Computer Engineering

Computer Systems and Electrical Engineering Concentrations

PhD Graduate Handbook

2020 - 2021

Ira A. Fulton Schools of Engineering
Arizona State University

MANUAL OF THE PhD DEGREE IN
COMPUTER ENGINEERING

ARIZONA STATE UNIVERSITY

http://cen.engineering.asu.edu

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Introduction to the Computer Engineering Program

Computer Engineering (CEN) is a multi-disciplinary program that builds on the fundamentals of Computer Science, Electrical Engineering, Applied Mathematics, and Physical Sciences. 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, and signal processing and actuation.

The PhD 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. Students with non-traditional background can also apply provided the student meets the academic preparation. Students lacking the academic preparation will be guided as needed to ensure success in the program. The PhD 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.

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 College's Policies and Procedures and the Computer Engineering (CEN) Program requirements. In these cases, CEN 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 via email and posting on the paper and CEN online website.

Student responsibility and resources

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

- Graduate College- visit the section on policies and procedures.
- The Schedule of Classes
- The Computer Engineering Program
- The International Student and Scholars Center if applicable.
- The Ira A. Fulton Schools of Engineering
- Maintain academic integrity standards per the ASU Student Code of Conduct
- Graduate Wellness Resources" – a one-page guide to Financial, Social, Emotional, and Physical Health and Wellness Resources for ASU Graduate Students, developed by the GPSA
- "10 Best Practices in Graduate Student Wellbeing" – proven ways to help graduate students better care for themselves under the increasing demands of graduate school

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 the list of the faculty names, areas of expertise, and research interest on the Computer Engineering website.

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 prepare them for the program coursework better. A student is encouraged to contact a graduate advisor in the respective concentration Advising Center to obtain advice on their educational pursuits.

Eligibility

A minimum of a bachelor's degree (*or equivalent*) or a graduate degree from a regionally accredited College or University of recognized standing in science, technology, engineering and math (STEM) fields

Application

All students are required to submit an application with Graduate Admission and pay the required fee 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. Students can apply through the Graduate Admission application portal. To receive full consideration, we ask that you have all the required documents submitted by the deadline.

GRE scores

Students who have obtained a degree where the School/College has an ABET accredited bachelor's program are not required to take the GRE.

Students who do not meet these requirements as outlined, will be required to take the GRE. The CEN Program is a highly competitive program and the GRE scores are expected to be commensurate with the high quality of the ASU CEN program. We do not require specific subject GRE scores. The ASU institution code is 4007 if department code is needed use 0000.

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 Language (TOEFL), the International English Language Testing System (IETLS), or the Pearson scores. This program expects scores of at least 90 on the TOEFL, 6.5 on the IELTS, or 65 on the Pearson Test of English as a minimum expectation for admission.

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. If a student has completed coursework in the US, they can contact Graduate Admission to see if they qualify for a waiver. Please address all TOEFL questions to Graduate Admissions. The ASU institution code is 4007 if department code is required use 0000.

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 CEN faculty with matching research interests.

Letters of recommendation

CEN 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. Our current application process allows students to indicate the names and emails of their recommenders. In turn, Graduate Admission sends an e-mail to the recommender alerting him or her to go online and submit a 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

A 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 PhD program.

Application evaluation

Several factors are taken into consideration when evaluating a student's application including but not limited to the student's cumulative GPA, major, institution, personal statement, letters of recommendation, standardized test scores, performance in individual courses, skills, and research experience.

Recommended Academic Preparation

Computer Engineering graduate students should know the following topics before applying for the program at Arizona State University: Computer Architecture & Organization, Algorithms & Data Structures, Digital Signal Processing, Digital VLSI, Discrete Math, and Random Signal Analysis. Additional prerequisites may be required these recommended courses,

ASU Recommended Courses (see Appendix I)

- CSE 230 – Computer Organization and Assembly Language Programming
- CSE 310 – Data Structures and Algorithms
- EEE 203 – Signals and Systems I
- EEE 350 – Random Signal Analysis
- MAT 243 – Discrete Math Structures

Notice of Admission

Computer Engineering submits its recommendation of admission to Graduate Admission. The final notice of admission decision is posted by Graduate Admission on MyASU.

Pre-admission Credits

Please refer to Graduate College's policies and procedures.

Transfer Credit

Only approved graduate-level CEN area courses taken at ASU can be applied towards the CEN Mandatory Concentration Degree Requirement. Up to 30 credits can be applied towards electives for students who already obtained a graduate MS 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. Degrees obtained in fields other than mentioned here will have to be evaluated and approved by the Program Chair and the Office of the Graduate College. Please consult with your area academic advisor to get the process started **after** enrolling in the CEN program.

Doctoral degree requirements

Degree requirements for the PhD include a minimum of 84 semester hours beyond the bachelor's degree. 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 and the Program Chair.

The PhD is comprised of several milestones, which all students are required to pass successfully before graduation.

- Filing an approved Plan of Study
- Completion of the core, area, and elective coursework along with research and dissertation credits.
- Passing the Qualifying Exam.
- Passing the Comprehensive Examination and obtain approval of the dissertation prospectus to advance to candidacy.
- Successful oral defense of an approved written dissertation.

Formulation of Plan of Study

In the first year of the study at ASU, each student must formulate and submit an official plan of study (iPOS). The plan of study should satisfy the degree requirement as described in this handbook. Coursework completed that is not listed in the approved course list or has not had a prior approval may not count toward a student's degree requirements if the coursework does not satisfy the degree requirements as described in this handbook. Students must list a faculty chair or co-chairs and obtain their approval before submission of the initial plan of study. All iPOSs must have the approval of the Program Chair and the Graduate College Associate Dean.

The plan of study may be amended as the student progresses through the program with the approval of the student's faculty advisor and the CEN Program Chair.

Courses with grades of "D," "E," "W," and "I" cannot be included on an iPOS and should be replaced with another course or complete the course with the grade is "I" within one year from the date the grade is posted. A check sheet can be found on the CEN website as a guide when creating the iPOS. The check sheet must be submitted to the advising office for approval along with the electronic submission of the iPOS.

Internship courses do not count toward the degree 84-credit requirement.

Core courses

There are 6 credit hours required core courses for the PhD in Computer Engineering

- CSE 551 – Foundations of Algorithms (3)
- EEE 554 – Random Signal Theory (3)

All students are required to take the core courses, CSE 551 Foundations of Algorithms and EEE 554 Random Signal Theory in their first two semesters. Students in the Computer Systems Concentration (CEN-CS) are required to take CSE 551 in their first semester. Students in the Electrical Engineering Concentration (CEN-EE) are required to take EEE 554 in their first semester. These courses have a pre-requisite of CSE 310 for CSE 551 and EEE 350 for EEE 554. If students are deficient in CSE 310 or EEE 350, they may choose to take these prior to registering for the advanced graduate level courses. CSE 310 and EEE 350 will not count towards degree requirements. Students are encouraged to consult an academic advisor to ensure they meet the minimum pre-requisites.

CEN Area courses

Total credits hours for program area courses:

- minimum of 12 credit hours. (Approved transfer courses can count towards the area courses)

The five (5) area courses in the graduate Computer Engineering program are listed in the table located on the CEN handbooks website. These courses will be referred to as Computer Engineering Area (CEN-Area) courses.

- **Concentration requirement is met by taking the correct prefix courses from the CEN Area course list for your degree concentration.**
    - CEN-CS Concentration: 9 credits CSE or CEN and 3 credits EEE or CEN
    - CEN-EE Concentration: 9 credits EEE or CEN and 3 credits CSE or CEN

The five (5) areas of study are:

1) Autonomous Systems and Robotics (ASR)
2) Communication and Networks (CN)
3) Distributed, Dependable and Secure Systems (DDSS)
4) Multimedia and Signal Processing (MSP)
5) VLSI, Architecture, and Embedded Systems (VAES)

Elective Courses

0- 30 credits of electives selected from an approved list of elective courses or CEN Area Courses. The combined set of area courses and elective courses should be chosen to ensure the student has adequate preparation to pursue research in the chosen area of the thesis.

- 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 combined 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 combined courses (4XX/5XX) can be included on the graduate student program of study.
    - All 400-level and combined (4XX/5XX) courses count towards elective credits.

Reading and Conference (CEN 690 and CEN 790) – Maximum 18 credit hours.

CEN 690 can be used as area coursework if needed and deemed appropriate by the student's faculty and the Graduate Program Chair. CEN 790 can be used as elective credits. Combined students cannot register for more than 18 credit hours of Reading and Conference.Reading and conference can be taken once a semester for a maximum of 3 credits each. Students are required to submit the required form and override request.

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. After completion of the independent study, the student needs to submit a written report to the faculty supervising the independent study. Once the report is approved by the supervising faculty, the report and the independent study grade form need to be submitted to the student's assigned advising staff to be given to the CEN Program Chair for review and approval.

Research credits (CEN 792)

24 credit hours of Research (CEN 792)

Dissertation credits (CEN 799)

12 credit hours of Dissertation (CEN 799)

Supervisory Committee

During the first semester in the PhD program, the student must select a faculty advisor who has the right to chair from the Computer Engineering Program Graduate Faculty. The list of faculty members is available at CEN Website and Graduate College.

At least one semester before taking the Qualifying Examination, the student must form a graduate supervisory committee. The chair of the committee will be the PhD faculty advisor who directs the student's research program. 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 one of the co-chairs must be a Computer Engineering

Graduate Faculty member with the right to chair. At least two members must be CEN Graduate Faculty members. The fourth member can be a CEN Graduate Faculty member or an outside member of the CEN Graduate Faculty. The supervisory committee must be approved by the CEN Program Chair and by Dean of Graduate College before taking the Qualifying Examination.

Qualifying Exam

Every student who wishes to pursue the PhD in Computer Engineering must pass a Qualifying Examination. Because the PhD is primarily a research degree, the Qualifying Examination is designed to test the candidate's research skills and abilities. The exam consists of a written research paper and an oral presentation of the research paper to the graduate supervisory committee. The research topic will typically be chosen by the student in collaboration with the committee chair and the graduate supervisory committee. More specifically, the research paper will typically present a state-of-the-art survey of the student's research topic area. The survey should give a comprehensive overview of the existing prior research in the topic area and identify the limitations of the existing approaches in the topic area. Ideally, the survey should present a coarse outline of avenues for addressing the identified limitations through original research that will later form the core of the PhD dissertation. A well-done survey can form the basis for the related work chapter of the PhD dissertation.

Students initiate their exam in collaboration with their supervisory committee. The supervisory committee, and the chair in particular, will guide the student regarding the content of the written and oral exam. The student will need to prepare a paper to the committee chair's specifications and send it to the committee at least 2 week prior to the exam. The student needs to coordinate with the committee to find a date, time, and location that is acceptable for all parties. The student needs to work with their advising office to reserve a conference room. After the exam, the student must submit the form with the required signatures and a copy of the written portion of the exam to their advising office. This can be submitted in person or via email.

The student should take the exam before the end of the **fourth semester** in attendance at ASU as a PhD candidate. If a student does not wish to take the exam according to the above schedule but wishes to continue in the program, he/she must petition the Graduate Program Chair for permission to take the exam at a later date. Petitions must be received well in advance of the required exam date. There is no guarantee that the Graduate Committee will approve such requests. If the student does not have a supervisory committee, they still must petition to delay taking the exam. In this situation, the Graduate Program Committee will review the petition. If a petition to delay the qualifying exam is denied, this constitutes as failure of the exam and therefore will result in removal of the program.

Students completing a Master of Science degree in computer engineering at ASU can combine the MS oral defense with the qualifying exam. When a student plans on remaining within the same area after completing their MS degree at ASU, the qualifying examination may be taken simultaneously with the final oral defense of the MS thesis. Assuming that the graduate supervisory committee advisor is not changed, this exam will be supervised by the MS committee. These members may, or may not, be part of the doctoral graduate supervisory

committee. If the doctoral advisor is not part of this committee, the advisor should be added to the committee. The graduate supervisory committee will be formed when the student's official program of study is filed.

The result of the exam is a pass or fail. A passing result indicates that the committee believes that the student is capable of doctoral research. A failing result indicates that the committee believes that the student is incapable of conducting the level of research required for the PhD. Therefore, students who fail the exam will be removed from the program. Only one exam is allowed. The student must submit their report to their committee 10 working days in advance. Once the exam is completed, the student must submit the form (which can be found on our website) and a copy of their report to their assigned academic advisor.

Comprehensive Exam and Dissertation Prospectus

The purpose of the doctoral comprehensive examination and dissertation prospectus is to address critical areas of the student's research topic and to ensure the research design and methods aligns well with the intended subject. The comprehensive exam consists of two components: an oral and a written component. The exam is typically completed in the 3rd year or the 6th semester of study at ASU for PhD students with a previously awarded MS degree, and by the 4th year or the 9th semester of study at ASU for Direct PhD students. The Comprehensive Exam **takes approximately six weeks**. A student should plan in advance and must ensure that he/she is registered at all times in at least one credit graduate level course (e.g. 580, 792, 795, or 799). This includes if either part of the written or oral portion of the comprehensive exam will be held in summer.

Important! Check List prior to starting the Comp Exam:

1. Interactive Plan of Study (iPOS) must be approved.
2. All committee members must be listed in the iPOS.
    a. Please see the Dissertation Supervisory Committee section (page 9) regarding requirements and paperwork.
    b. The committee request must be requested and approved electronically through the iPOS tab on your MYASU to start your comprehensive exam.
3. A student must be in good academic standing regarding GPA requirements prior to taking doctoral comprehensive examination

The examination is administered by the student's graduate supervisory committee after the student has essentially completed courseworkThe comprehensive examination will be given by the four members of the supervisory committee. The student must pass the written portion of the exam before proceeding to the oral portion. Each committee member grades and reports the results of the written component to the chair of the of comprehensive examination committee who in turn reports them to the whole committee. The student has 10 business days to prepare the written portion of the exam. The written component will be composed of a background paper on the area of research and includes the current status of this area, a summary of work the student has already done, and a thesis proposal (dissertation prospectus). The oral component will be an examination of the contents of the paper in general and thesis proposal in particular. The oral portion consists of a presentation which is open to the public and a closed session with the committee members.

The student is required to bring a Doctoral Comprehensive Examination form available on the Computer Engineering website to the oral examination. Following the completion of the exam, the completed Doctoral Comprehensive Examination form must be returned to the student's assigned advising staff to be given to the CEN Program Chair.

Retaking the exam

The PhD in Computer Engineering program requires students to pass certain milestones, which are listed below:

1. The Qualifying Exam
    a. Written
    b. Oral
2. The Comprehensive Exam
    a. Written
    b. Oral
3. Prospectus
    a. Written
    b. Oral

Failure of the qualifying exam, the comprehensive examinations and the dissertation prospectus is considered final unless the supervisory committee and the Graduate Program Chair recommend, and the Dean of the Graduate College approves, a re-examination. A student who fails any portion of the Comprehensive Exam is not allowed to proceed to the next examination portionA reexamination of the failed portion must be petitioned and approved by the Graduate Program Chair and the Dean of the Graduate College. A re-examination may be administered no earlier than three months and no later than one year from the date of the original examination. Only one re- examination is permitted.

The student will be advanced to candidacy by Graduate College after passing both the comprehensive exam and successfully defending the dissertation prospectus.

The final committee-approved version of the dissertation prospectus (thesis proposal) that is included in the written part, is a binding agreement between the student and the supervisory committee and will be enforced by the CEN Program. Satisfactory completion of the research as outlined in the prospectus will result in an approved dissertation. Following approval of the written dissertation by the supervisory committee chair, the student must schedule and pass a final oral defense.

Dissertation and Oral Defense

A student is expected to become an active participant in a research program during the first semester of study in the PhD program. The research leading to a dissertation is performed under the direction of the supervisory committee. The candidate must register for a total of at least 12 - 24 credits of Research (CEN 792) and 12 credits of Dissertation (CEN 799). Credits for Research (CEN 792) will be graded with options of, E, Z, or Y. A grade of Z indicates satisfactory progress and is at the discretion of the dissertation advisor. Such a grade may later be changed to a letter grade or left on the permanent record. The Y is the usual grade for Research. The Z grade is typically used for Dissertation (CEN 799) credits until you complete your dissertation defense. When the dissertation is satisfactorily completed, a grade of Y is given for

successful completion of the dissertation and for passing the oral dissertation defense. If a student does not complete the dissertation, the dissertation advisor may assign a failing grade of E for CEN 799.

Students are required to submit at least one paper based on the dissertation research to a CEN-related refereed journal before the final examination. They are strongly encouraged to present a conference paper(s) on their work during their research. These publications usually are jointly written with the advisor and other appropriate faculty.

Upon completion of the dissertation, the student must successfully defend it by passing the oral defense. The defense can be scheduled as early as receiving the candidacy. Also, once the dissertation is approved by the chair or co-chairs of the supervisory committee, the student must submit the dissertation to Graduate College for format review at least 10 calendar days before the oral defense date. No exceptions to this rule will be made. In addition, the dissertation must be delivered to all committee members at least 10 calendar days before the oral defense. The oral defense must be scheduled through Graduate College **10 working days in advance**. The PhD Dissertation Chair and the committee will receive an electronic copy of the pass/fail form from Graduate College.

The student is required to bring a list of archival publication form available on the Computer Engineering website to the oral examination. The publication form must be signed by the PhD committee and returned to the student's advising staff to be given to the CEN Program Chair. The pass/fail form should be submitted to Graduate College following the instructions they provided.

Successful dissertation defense of the dissertation fulfills the CEN 799 grading requirement.

Steps to Preparing for Your Defense

Detailed instructions can be found on the Graduate College website.

Prior to defense

1. Obtain a consensus of approval from the committee chair and the committee members to proceed with the oral defense.
2. The chair or one co-chair must be physically present at the defense. If this is not possible, the defense must be rescheduled. The student cannot submit a committee change after the defense is scheduled.
3. A minimum of 50% of the student's official committee must be physically present with the student at the defense. If at least 50% of the committee cannot be physically present, the defense must be rescheduled. This is true if you are doing it virtual.
4. Schedule a date and time with your committee for the oral defense.
5. Visit the Graduate College website to familiarize yourself with the dates and deadlines on format approval.

10 calendar days prior to the defense

Submit a draft of the dissertation to Graduate College following the instructions on the Graduate College website.

10 working 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. Contact your respective concentration advising center for help with the room reservation. CS Concentration students please contact Monica Dugan. EE Concentration students please contact your chair's administrative support person.
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 to the individual scheduling the room reservation.
3. Schedule your defense through your iPOS.

On the day of the defense

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 have comments and a discussion with you. At the end of the discussion, the committee makes a recommendation: Pass, Pass with minor revisions, Pass with major revisions, or Fail.
2. A fail at the oral defense level is final.
3. You must be registered for at least one credit hour of graduate level coursework each semester until the final submission of your thesis. Revisions must be completed within one year from the date of the defense.
4. After you have passed the defense and/or completed all required revisions, your committee chair should sign part D on your Pass/Fail e-form.
5. Upload your thesis online through ProQuest.

General Information

Masters in Passing

The CEN program awards a master in passing (MIP). Students can request to obtain an MS in Computer Engineering if the students can meet the criteria. The student cannot already have an awarded master's degree that is being used towards their PhD degree requirements.

Eligibility requirements:

- Have an approved iPOS and have not listed previously awarded master's degree in the iPOS.
- Pass the PhD Qualifying Exam

- File the MIP form https://graduate.asu.edu/forms (consult your academic advisor)
- File an MS in CEN iPOS
- File for graduation for MS in CEN degree

Research standards for publication of the dissertation

Graduate research is the study of an issue that is of sufficient breadth and depth to be publishable in a CEN-related journal. The effort should reflect a minimum of 1,500 hours of thoughtful work for a dissertation (PhD). 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 in written English and should conform to Graduate College format guidelines. For more information on format guidelines, please visit the Graduate College website.

Financial assistance and fellowships

The Computer Engineering Program's goal is to provide support to all incoming PhD 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 statement and their resume.

Continuous Enrollment and Leave of Absence Policies

Once admitted to a graduate degree program or graduate certificate program, students must be registered for a minimum of one credit hour during all phases of their graduate education, including the terms in which they are admitted and graduate. This includes periods when students are engaged in research, conducting a doctoral prospectus, working on or defending theses or dissertations, taking comprehensive examinations, taking Graduate Foreign Language Examinations or in any other way utilizing university resources, facilities or faculty time.

Registration for every fall semester and spring semester is required. Summer registration is required for students taking examinations, completing culminating experiences, conducting a doctoral prospectus, defending theses or dissertations or graduating from the degree program.

To maintain continuous enrollment, the credit hour(s) must:

- Appear on the student's Interactive Plan of Study, OR
- Be research (792), dissertation (799), or continuing registration (795), OR
- Be a graduate-level course.

Grades of "W" and/or "X" are not considered valid registration for continuous enrollment purposes. "W" grades are received when students officially withdraw from a course after the drop/add period. "X" grades are received for audit courses. Additionally, students completing work for a course in which they received a grade of "I" must maintain continuous enrollment as defined previously. Graduate students have one year to complete work for an incomplete grade;

if the work is not complete and the grade changed within one year, the "I" grade becomes permanent and will remain on the students' transcripts. Additional information regarding incomplete grades can be found at https://www.asu.edu/aad/manuals/ssm/ssm203-09.html.

Leaves of Absence

Graduate students planning to discontinue registration for a semester or more must submit a *Leave of Absence* request via their iPOS. This request must be submitted and approved before the anticipated semester of non-registration. Students may request a maximum of two semesters of leave during their entire program. Having an approved *Leave of Absence* by the Graduate College will enable students to reenter their program without re-applying to the university.

Students who do not register for a fall or spring semester without an approved Leave of Absence are considered withdrawn from the university under the assumption that they have decided to discontinue their program. Students 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.

Students with a Graduate College approved *Leave of Absence* are not required to pay tuition and/or fees, but in turn are not permitted to place any demands on university faculty or use any university resources. These resources include university libraries, laboratories, recreation facilities or faculty and staff time.

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 before admission that are included on the iPOS must have been completed within three years of the semester and year of admission to the program.

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

Students awarded an assistantship within the Ira A. Fulton Schools of Engineering are required to be registered for 12 credit hours (no more, no less). Audit credit hours do not count towards the 12 credit hours.

Students who obtain an assistantship outside the Ira A. Fulton Schools of Engineering are required to follow the policy of the unit that hires them.

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's health insurance premium for those TAs and RAs working 20 hours per week (50 percent FTE). The student is responsible for fees other than tuition.

Satisfactory Progress, Academic Probation, Progress probation, and Withdrawal from the CEN 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:

Satisfactory progress

Satisfactory Progress means that the student does not have any academic and progress probationary issues. In addition to the probationary rules, satisfactory progress includes communication each semester with the student's faculty advisor regarding his or her progress.

Academic Probation

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 iPOS courses.
- Overall post-baccalaureate (cumulative) GPA below 3.0.
- Overall graduate (500 level or above) GPA below 3.0.

Progress Probation

Progress Probation pertains to issues dealing with making progress towards a degree. The following are notices/letters, to name a few, a student may receive if one of these pertains to the student's academics:

- Failure to file an iPOS by end of the 1st year.
- Failure to complete core courses within the first year of study
- Failure to complete the Qualifying Exam in a satisfactory time (as determined by the Graduate Program Chair or supervisory committee)
- Failure to pass the Qualifying Exam (including petitions to delay the exam that are denied)
- Failure to pass the Comprehensive Examination or the dissertation prospectus
- Failure to make satisfactory progress towards completing the dissertation, this includes maintaining regular contact with your dissertation committee chair.
- Failure to maintain regular contact with your Dissertation Chair on your research.

Removal from the Program

A student is recommended for removal from the CEN Program if he/she fails to meet the probationary standards placed upon him/her in the semester mentioned in the probationary letter. The student will receive a letter from the Computer Engineering Program explaining the reasons for the removal. The student will have 5 calendar days from the date of the letter to appeal the decision. The Computer Engineering 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 requirements 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 of Academic Affairs to remove the student from the CEN Program. The Ira A. Fulton Schools Standards Committee reviews the student's case and makes the final ruling to the Associate Dean of Graduate College and the CEN Program. If the appeal is not granted in favor of the student, the Dean of Academic and Student Affairs will recommend to Graduate College to remove the student from the CEN PhD Program. Graduate College makes the final decision to dismiss the student from the program. If the appeal is granted in favor of the student, the Dean of Academic and Student Affairs will recommend to the unit to continue in the program whereby the student will have to meet all the outlined requirements at the end of the specified period.

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. Also, 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.

CEN 584 Internship (Curricular Practical Training)

Internship (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 some 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 internship (CPT) is available to both domestic and international students. International students need to be aware of immigration policies and regulations, which may jeopardize their academic status. It is strongly recommended for international students to consult with the International Students and Scholars Center (ISSC). Students will be required to submit the required documentation to obtain work authorization from ISSC.

The internship (CPT) experience (up to three 1-credit CEN 584) must be included as part of the student's Program of Study. It is highly recommended that the internship (CPT) course(s) be listed at the initial submission of the student's iPOS during the first semester of study.

Internship (CPT) should occur prior to the student completing the required 84 hours. CPT cannot be the only course remaining in the last semester of study. An 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 the student's dissertation research. The Graduate Program Chair will determine the need for a CPT internship in such cases in consultation with the Graduate Academic Advisor.

To be eligible for internship all students must be in good academic standing. Please refer to your department's specific policies and procedures for CPT processing.

All students (domestic and international) can participate in an out of state or an in-state internship, full time or part-time in the summer semester if **ALL**[1] their GPA's are at least 3.0.

Students with all GPA's between 3.0-3.24 may participate in an in-state internship, part-time only in the fall and spring semesters.

Students with all GPA's 3.25 or higher may participate in an out of state or in-state internship, part-time or full time in the fall and spring semesters.

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 an ASU campus. A maximum of three (3) credit hours of online courses is permitted.

Internships cannot start before the semester or session students enroll in the CPT credit (CEN 584). For example, if you are interested in doing an internship in the summer semester, you cannot start working until the summer semester officially starts (1st day of classes). Exceptions are given to students who provide proper justification from the company supporting this request.

Internship end dates can be the last day of classes or continue until the day before classes start in the following semester (unless it is the student's final semester - contact your academic advisor). Refer to the Academic Calendar for semester start and end dates.

Required documents and forms for the internship proposal must be submitted to the respective CEN concentration advising office two to three weeks before 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 registration request form and employer letter are required before beginning the internship. The employer letter will include a statement from the employer that indicates they understand that the work is to satisfy a degree requirement. The required forms are available on the Computer Engineering website. Failure to submit all required documents will result in a failing grade. Students must receive approval from their faculty advisor and the Graduate

[1] ALL GPA includes: Plan of study GPA (courses listed in the iPOS), Graduate (500-level) GPA, and CUM GPA (all courses taken after starting post-baccalaureate).

Program Chair before registering for CEN 584. To be eligible to register for CEN 584, a student must meet the GPA requirements mentioned in the internship section of this handbook.

Renege Policy

Renege: (verb) to fail to carry out a promise or commitment.

It is unethical for students to continue to seek or consider other employment opportunities once an offer has been accepted. CIDSE and ECEE expect students to honor an acceptance and immediately stop all employment seeking activities.

Never accept a job with the intention of turning it down if "something better" comes along. Not only is it inconsiderate and unprofessional, but 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" to become familiar with Principles for Professional Practice.

Students who accept an offer from an organization and later renege the offer will be prohibited from requesting future internship opportunities pending a meeting with the Assistant Director.

Required report

A two-page typed minimum final report is required before a grade, and credit is given. The final report must be submitted to the internship supervisor for comments and then submitted for evaluation. Students should follow the submission instructions on the CEN internship webpage.

Engineering Student Organizations

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 the Engineering Student Organizations website for a list of student organizations you can join.

Instructional Concerns and Course-Related Complaints

Being part of a large university creates opportunities to learn from a diverse instructor population with different teaching styles and modalities for delivering course content. Courses are offered by a diverse set of faculty including those who are research intensive, those whose primary responsibility is teaching, and part-time faculty who are working in the field. Based on enrollment or modality of the offering, faculty may also be supported by graduate student teaching assistants and graders. This diverse higher education delivery platform may differ significantly from the high-school experience, and while it provides an opportunity to expand the student's ability to learn and develop problem-solving skills, concerns and conflicts with requirements and instructors may occasionally arise. CEN students with instructional concerns should review and adhere to the following guidelines for attempting to resolve their issues. First

and foremost, keep in mind that the faculty and advising staff are experienced, dedicated educators that are here to help you achieve your educational goals but at the same time they have a responsibility to ensure standards are maintained and student outcomes are achieved before graduation. The university culture recognizes the value of diversity in multiple dimensions as well as the presumption of expertise and academic freedom of the faculty.

Communicate with your Instructor

If you have a difference of opinion with your instructor or teaching assistant (TA) or have concerns about technical or administrative aspects of the course, visit the instructor or TA during office hours or contact them via email (if you cannot visit them during the office hours). Express your concerns clearly and respectfully and ask for help. Be sure to provide succinct information about what you have trouble understanding in the course or your concern. Instructors and TAs are here to help. Please remember that you are responsible for pre-requisite knowledge/skills required for a course and regularly studying the material taught in the course. The teaching staff may not be able to help you with your problem if you lack in the pre-requisite knowledge/skills or have not been keeping up with the course material. As a guideline, you should be spending three hours studying every week for each hour of course credit. Thus, you should schedule 8-10 hours of time each week to devote to each 3-credit course. In addition, make sure to resolve the issues as soon as they occur and maintain all documentation. For example, if the assignment instructions are not clear, get the clarification on the day the assignment is assigned and do not wait until the deadline of the assignment.

If, after communicating with your instructor or TA, you are still having problems in the course, connect with your academic advisor to understand your options moving forward.

Connect with your Graduate Program Chair

If you are unable to resolve the concern after initial contact with the instructor or the TA, and you have met with your academic advisor, you should then connect with the Computer Engineering Program Chair (or the department offering the course). The Graduate Program Chair will confer with the instructor and/or TA to better understand the concern and try to resolve the problem. Please note that before meeting with the Graduate Program Chair you should have made a reasonable effort to meet with the course instructor (not just the TA) and get the issue resolved. When contacting the Graduate Program Chair provides all the relevant details such as the course syllabus, assignment handout, email exchange with the instructor, etc. so that the Graduate Program Chair can promptly act on your concerns. Please be brief and precise in the description of your concerns. In some cases, the Graduate Program Chair would like to meet you. When coming for the meeting, please bring along all the relevant documents.

If the instructional concern is not resolved with the Graduate Program Chair or the department offering the course, contact the Associate Dean of Academic Affairs office for the college offering the course for assistance.

Remain Focused

When faced with instructional concerns, it is important to remain focused on the rest of the course while addressing specific areas that are under review. Be sure to stay connected with your academic advisor if there are any changes in your situation.

NOTE:

- Misrepresentation of facts or disrespectful behavior when confronting your instructor or teaching assistant is considered an academic integrity violation.
- Maintain all documentation.
- Act proactively and promptly.

In Summary, Guidelines for Avoiding Problems

- Be sure you have the necessary prerequisite knowledge before starting a course;
- Attend class and on-line exercises regularly;
- Devote time each week to studying to avoid getting behind;
- Contact the TA (if assigned) or instructor during office hours at first sign of trouble and come prepared to ask precise questions and to explain your difficulty;
- Accept the fact that you grow intellectually and professionally by being challenged and learning to deal with diverse expectations and environments.

Process for Resolving Conflicts in Grading, Course Expectations, etc.

- Contact the TA (if available) or instructor to explain your concern and seek resolution;
- If the TA/instructor has attempted to assist you, but you are still having the academic difficulty that is causing personal stress or hindering your academic success, see your Academic Advisor;
- If the TA/instructor is not responsive or does not provide a legitimate response/accommodation, then contact your Graduate Program Chair;
- If you still feel there is a legal, ethical or procedural violation that is victimizing you, contact the Office of the Associate Dean of Engineering for Academic Affairs;
- Circumventing this process will be considered a violation of professional ethics and protocol.

Appendix I-Computer Engineering graduate program study guide

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

Random Signal Analysis (ASU Course: EEE 350)

Textbook: Yates and Goodman, Probability and Stochastic Processes, second edition, Wiley, 2005.

1. Axiomatic probability
2. Random variables, distribution functions, and density functions
3. Special distributions: Gaussian, exponential, etc.
4. Expectation and variance
5. Multiple random variables
6. Central limit theorem and law of large numbers
7. Maximum-likelihood estimation and confidence intervals
8. Random processes
9. Statistical analysis using sample statistics, histograms, and linear regression

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 the 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;
1. 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; the 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. The 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 trees (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)