ 6. Number of weekly meetings: ______________
7. Number of weeks of course duration: __________________________________________
8. Proposed UM equivalent course number: _____________________________________
9. UM faculty member who is teaching course in present term or previous term (time schedules are available on the EECS website with this information): _____________________________

In addition to this form, provide the following:
a) Course outlines or syllabus.
b) Catalog course description.
c) Names of texts used (provide a copy of the text if it is not universally available).
d) Lecture notes, homework problems and tests.
e) Any other material indicative of the coverage and level of the course.
f) A copy of the transcript showing the course and grade. (It does not need to be a certified copy; normally, the EE Graduate Office will have a transcript or copy on file from admissions, but check to be sure).

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For department use only: Circle one.
Equivalent for course no. ______________ is / is not approved.

EE Graduate Chair: ___________________________ Date ______________________
5. Cognate Requirement For the Ph.D. Degree

In order to ensure sufficient breadth of study, the Rackham Graduate School requires graduate students to satisfy a cognate requirement of at least two graduate-level courses for a minimum of two credit hours each in areas outside of one’s own field. Ordinarily, these courses are from departments other than EECS. Because of the diversity of courses within EECS, in rare circumstances it is permissible however to use EECS courses that are not associated with the student’s own program to satisfy the cognate requirement as outlined further below.

For EE Division students, courses in the EE Division are not acceptable as cognates, nor are courses in other EECS divisions if they are associated with the student’s program. All other graduate courses offered by EECS or other departments may be used, although the necessity of obtaining approval of the Academic Advisor must be especially emphasized in the case of cognates. Courses in other departments that are cross-listed with EECS courses associated with the student’s program may not be used for cognates.

Courses taken elsewhere as part of a Master’s degree program or other graduate studies may be used providing they are outside the student’s major area, are of graduate level, appear on the student’s official graduate school transcript and were graded by a letter grade of B (or the equivalent) or higher. These courses do not have to be formally transferred.
## 6. Ph.D. Plan of Study Template

### Electrical Engineering

Name (Print) __________________________ Signature ________________ Date __________

Email: __________________________ UM ID# __________________________

Admission Date _______________ Advisor Approval __________________________ Date __________

Date to Qualify _______________ Date for Candidacy __________________________

Research Advisor Name __________________________ INDI# __________

<table>
<thead>
<tr>
<th>Category</th>
<th>Requirements</th>
<th>Level</th>
<th>Course #</th>
<th>Credit hours</th>
<th>Term</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Topic of Study</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Check one:</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applied Electromagnetics &amp; RF Circuits</td>
<td>Pre-Qualification (Circle courses chosen to qualify, GPA ≥ 3.57, all with grade ≥ B)</td>
<td>Equivalency or Transfer from BSE/MSE (give U-M Course Number)</td>
<td>400</td>
<td>&gt; 500</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrated Circuits &amp; VLSI</td>
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<tr>
<td>MEMS &amp; Microsystems</td>
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<td>Optics &amp; Photonics</td>
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<td>Solid State</td>
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</tbody>
</table>

| Other graded EECS courses not needed for Major topic of study: | |

| Directed study, Seminar or Research (S/U-graded courses) | Do not count these credits toward the hour requirement | |

| Other technical courses (non-EECS): Math, Science, etc., not used for Cognates: | |

| Cognate outside EE Division and Students field of study: | 2 courses | 6 credits total | Course 1 | |
|                                                        |          |                |          | |
|                                                        |          |                |          | |
|                                                        |          |                |          | |

### TOTAL CREDIT HOURS FOR CANDIDACY:

(≥ 18 credits if entering with Master’s degree, ≥ 36 credits if entering with Bach. Degree) Cognates may be counted if technical

| Total credit hours: | |

| Nontechanical courses (credit hours do not count toward the total credit hour requirement) | |

<table>
<thead>
<tr>
<th>Course No.</th>
<th>Credit Hrs</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
7. Course Selection Guide EE Program Master’s & Ph.D. by Major Topic

*Students should select courses each term from the list of offerings associated with their Major Topic or research area. However, you are encouraged to satisfy the most recent revisions of the Graduate Manual and list of approved courses as much as possible. If in doubt, consult your advisor. Ph.D. students are also encouraged to take Tech Com 610 (Dissertation Writing).*

**Topic 1: Applied Electromagnetics and RF Circuits**

**Master’s Degree**

Four courses at the 500 level or above with at least three of the four courses from the approved course list for this Major Topic.

**Ph.D. Degree**

For QUALIFICATION: EECS 530, plus three other courses, with at least two of the three courses from the approved course list for this Major Topic. At least one of the applied EM and RF Circuits courses must be at the 500 level or above.

FOR CANDIDACY: EECS 530, plus five other courses at the 500 level or above, with at least three of the five from the approved course list for this Major Topic. At least two of the Applied EM and RF Circuits courses must be at the 500 level or above, and two other courses must be at the 500 level or above.

**Topic 2: Integrated Circuits and VLSI**

**Master’s Degree**

At least three courses from the list of approved courses for this Major Topic, including at least two courses at the 500 level or above.

**Ph.D. Degree**

For QUALIFICATION: At least four courses from the list of approved courses for this Major Topic, including at least three courses at the 500 level or above.

For CANDIDACY: At least six courses from the list of approved courses for this Major Topic, including four at the 500 level or above.
**Topic 3: MEMS and Microsystems**

**Master’s Degree**

At least three courses from the list of approved courses for this Major Topic, including at least two courses at the 500 level or above.

**Ph.D. Degree**

For QUALIFICATION: At least four courses from the list of approved courses for this Major Topic, including at least three courses at the 500 level or above.

For CANDIDACY: At least six courses from the list of approved courses for this Major Topic, including four at the 500 level or above.

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**Topic 4: Optics and Photonics**

**Master’s Degree**

At least three courses from the list of approved courses for this Major Topic, with two or more courses at the 500 level or above.

**Ph.D. Degree**

For QUALIFICATION: EECS 537 and 538; plus two courses from the approved course list for this Major Topic with at least one of these two courses at the 500 level or above.

For CANDIDACY: EECS 537, 538 and 539; plus at least two courses from the approved course list for this Major Topic with at least one of these two courses at the 500 level or above.

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**Topic 5: Solid-State**

**Master’s Degree**

At least three courses from the approved course list for this Major Topic with two or more courses at 500 level or above.

**Ph.D. Degree**

For QUALIFICATION: EECS 520 and EECS 521 plus two other courses from the approved course list for this Major Topic.

For CANDIDACY: EECS 520 and EECS 521 plus four other courses from the approved course list for this Major Topic. At least two of the four additional courses must be at the 500 level or above.
### 8. Approved List of Courses by Major Topic

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<th>Course Number &amp; Name</th>
<th>Integrat. Circ. &amp; VLSI</th>
<th>Optics &amp; Photo.</th>
<th>Solid-State</th>
<th>App. EM &amp; RF Circuits</th>
<th>MEMS &amp; Microsystems</th>
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