Computer Engineering

Computer Systems and Electrical Engineering Concentrations

Ph.D. Graduate Handbook

2015 - 2016

ARIZONA STATE UNIVERSITY

MANUAL OF THE PH.D. DEGREE IN COMPUTER ENGINEERING

ARIZONA STATE UNIVERSITY

2015 – 2016

Computer Engineering (Computer Systems) graduate degrees please contact:

School of Computing, Informatics, and Decision Systems Engineering
Arizona State University
PO Box 878809
Tempe, AZ 85287-8809
PHONE: (480) 965-3199
E-mail address: cidse.advising@asu.edu
http://cidse.engineering.asu.edu/forstudent/graduate/computer-engineering/

Computer Engineering (Electrical Engineering) graduate degrees please contact:

School of Electrical, Computer and Energy Engineering
Arizona State University
PO Box 875706
Tempe, AZ 85287-5706
PHONE: (480) 965-3424
E-mail address: askee@asu.edu
http://ecee.engineering.asu.edu/programs/graduate-electrical-engineering/

Computer Engineering on the web:
http://more.engineering.asu.edu/cen/

Revised on September 17, 2015

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I. Introduction to the Computer Engineering Program

Computer Engineering is a multi-disciplinary program that builds on the fundamentals of Computer Science, Electrical Engineering, Industrial Engineering and Applied Mathematics. Graduates of this program will have the knowledge and skills necessary to advance the design, system integration, testing, evaluation and deployment of the state-of-the-art hardware and software for systems that include computing, communications and networking (wired and wireless), control functions, sensing, signal processing and actuation.

The Ph.D. program is intended for students with excellent skills in mathematics and physical science that are interested in gaining an in-depth knowledge of the foundational principles of engineering, as they pursue a career in academia, research or highly technical entrepreneurial innovation. The Ph.D. program provides a broader and more in-depth preparation than the M.S. program, in anticipation of a demonstrated ability to independently pursue more creative and substantive innovation with higher impact.

II. Objective of the handbook

The purpose of this handbook is to provide guidance and information related to admission, degree requirements, and general policies and procedures. Please note that in some cases you will find differences between the Graduate Catalog and the Computer Engineering program requirements. In these cases, CE has established higher standards. Students must satisfy both sets of requirements. Please note that policies and procedures are occasionally amended to improve the program. Changes will be communicated to students through e-mail, and posting on the paper and online bulletin boards.

III. Student responsibility

All students are expected to become familiar with university and program policies and procedures and abide by the terms set forth. Information is available both online and by hardcopy upon request. Most importantly you should visit the following websites:

- The Office of Graduate Education – http://graduate.asu.edu - visit the section on policies and procedures.
- The Schedule of Classes – www.asu.edu/catalog
- The Computer Engineering Program – http://engineering.asu.edu/cen/
- The International Student and Scholars Center – https://students.asu.edu/international , if applicable.
- The Ira A. Fulton School of Engineering – http://engineering.asu.edu

IV. Faculty responsibility

The members of the faculty of Computer Engineering have diverse backgrounds and knowledge. They are available to guide you in your plan of study and your educational and career goals. We encourage you to take the opportunity to make individual appointments with faculty members with whom you have common interests. Please refer to a list of the faculty names, areas of expertise, and research interest at the end of this handbook.

V. Admission and eligibility to the doctoral degree program

The Computer Engineering doctoral degree requires a background in computer engineering, computer systems engineering, electrical engineering, and computer science. However, in some cases, students with non-traditional educational backgrounds will be considered for admission. These students may be required to take fundamental courses to better prepare them for the program coursework. A student is encouraged to contact a graduate advisor in the respective concentration Advising Center to obtain advice on their educational pursuits.

Eligibility - Minimum of a bachelor's degree (*or equivalent*) or a graduate degree from a regionally accredited College or University of recognized standing in a related field such as: Computer Engineering, Computer Systems Engineering, Electrical Engineering, and Computer Science.

Application - All students are required to submit an application with the Office of Graduate Education and pay the required fee in order to have their application properly processed.

Application deadlines – December 31 for Fall and August 15 for Spring:
To receive full consideration, we ask that you have all the required documents submitted by the deadline.

GRE scores - Students (International and Domestic) are exempt from taking the GRE who have degrees from an ABET accredited program (from US or overseas institutions) and meet the minimum GPA requirements of the academic units. Students, who do not meet these requirements as outlined, will be required to take the GRE.

English Proficiency - The University requires all international applicants from a country whose native language is not English to provide the Test of English as a Foreign Languages (TOEFL), the International English Language Testing System (IETLS), or the Pearson Test of English (PTE) scores. **Please note that your application will not be processed until the university receives official scores, which are valid two years from the start date of the degree program.** There are some exceptions for students who have been living in the United States and would like to have the English Proficiency waived. Consult the Graduate Catalog under "English Language Requirement" and the Office of Graduate Education website for details. Please address all English Proficiency questions to the Office of Graduate Education.

Personal statement - The application must include a personal statement. The statement should: 1) explain professional goals and reasons for desiring to enroll in the doctorate program; 2) describe any research experiences; 3) indicate personal research interests; **and 4) identify two or three ASU CE faculty with matching research interests.**

Letters of recommendation - CE requires three (3) letters of recommendation, at least one of which must come from former faculty. There is no standard form for letters of recommendation. We encourage letters from people who know you well, such as teachers,

professional associates and supervisors. Ask people who can comment on your academic, emotional, intellectual and professional development.

GPA requirement – Minimum of a 3.00 cumulative GPA (scale is 4.0=A) in the last 60 hours of a student's first bachelor's degree program. A minimum GPA of 3.0 is required in the MS/MSE work for acceptance into the Ph.D. program.

Application evaluation - Several factors are taken into consideration when evaluating a student's application: the student's cumulative GPA, major, institution, personal statement, letters of recommendation, standardized test scores, and performance in individual courses.

Recommended Academic Preparation – Computer Engineering graduate students should have knowledge in the following topics prior to applying for the program at Arizona State University: Computer Architecture & Organization, Algorithms & Data Structures, Digital Signal Processing, Digital VLSI, and Discrete Math.

ASU Recommended Course

CSE 230 – Computer Organization and Assembly Language Programming

CSE 310 – Data Structures and Algorithms

EEE 203 – Signals and Systems I

EEE 335 – Analog and Digital Circuits

MATH 243 – Discrete Math Structures

Notice of Admission - CE submits its recommendation of admission to the Office of Graduate Education and the final notice of admission decision is notified in writing by the Office of Graduate Education. You may check your application status on MyASU(my.asu.edu).

Pre-admission Credits and Transfer Credit – Please refer to the Office of Graduate Education policies and procedures.

VI. Doctoral degree requirements

Degree requirements for the Ph.D. include a minimum of 84 semester hours beyond the bachelor's degree and deficiency courses. Students are allowed up to 30 credit hours from a previously awarded master's degree to count towards the degree requirements for the doctoral program, if approved by the student's supervisory committee.

The Ph.D is comprised of four major milestones which all students are required to pass successfully prior to graduation.

a. Completion of the core and elective coursework
b. Filing an approved Plan of Study

c. Passing the Comprehensive Examination and approval of the dissertation prospectus to advance to candidacy
d. Successful oral defense of an approved written dissertation.

a. Core courses: All incoming students are required to complete the two core courses.

- CEN 501 – Computer Systems I: Circuits to Architectures
- CEN 502 – Computer Systems II: Fundamentals of Algorithms and Optimization Techniques

The combination of CEN501 and CEN502 serves to integrate the required knowledge of electrical engineering and computer science to ensure that all students have the necessary background to pursue advanced study in the areas of computer engineering. CEN501 focuses on circuit and logic design, topics that span the electrical engineering to computer engineering interface. CEN502 begins with computer architecture and focuses on operating systems, compilers, and networking topics that cover the computer science to computer engineering interface. Together this pair of courses provides a common and necessary background for all students in the program to pursue further advanced study in the six areas of the program. As such, these courses must be taken during the first semester of availability.

b. Formulation of the Plan of Study: After successfully completing the core courses, students will be required to develop and submit a Plan of Study through MyASU. A minimum of 84 credit hours are required in the Plan of Study. A maximum of six credit hours of 400 level coursework may be used on an approved POS (400 level courses taken for a grade of Pass/Fail cannot be included on a POS). Courses with grades of "D" (1.00) and "E" (0.00) cannot be included on a POS.

The Plan of Study must have the following required minimum components:

1. Two core courses (6 credit hours) (see previous *Core courses* for details)
2. Elective Courses
   Must have a minimum of 42 credit hour elective courses.
   The elective course in the graduate Computer Engineering program are partitioned into six areas of study, and listed below. These courses will be referred to as Computer Engineering Area (CE-Area) courses.

   The six areas of study are:

   1. VLSI and Architecture
   2. Embedded Control Systems
   3. Communication and Networks
   4. Disturbed, Dependable and Secure Systems
   5. Multimedia and Signal Processing
   6. Systems Optimization

At least **24 credit hours of CE-Area courses** are needed to provide a breadth of knowledge in CE to support an extensive research and dissertation experience.

At least **18 credit hours of other graduate courses** (Graduate courses in Science, Engineering, or Mathematics with the approval of the Computer Engineering Graduate Committee). These courses are intended to provide a level of breadth and depth in basic science and analytical methods well beyond that required for the Masters level.

The above CE area courses must satisfy the following constraints:

- At most 6 credit hours of M*
- At least 12 credit hours of M* or D*

Remaining credit hours can be other graduate courses (Graduate courses in Science, Engineering, or Mathematics with the approval of the Computer Engineering Graduate Committee).

Mandatory Concentration Requirement

The Computer Systems concentration requires the student take 18 total credit hours as follows:

- At least **12** credit hours of graduate level courses in CSE or CEN, and
- At least **6** credit hours of graduate level courses in EEE or CEN.

The Electrical Engineering concentration requires the student take 18 total credit hours as follows:

- At least **12** credit hours of graduate level courses in EEE or CEN, and
- At least **6** credit hours of graduate level courses in CSE or CEN.

Reading and Conference

- At most 6 credit hours of CEN 790 Reading and Conference

Research & Dissertation

- CEN 792 Research or graduate coursework (at least 12 and at most18 credit hours)
- CEN 799 Dissertation (12 credit hours)

400-Level Courses and Cross Listed Courses:

No more than 6 hours of 400-level coursework can be included on the graduate student program of study. No more than 12 hours of cross listed courses (4XX/5XX) can be included on the graduate student program of study. No more than a total of 12 hours of a combination of 400-level and cross listed courses (4XX/5XX) can be included on the graduate student program of study.

NAME: _____

Ira A. Fulton Schools of Engineering
ARIZONA STATE UNIVERSITY

ASU ID: _____

PH.D. in Computer Engineering

☐ Computer Systems (CS) ☐ Electrical Engineering (EE)

6 Core Credits + 42 Elective Credits + 0-6 Reading and Conf. + 12-18 Research + 12 Dissertation + 0-12 Electives = 84 Credit Hours

6 Credit Hours Core Courses

☐ CEN 501 Computer Systems I Semester:_____ Year:_____
☐ CEN 502 Computer Systems II Semester:_____ Year:_____

42 Credit Hours Elective Courses

☐ Select at least **24 credit hours** of courses from the CE-Area of Study to provide a breadth of knowledge in CE to support an extensive research and dissertation experience. Selection of CE-Area courses must satisfy the following constraints:

Select at least **12 credit hours** of courses noted with **M*** or **D*** from the CE- Areas of Study.
Only **6 credit hours** can be courses noted with **M***in the CE-Areas of Study.

- M*or D* Course _____ Area _____ Semester:_____ Year:_____
- M*or D* Course _____ Area _____ Semester:_____ Year:_____
- D* Course _____ Area _____ Semester:_____ Year:_____
- D* Course _____ Area _____ Semester:_____ Year:_____

Remaining credit hours can be other courses from the CE-Areas of Study **(No M* Courses)**

- Course _____ Area _____ Semester:_____ Year:_____
- Course _____ Area _____ Semester:_____ Year:_____
- Course _____ Area _____ Semester:_____ Year:_____
- Course _____ Area _____ Semester:_____ Year:_____

☐ Select at least **18 credit hours** of Science, Engineering, or Mathematics courses, in consultation with your graduate faculty advisor, that are intended to provide a level of breadth and depth in basic science and analytical methods well beyond that required for the Masters level.

- Course _____ Semester:_____ Year:_____
- Course _____ Semester:_____ Year:_____
- Course _____ Semester:_____ Year:_____
- Course _____ Semester:_____ Year:_____
- Course _____ Semester:_____ Year:_____
- Course _____ Semester:_____ Year:_____

CE Areas of Study

VLSI and Architecture – VLSI & A	Distributed, Dependable and Secure Systems – DDSS
Embedded Control Systems – ECS	Multimedia and Signal Processing - MSP
Communications and Networks – CN	Systems Optimization – SO

Ira A. Fulton Schools of Engineering
ARIZONA STATE UNIVERSITY

Reading and Conference

☐ At most 6 credit hours of CEN 790: Reading and Conference

- CEN 790: Credit Hours _____

Research

☐ At least 12 and at most 18 credit hours of CEN 792: Research

- CEN 792: Credit Hours _____

Dissertation

☐ 12 credit hours of CEN 799: Dissertation

☐ A successful oral dissertation defense

Electives - If needed to meet 84 Credits

- Course _____ Semester:_____ Year:_____
- Course _____ Semester:_____ Year:_____
- Course _____ Semester:_____ Year:_____
- Course _____ Semester:_____ Year:_____

Overall Credits

☐ **At least 84 Credits**
☐ **CS: 12 Credits CSE or CEN**
☐ **CS: 6 Credits EEE or CEN**
☐ **EE: 12 Credits EEE or CEN &**
☐ **EE: 6 Credits CSE or CEN**
☐ **CEN 584 Credit Hours (Maximum 2) _____**
☐ **No more than 6 credits 400 level courses**
☐ **No more than 12 credits cross listed courses (5XX/4XX)**
☐ **No more than 12 credits of combined cross listed courses and 400 level courses**

If you are planning to apply credits from a previously earned MS degree, please attach the Computer Engineering Transfer Credit Request Form.

Please use this sheet as a guide when filling out the iPOS. After electronic submission of the iPOS please turn in this sheet, along with your iPOS signed by your faculty advisor, to the appropriate Advising Center:
CS - BYENG 225 EE - Goldwater Center 209.

Academic Advisor: _____	Faculty Advisor: _____

Updated 1/2015 CS

c. Dissertation Supervisory Committee: The role of the supervisory committee is to provide guidance and direction for the student's educational and research plan. As such, the committee must have the necessary expertise to guide and evaluate research in the proposed dissertation area. A minimum of four committee members is required, including the committee chair or two co-chairs. The committee chair or at least one of the co-chairs must be a Computer Engineering Graduate Faculty member. At least two members must be CEN Graduate Faculty members. . The supervisory committee must be approved by the CEN Program Chair and by the Office of Graduate Education prior to taking the Comprehensive Examination.

d. Comprehensive Examination: The comprehensive exam is two part:

- Written exam and
- Oral exam

Your committee chair will advise you of the expectations of the exam. The syllabus for the written exam will be decided by your committee.

The student first makes arrangements with the advisory committee chair to schedule a five-week time period for the examination. Care must be taken to ensure that the entire examination will fall into one of the two regular semesters. **The student is required to bring a Report of Doctoral Comprehensive Examination available on the CIDSE website http://cidse.engineering.asu.edu/academic-advising/graduate-advising/gradforms/ to the oral examination, and after completion of the written examination, the Chairperson should submit the form to the Graduate Academic Advisor Office.**

The five-week period will be spent as follows:

1. The consults the committee members to determine the day the written portion of the exam starts. This has to happen at least two weeks before the start date.
2. The members of the committee will submit written question(s) to the chair of the committee before the start date. These questions should relate to the syllabus decided by the committee
3. The student will have 17 consecutive calendar days to develop written responses to the questions. The candidate should submit one complete, bound set of answers to all questions to each committee member.
4. The oral portion of the examination will be held within two weeks of submission of the written responses. This examination normally lasts about two hours
5. The final Pass/Fail is determined based on the combined responses to written and oral examination questions. A majority vote by the committee and a pass vote by the committee chair are required to pass.
6. Passing the examination makes the student a candidate for the Ph.D. degree. The Office of Graduate Education will inform the student and CE Office when candidacy is granted.

Should a student fail the examination, the advisory committee will decide if and when a retake of the examination is possible. A reexamination may be administered as early as three months and no later than one year from the date of the original examination. Only one retake is allowed.

e. The **Dissertation Prospectus** is a document that introduces the doctoral student's proposed original contribution to the field of computer engineering that will be created through the doctoral research and writing of the dissertation. The prospectus should raise an important issue in the field and discuss the issue's contribution to the discipline. The doctoral student should work with their advisor or co-advisors to prepare the prospectus. . While the format of the proposal is up to the committee chair, the written proposal typically contains:

1. A title page with author's name, committee members' names, institution, and date.
2. A table of contents.
3. An introduction explaining the nature of the research.
4. A clear statement of the research problem.
5. A thorough review of all relevant literature.
6. An argument that the problem is of sufficient relevance and importance to study.
7. A description of the proposed methodology and argument for its acceptability.
8. A statement of the expected contributions of the research.
9. A plan/schedule for completion of the research.
10. A complete bibliography following an accepted style.

Once the prospectus has been approved by the chair of the supervisory committee the students should schedule doctoral prospectus defense. The committee members should be given at least two weeks to review the prospectus.

The oral portion consist of presentation which is open to public and a closed session with the committee members.

The final version of the proposal is a binding agreement between the student and the Committee and will be enforced by the CE Program. Satisfactory completion of the research as outlined in the proposal will result in an approved dissertation. Following approval of the written dissertation, the student must schedule and pass a final oral defense.

f. Doctoral Dissertation Defense:

Dissertation Defense and 10-Day Rule: Defense of a dissertation comprises submission of an approved dissertation followed by its successful oral defense. Students are required to submit a paper based on the dissertation research to a CE-related refereed journal before the final examination. They are strongly encouraged to present a conference paper(s) on their work during the course of the research. These publications are normally jointly written with the advisor and other appropriate faculty. Successful oral defense of the dissertation fulfills the CEN 799 requirement.

Steps to Preparing for Your Defense

Prior to defense:

1. Student should have submitted a paper based on dissertation research to a CE-related refereed journal. Also, a student is encouraged to present work at conference during course of research.
2. Obtain a consensus of approval from the committee chair and the members to proceed with the oral defense.
3. Schedule a date and time with your committee for the oral defense.
4. Important: Ensure that a minimum of 50% of the official committee be physically present at the defense. The Chair must be physically present at the defense. If at least 50% of the committee cannot be physically present, the defense must be rescheduled.
5. Visit the Office of Graduate Education website and MyASU Programs and Degree under the defense tab to become familiar with the dates and deadlines on format approval and oral defense.
6. REVIEW ALL GRADUATION DEADLINES! http://graduate.asu.edu/graddeadlines.html

10 days prior to the defense:

These steps are required to be completed prior to 10 working days from the date of oral defense.

1. Reserve a room for your defense.
    a. CS please see the CIDSE front desk (Brickyard 5th floor).
    b. EE please visit your Graduate Academic Advisor
2. Submit an electronic version of your abstract with title, full names of your committee members, defense date/time/place, and your name as you want it to appear on the defense announcement to your respective concentration advising center.
3. Schedule your defense through your MyASU (my.asu.edu) defense tab.

On the day of the defense:

1. Set-up all your equipment at least one half-hour prior to your presentation to make sure they work.

After the defense:

1. Your committee will discuss the results of the exam with you and may have additional comments for you. At the end, the committee will make a recommendation: Pass, Pass with minor revisions, Pass with major revisions, or Fail.
2. Revisions are normal and must be completed within one year. This includes remaining registered and uploading the finished document on MyASU Format Tools.
3. If you have revisions you must submit a copy of the Doctoral Defense Report Form (Pass/Fail form) to the Office of Graduate Education within 10 working days of the

defense. A copy of the pass/fail form should be submitted to the advising office as well. Your graduate advisor can assist you by emailing the form to the Office of Graduate Education.

4. You must be registered for at least one credit hour graduate level coursework each semester until the final submission of your dissertation.
5. After you have passed the defense and/or completed all revision hand-deliver the original Doctoral Defense Report (Pass/Fail Form) to your respective concentration advising center. The graduate advisor will email the form to the Office of Graduate Education.
6. Upload your dissertation online through ProQuest.

VI. General Information

a. Research standards for publication of dissertation

Graduate research is the study of an issue that is of sufficient breadth and depth to be publishable in a CE-related journal. The effort should reflect a minimum of 1,500 hours of thoughtful work for a dissertation (Ph.D.). The research should follow the 'scientific method' and thus be both objective and reproducible. The dissertation should demonstrate independent, original, and creative inquiry. There should be predefined hypotheses or developmental goals and objectives that are measurable and can be tested. The document should demonstrate proficiency with written English and should conform to the Office of Graduate Education format guidelines.

b. Financial assistance and/or fellowships

The Computer Engineering Program's goal is to provide support to all incoming Ph.D. students. According to the student's academic performance and past academic research, funding offers will be extended to individual students with the highest academic achievements. We encourage students to highlight their past academic achievements in their personal statement and in their resume.

c. Continuous Enrollment and Leave of Absence Policies

Once admitted to a graduate degree program, doctoral students must be registered for a minimum of one graduate credit hour (not audit or undergrad) during all phases of their graduate education. This includes periods when they are engaged in research, working on or defending theses or dissertations, taking comprehensive exams, or in any other way using university facilities or faculty time including the term in which they graduate. This credit must appear on the Plan of Study or must be an appropriate graduate-level course (e.g. 695, or 795, 580, Continuing Registration). Courses with grades of "W" and "X" are not considered valid registration for continuous enrollment purposes.

Students planning to discontinue enrollment for a semester or more must request approval for a leave of absence. Student may petition the Office of Graduate Education for a leave of absence for a maximum of two semesters during their entire program. A petition for a leave of absence, endorsed by the members of the student's supervisory

committee and the head of the academic unit, must be approved by the Office of Graduate Education. This request must be filed and approved before the anticipated absence.

An approved leave of absence will enable students to re-enter their program without re-applying to the university. Students who do not enroll for a fall or spring semester without an approved leave of absence by the Office of Graduate Education are considered withdrawn from the university under the assumption that they have decided to discontinue their program. A Student removed for this reason may reapply for admission to resume their degree program; the application will be considered along with all other new applications to the degree program.

A student on leave is not required to pay fees, but in turn is not permitted to place any demands on university faculty or use any university resources.

d. Maximum Time Limit

Doctoral students must complete all program requirements within a ten-year period. The ten-year period starts with the semester and year of admission to the doctoral program. Graduate courses taken prior to admission that are included on the Plan of Study must have been completed within three years of the semester and year of admission to the program (previously awarded master's degrees used on the Plan of Study are exempt).

In addition, the student must defend the dissertation within five years after passing the Comprehensive Examinations. Therefore, the maximum time limit is the shortest of the following:

1. Time period since initial enrollment (10 year time limit).
2. Time after passing the comprehensive exams (5 year time limit).

Any exceptions must be approved by the supervisory committee and the Office of Graduate Education and ordinarily involves repeating the comprehensive examinations. The Office of Graduate Education may withdraw students who are unable to complete all degree requirements and graduate within the allowed maximum time limits.

e. Registration requirements for research assistants (RA) and teaching assistants (TA)

Students awarded an assistantship within the Ira A. Fulton School of Engineering are required to be registered for at least 12 credit hours. Audit credit hours do not count towards the 12 credit hours.

Students who obtain an assistantship outside the Ira A. Fulton School of Engineering are required to be enrolled a minimum of 6 credit hours. Audit credit does not count towards the 6 credit hours. Enrollment in continuing registration (CEN 795) does count towards the 6 hour requirement.

TAs and RAs are treated as residents for tuition purposes. To be eligible for tuition remission, TAs and RAs must be employed a minimum of 10 hours per week (25 percent Full Time Equivalency {FTE}). TAs/RAs working 10-19 hours per week (25-49 percent FTE) receive a 50 percent remission of tuition for the semester or summer session of their employment. TAs/RAs working 20 hours per week (50 percent FTE) do not pay tuition during the semester or summer session of their employment. In addition, the university pays the individual health insurance premium for those TAs and RAs working 20 hours per week (50 percent FTE).

f. Satisfactory Progress, Academic Probation, Progress probation, and Withdrawal from the CE Program

Each semester, the Computer Engineering Program reviews students' files for satisfactory progress towards completion of the degree. All students are placed on one of the four categories:

1) Satisfactory progress;
2) Academic Probation;
3) Progress probation;
4) Withdrawal from the CE Program.

1. **Satisfactory progress** means that a student does not have any academic and progress probationary issues. In addition to the probationary rules, satisfactory progress includes each semester communication with the student's Committee Chair regarding his/her progress.

2. **Academic Probation** pertains to grades that might affect Program and University policies including graduation. The following are notices/letters you will receive if one of these pertains to your academics*:*
    - GPA below 3.0 in approved POS courses.
    - Overall post baccalaureate (cumulative) GPA below 3.0.
    - Overall graduate (500 level or above) GPA below 3.0.

3. **Progress probation** pertains to issues dealing with making progress towards a degree. The following are notices/letters you will receive if one of these pertains to your academics:
    - Failure to pass the Ph.D. Comprehensive Examination.

4. A student is recommended for **withdrawal from the CE Program** if she or he fails to meet the probationary standards placed upon in the semester mentioned in the probationary letter. The student will receive a letter from the Computer Engineering Program explaining the reasons for the withdrawal. The student will have 5 calendar days from the date of the letter to appeal the decision. The CE Graduate Programs Committee (GPC) will review the case and will make the necessary recommendation. The Graduate Program Chair, on behalf of the GPC, will provide a written explanation of the outcome. If the outcome is favorable, the

student will have to meet all the outlined requirements at the end of the specified period. The student will be required to sign an agreement acknowledging the recommendations and the consequences if the agreements are not met. If the GPC recommends that the appeal is not granted in favor of the student, the Graduate Program Chair, on behalf of the GPC, will recommend to the Dean's Academic Affairs to withdraw the student from the CE Program. The student will then have the opportunity to appeal to the Ira A. Fulton Schools Standards Committee which reviews the student's case and makes the final ruling to Associate Dean and the CE Program. If the appeal is not granted in favor of the student, the Dean's Academic and Student Affairs will recommend to the Office of Graduate Education to withdraw the student from the CE Program. Please refer the Office of Graduate Education website for policies and procedures or contact your respective concentration graduate advisor.

g. Academic Integrity

The highest standards of academic integrity are expected of all graduate students, both in the academic coursework and in their related research activities. The failure of any graduate student to meet these standards may result in serious consequences including suspension or expulsion from the university and/or other sanctions as specified in the academic integrity policies of individual colleges as well as the university.

Violations of academic integrity include, but are not limited to: cheating, fabrication, tampering, plagiarism, or aiding and/or facilitating such activities. At the graduate level, it is expected that students are familiar with these issues and each student must take personal responsibility in their work. In addition, graduate students are expected to follow university guidelines related to the Student Code of Conduct. University policies related to academic integrity and code of conduct are available in the Office of Student Life, or at www.asu.edu/studentaffairs/studentlife/judicial.

h. CEN 584 Internship (Curricular Practical Training)

Curricular Practical Training (CPT) is an academic experience usually obtained at off-campus work settings, allowing the student to apply knowledge and skills gained in various classes. It is intended as a unique, hands-on learning experience to provide students with a number of valuable skills that they can use upon graduation from their graduate degree programs. Accordingly, it is not available to full-time or part-time workers regularly employed by the company where the internship is proposed.

The CPT is available to both domestic and international students. However, international students must work with the International Students and Scholars Center (ISSC) and submit additional documentation to obtain work authorization. Furthermore, international students must include the CPT course CEN 584 (1 credit hour) as an integral part of their Program of Study, reflected by their approved iPOS.

Addition of the CPT course(s) should be done at the initial submission of the student's iPOS during the first semester of study. (Note that each student is required to file an iPOS by the end of his/her first semester of study). Later additions of CPT courses must

be requested and approved at least one full semester (fall, spring or summer) prior to the proposed start date of the internship course. For example, a student planning to do an internship during the summer semester should have an approved iPOS with the internship course before the beginning of classes in the preceding Spring semester. The Internship course cannot be added to an approved iPOS once all coursework has been completed. Exceptions may be made if the internship is relevant to thesis (or dissertation) research.

The Graduate Program Chair will determine the need for a CPT internship in such cases in consultation with the Graduate Academic Advisor. Note that approval of an iPOS with the CEN 584 course confirms that the internship is an integral part of the degree requirements as planned by the student. Hence, students who are not able to fulfill the internship credit requirements in their iPOS are required to replace the course credit requirements through the following options:

- taking a 3-credit hour graduate course,
- signing up for CEN 580 Practicum and being involved in various applied projects at the department with faculty,
- taking a one credit hour of CEN 590 – Reading and Conference (Independent Study).
- taking the 1-credit hour CEN 594 seminar course

In order to be eligible for internship, a student must be in **good academic standing and not have an academic integrity violation** in a course for two full semesters (summer semesters not included) from the initial reporting of the incident. For example, a sanctioned academic integrity violation initially reported on April 15, 2012 will make the student ineligible for this approval until the end of Spring 13 semester.

International students need to be aware of immigration policies and regulations, which may jeopardize their academic status. Hence, it is strongly recommended for international students to consult with the International Students and Scholars Center (ISSC).

All students (domestic and international) may take part in an Out-Of-State internship in the Summer semester. The eligibility requirements for CPT internships remain the same as mentioned.

During the regular Fall and Spring semesters international graduate students in F-1 status must register for a minimum of nine (9) credit hours to maintain full-time status and be enrolled in a minimum six (6) credit hours of in-person, on-campus coursework at the ASU Tempe campus. A maximum of three (3) credit hours of online courses is permitted. The CEN 580 Practicum course will not count as satisfying the student's "physical presence" at ASU. Students will not be able to take part in internships outside the Phoenix metropolitan area. In some cases students may be approved to do an internship in Tucson or other nearby locations to Phoenix, as long as the student is able to prove they can physically attend their courses on campus.

Required documents and forms for the internship proposal must be submitted to the CIDSE Advising Office at least two weeks prior to the beginning of the semester in which the internship is planned. Students will not be able to request late-add registration of the CEN 584 Internship credit to their class schedule after the drop/add deadline of each semester.

An approved proposal is required before commencing the internship. The request will include a statement from the employer that indicates they understand that the work is to satisfy a degree requirement. A sample letter and other required forms are available from the Graduate Advisor. Students must receive approval from their faculty advisor and from the Graduate Program Director before registering for CEN 584. **In order to register for CEN 584, a student must have a CUM GPA of 3.00 or higher.** A final Plan of Study must be filed with the Office of Graduate Education showing the Internship course before registering for CEN 584. All application materials for an Internship must be completed by the last day of regular registration for any semester. The student must take classes appearing on the Plan of Study the semester following the internship.

Renege: (verb) to fail to carry out a promise or commitment
Never accept a job with the intention of turning it down if "something better" comes along. Not only is it inconsiderate and unprofessional, it also reflects badly on Arizona State University and might negatively impact another ASU student's opportunities with that employer. Also, employers communicate with each other and you don't want to get a bad reputation.

After you have given your decision careful consideration and accepted an offer, stop looking. Inform other employers who have extended offers that you have accepted another position. Don't accept further interview invitations or search further. Please refer to NACE's Playing Fair…Your Rights and Responsibilities as a Job Seeker http://www.naceweb.org/playing_fair/ to become familiar with Principles for Professional Practice.

A five-page final report is required before a grade and credit is given. The final report must be submitted to the reporting supervisor for comments and then to the faculty advisor for grade assignment.

i. Optional Practical Training (OPT)

Please visit the International Students Services website for details regarding OPT and Pre-OPT. Students must be in good academic standing and have an approved iPOS.. A student does (Pre-) OPT at their own risk since if the student doesn't graduate in the semester indicated on the iPOS, no letter will be issued by advising to support a later graduation date unless the delay is for reasons beyond the control of the student.

j. CEN 790 Reading and Conference (Independent Study)

Independent study is available for Ph.D. students. The student must get written approval from the supervising faculty outlining the coverage of the content. The Independent Study form must be approved by the Program Chair and will be placed in the student's file.

k. Engineering Student Organizations

There are dozens of engineering student organizations and teams ranging from honors and professional associations to groups creating underwater robots, concrete canoes and launching rockets. Student organizations are excellent opportunities to learn about career possibilities as many of the student groups operate in conjunction with industry professional societies … get involved today!

Please visit http://studentorgs.engineering.asu.edu/ for a list of Engineering Student Organization.

Computer Engineering Areas of Study

1. VLSI – VLSI and Architecture
2. ECS – Embedded Control Systems
3. CN – Communications and Networks
4. DDSS – Distributed, Dependable Secure Systems
5. MSP – Multimedia and Signal Processing
6. SO – Systems Optimization

M*- Content of course is Master level
D* - Content of course is Doctorate level

Course & Prefix	**Course Title (Credit Hours)**	**VLSI**	**ECS**	**CN**	**DDSS**	**MSP**	**SO**
APM 506	Computational methods (3)						X
APM 523	Optimization (Continuous) (D*) (3)						X
CSE 408/598	Multimedia Information Systems (3)					X	
CSE 412/598	Database Management (3)				X		
CSE 420/598	Computer Architecture I (M*) (3)	X					
CSE 430	Operating Systems (M*) (3)				X		
CSE 434/598	Computer Networks, or (M*) (3)			X			
CSE 440/598	Compiler Construction I (M*) (3)				X		
CSE 445/598	Distributed Software Development (3)				X		
CSE 450/598	Design and Analysis of Algorithms (M*) (3)						X
CSE 468/598	Computer Network Security (3)			X			
CSE 509	Digital Video Processing (D*) (3)					X	
CSE 512	Distributed Database Systems (3)				X		
CSE 515	Multimedia Web Databases (3)					X	
CSE 520	Computer Architecture II (D*) (3)	X					
CSE 522	Real Time Embedded Systems (D*) (3)				X		
CSE 531	Distributed & Multiprocessor Operating Systems (D*) (3)				X		

Course & Prefix	Course Title (Credit Hours)	VLSI	ECS	CN	DDSS	MSP	SO
CSE 534	Advanced Computer Networks (D*) (3)			X			
CSE 535	Mobile Computing (3)			X			
CSE 536	Advanced Operating Systems (D*) (3)				X		
CSE 539	Applied Cryptography (3)				X		
CSE 543	Information Assurance and Security (3)				X		
CSE 545	Software Security (3)				X		
CSE 550	Combinatorial algorithms and intractability (M*) (3)						X
CSE 591/551	Foundations of Algorithms (M*) (3)						X
CSE 552	Randomized and Approximation Algorithms (3)						X
CSE 555	Theory of Computation (3)						X
CSE 565	Software Verification, Validation, and Testing (3)				X		
CSE 572	Data Mining (3)				X		
CSE 574	Planning and Learning Methods in AI		X				
CSE 575	Statistical Machine Learning (3)		X				
EEE 404/591	Real-Time Digital Signal Processing (M*) (4)					X	
EEE 407/591	Digital Signal Processing (M*) (4)					X	
EEE 425/591	Digital Circuits and Systems (M*) (4)	X					
EEE 455/591	Communication Systems (M*) (3)			X			
EEE 459/591	Communication Networks (M*) (3)			X			

Course & Prefix	Course Title (Credit Hours)	VLSI	ECS	CN	DDSS	MSP	SO
EEE 480/591	Feedback Systems (M*) (4)		X				
EEE 481/591	Computer Controlled Systems (M*) (3)		X				
EEE 505	Time-Frequency Signal Processing (3)					X	
EEE 507	Multidimensional Signal Processing (3)					X	
EEE 508	Digital Image and Video Processing and Compression (D*) (4)					X	
EEE 509	DSP Algorithms and Software (3)					X	
EEE 511	Artificial Neural Computation (3)		X				
EEE 525	VLSI Design (D*) (4)	X					
EEE 526	VLSI Architectures (3)	X					
EEE 551	Information Theory (D*) (3)			X			
EEE 552	Digital Communications (3)			X			
EEE 553	Coding and Cryptography (3)			X			
EEE 554	Random Signal Theory (D*) (3)					X	
EEE 555	Modeling and Performance Analysis (3)					X	
EEE 557	Broadband Networks (3)			X			
EEE 558	Wireless Communications (3)			X			
EEE 582	Linear System Theory		X				
EEE 585	Digital Control Systems (D*) (3)		X				
EEE 586	Nonlinear Control Systems (3)		X				
EEE 587	Optimal Control (3)		X				

Course & Prefix	Course Title (Credit Hours)	VLSI	ECS	CN	DDSS	MSP	SO
EEE 588	Design of Multivariable Control Systems (3)		X				
EEE 606	Adaptive Signal Processing					X	
EEE 607	Speech Coding for Multimedia Communications			X			
EEE 625	Advanced VLSI Design (4)	X					
EEE 686	Adaptive Control (3)		X				
IEE 533	Scheduling (3)						X
IEE 572	Design of Engineering Experiments (3)						X
IEE 574	Applied Deterministic Operations Res. Methods (3)						X
IEE 575	Applied Stochastic Operations Res. Methods (3)						X
IEE 620	Optimization I (Discrete) (D*) (3)						X
IEE 670	Mathematical Statistics (3)						X

Course Descriptions
For course descriptions please see the course catalog: https://webapp4.asu.edu/catalog/

Appendix I

Computer Engineering Graduate Program
Prospective Student Information and Study Guide

Computer Engineering graduate students should have knowledge in the following topics prior to applying for the program at Arizona State University: Digital VLSI, Discrete Math, Digital Signal Processing, Computer Architecture & Organization, and Algorithms & Data Structures.

For each of the topics there is a suggested book and list of topics along with suggested Chapters from the book in some cases. Note that a student is free to study from any other relevant book on the subject.

Digital VLSI (ASU Course: EEE 335)

Textbook: Digital Integrated Circuits: A Design Perspective by Rabaey, Chandrakasan and Nikolic. Prentice Hall. 2nd edition.

1. Diode -- static and dynamic behavior. (Chapter 3)

2. MOSFET transistor -- static and dynamic behavior. (Chapter 3)

3. CMOS inverter characteristics including switching threshold, propagation delay, power consumption. (Chapter 5)

4. Designing complex CMOS gates, Boolean logic.

EEE 335 Course Textbook: Microelectronic Circuits by Sedra/Smith. 6th Edition

Discrete Mathematics (ASU Course: MAT 243)

Textbook: Discrete Mathematics and Its Applications, Kenneth H. Rosen; Publisher: McGraw-Hill; 7th Ed.

1. Foundations: Logic and Proofs: understand mathematical reasoning and ability to construct mathematical proofs; mathematical induction. (Chapter 1 & 5)

2. Combinatorial Analysis: ability to solve counting problems. (Chapter 6 & 8)

3. Elementary Number Theory: (Chapter 4)

4. Discrete Probability: fundamentals of probability theory, conditional probability, random variables. (Chapter 7)

5. Graph Theory: basics of graph theory including properties of trees. (Chapter 10-11)

6. Boolean Algebra: basics of Boolean algebra, Boolean functions and their representation, minimization of Boolean circuits. (Chapter 12).

Digital Signal Processing (ASU Course: EEE 203)

Textbook: Signals and Systems by Oppenheim, Willsky and Nawab. Prentice Hall 2nd edition.

1. Signals: continuous-time and discrete-time; unit step; unit impulse; sinusoids;

transformations of the time variable. (Chapter 1)

2. Systems: LTI systems -- linearity, time-invariance, causality, stability; impulse response; convolution (graphical as well as analytical); block diagrams, input-output equations. (Chapter 1, 2)

3. Fourier Transform (FT): calculation of forward and inverse transform of simple signals; use FT properties to determine the FT of a transformed signal; frequency response. (Chapter 4)

4. Discrete-time Fourier Transform (DTFT): calculation of forward and inverse transform of simple signals; use DTFT properties to determine the DTFT of a transformed signal; frequency response. (Chapter 5)

5. Sampling: converting a continuous-time signal to a discrete-time signal; sampling theorem. (Chapter 7)

6. z-Transform: calculation of forward and inverse transform of simple signals; region of convergence; properties. (Chapter 10)

Computer Architecture & Organization (ASU Course: CSE 230)

Textbook: "Computer Organization and Design" The hardware software Interface, by David A. Patterson, and John L. Hennessey, 4th edition.

1. Assembly Language Programming: Understand assembly language, and write assembly language programs for simple problems.

2. Procedure Calling Convention: Know about register conventions, including caller saved, callee saved, argument and return value registers. Student should be able to write procedures and recursive functions in assembly language.

3. Data Representation: Understand the data representation (unsigned, 2's complement, and floating point) inside the processor, and perform arithmetic operations on them. An understanding of hardware structures to perform these operations will be a plus.

4. Pipelined Processor Design: Understand the working of a single-cycle, and pipelined processor. Pipeline hazards, and basic techniques on how to avoid them.

5. Memory Hierarchy: Understand the rationale behind the memory organization, and know how caches operate.

6. I/O: Have a basic understanding of storage and I/O.

7. Advanced Computer Architecture: Be aware of the trends in computer organization and design, including superscalar, multi-threading, and multi-core architectures.

Algorithms and Data Structures (ASU Course: CSE 310)

Textbook: Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 3rd Ed.

1. Basics of algorithm design and analysis (Chapter 1 to 3).
2. Divide and Conquer (Chapter 4)
3. Elementary Data Structure, hash tables (Chapter 10,11)
4. Sorting: Heapsort (Chapter 6), Quicksort (Chapter 7), Radix Sort and Bucket Sort (Chapter 8)
5. Searching: Binary Search Trees. (Chapter 12), red-black teees (Chapter 13.1-4)
6. Dynamic Programming (Chapter 15)
7. Greedy Algorithms. (Chapter 16)
8. Minimum Spanning Tree (Chapter 23)
9. Shortest-Path Problems (Chapter 24-25)
10. Elementary Graph Theory (Chapter 22)
11. String Matching (Chapter 32)
12. NP-completeness (Chapter 34)