ABET
Self-Study Report
for the
MSEE Degree Program
at
Naval Postgraduate School

1 University Circle
Monterey, CA 93943

01 July 2019

CONFIDENTIAL

The information supplied in this Self-Study Report is for the confidential use of ABET and its authorized agents, and will not be disclosed without authorization of the institution concerned, except for summary data not identifiable to a specific institution.
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Master’s Level Program Self-Study Report
for
EAC of ABET
Accreditation or Reaccreditation

BACKGROUND INFORMATION (*)

A. Contact Information
List name, mailing address, telephone number, fax number, and e-mail address for the primary pre-visit contact person for the program.

The primary pre-visit contacts are the Program Chair and Academic Associate:

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831-656-2859
Fax: 831-656-2760
fargues@nps.edu

B. Program History
Include the year implemented and the date of the last general review. Summarize major program changes with an emphasis on changes occurring since the last general review.

The last general review was held in the 2013-2014 Accreditation Cycle (Self-Study Report was due 1 July 2013). The date of our initial accreditation is October 1, 1973.

The first Self-Study Report template for Master’s Level Programs was made available on 16 August 2017. As a result, at the ECE Department’s Faculty Meeting on 31 October 2017, the faculty voted in favor of replacing one of our MSEE Student Outcomes “Criterion 3 of the Engineering Accreditation Commission (EAC) of ABET – student outcomes (a) through (k)” – with the new outcome “Depth and Breadth of Study”.

4
Depth and Breadth of Study: Students will complete a course of study that includes appropriate depth and breadth for a masters-level student in an Electrical Engineering program by completing the graduate-level course requirements for one focus area and two specialty areas within the MSEE degree program at the Naval Postgraduate School.

C. Options
List and describe any options, tracks, concentrations, etc. included in the program.

In the ECE Department, there are four Focus Areas: 1) Communications and Information Engineering, 2) Cyber Engineering, 3) Nano-electronics and Energy Engineering, and 4) Sensor and Control Engineering. Each focus area consists of four or more of nine specialties: 1) Communications Systems, 2) Computer Systems, 3) Cyber Systems, 4) Electronics, 5) Guidance, Control, and Navigation Systems, 6) Network Engineering, 7) Power Systems, 8) Sensor Systems Engineering, and 9) Signal Processing Systems. For example, the Cyber focus area includes the communications, computers, cyber, networks, and signal processing specialties. The complete mapping of focus areas and specialties is shown in the matrix below.

<table>
<thead>
<tr>
<th>Specialties</th>
<th>Focus Areas</th>
<th>Communications &amp; Information Engineering</th>
<th>Cyber Engineering (For USN students selecting this focus area: “Cyber” is required as one of the two specialties)</th>
<th>Nano-electronics &amp; Energy Engineering</th>
<th>Sensor &amp; Control Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computers</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyber</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronics</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Guidance &amp; Control</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Networks</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensors</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal Processing</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

D. Program Delivery Modes
Describe the delivery modes used by this program, e.g., days, evenings, weekends, cooperative education, traditional lecture/laboratory, off-campus, distance education, web-based, etc.

Resident-Student Program
The great majority of students in the MSEE Degree Program at NPS are resident students. Courses for the resident students are offered during the daytime, Monday through Friday, face-to-face, in the traditional lecture/laboratory mode of delivery.

Distance-Learning Program
The great majority of distance-learning (DL) students are enrolled either in Academic Certificates or in the Master of Engineering [MEng (EE)] Degree Program, which are not
ABET accredited programs; however, in the recent past, a few DL students have opted for the MSEE Degree Program. Non-resident DL students generally take courses simultaneously with resident students. All DL classes are scheduled weekdays during normal business hours. Distance-learning courses are delivered in three different ways, listed below.

- **Video Teleconferencing (VTC):** Distance-learning courses are delivered to remote sites via a live television link, from classrooms at NPS specially equipped with cameras and monitors. The instructor has live contact with resident students, physically present in the classroom, and with DL students from one or multiple sites via a live television link. Usually DL students at the remote sites are in classrooms or conference rooms with similar audiovisual equipment, and both the instructor and the DL students can see each other and interact for live questions. In addition to live VTC, DL classes are also streamed through the internet so that DL students without access to a VTC studio can follow lectures on their own desktop/laptop at any location of choice. In this case, DL students can ask questions live via a dedicated telephone line. Furthermore, all DL classes are recorded and may be viewed any time online. Video Teleconferencing has been the delivery method of choice for the majority of DL courses since instructors receive assistance from NPS personnel in the VTC studio.

- **Collaborate Live!:** Classes are taught “desktop to desktop” using a collaborative learning software program available directly from the Sakai Learning Management System. This option allows for two-way voice and video communications, as well as sharing of slides and a virtual whiteboard. Video resolution is higher than that available with VTC, albeit at a slower frame rate. This approach is particularly suitable for classes making extensive use of Power Point slides with live handwritten annotations from the instructor. This environment can be used to teach from/to anywhere with an internet connection at a reasonable speed.

- **Asynchronous, Prerecorded Videos:** In a few cases, especially in the Digital Signal Processing area, DL classes are taught in a flipped classroom format where lectures have been prerecorded and packaged for online viewing. Recordings allow non-resident DL students to follow a class in parallel with a regularly scheduled class. Office hours and problem sessions are scheduled on a regular basis using “Collaborate Live!” so that DL students can ask questions and interact with the instructor.

Non-resident DL students who want to pursue the MSEE Degree Program in the ECE Department must satisfy the same academic requirements as the resident students. Since not all courses offered to resident students are available for DL offering, non-resident DL students have two main options, according to whether or not they are part of a cohort of at least 10 students. In the case of a cohort, funded by a sponsor, a course of study is designed and properly scheduled so that all courses required for the degree are guaranteed to be available in a DL mode. For the DL students who are not part of a
cohort interested in pursuing a DL degree, including the MSEE degree, we regularly maintain a website listing all present and future courses so that the non-resident DL students can plan accordingly. The URL for the website is

https://www.nps.edu/documents/103424449/106895292/FY15-FY21-ECE-OverviewOnlyJuly2018b.pdf/0c61b813-17ab-470d-b650-1adb3573059d

Laboratories for DL courses are handled according to specific course requirements. Distance-learning students enrolled in courses using computer based assignments follow the same procedures as the resident students, with no distinction.

When enrolled in courses where the laboratories require live hardware-based experiments, there are a number of options, again according to the courses and the cohorts. For laboratories where the students handle equipment to collect measurements, DL students can travel to NPS for a few days where they perform the laboratory experiments during special sessions, usually scheduled towards the end of the quarter. When laboratory experiments require the presence of a qualified technician to closely supervise the use of equipment, video recordings of relevant sections of the laboratory experiments are made available and the DL students paired with resident students analyze the data. This hybrid approach is followed in Power Systems laboratories where the students are exposed to high voltage equipment, thus requiring qualified personnel to be present during the experiments. Since most modern laboratory equipment could be made accessible via the internet, we are considering upgrading additional laboratories to take advantage of this capability.

E. Program Locations
Include all locations where the program or a portion of the program is regularly offered (this would also include dual degrees, international partnerships, etc.).

The MSEE Degree Program is regularly offered to resident students in Monterey, CA.
The MSEE Degree Program is not regularly offered to non-resident students.

F. Public Disclosure
Provide information concerning all the places where the Program Education Objectives (PEOs), Student Outcomes (SOs), annual student enrollment and graduation data is posted or made accessible to the public. If this information is posted to the Web, please provide the URLs.

The Program Educational Objectives, Student Outcomes, and annual student enrollment and graduation data of the NPS MSEE program can be found at:
https://www.nps.edu/web/ece/msee-accreditation

The Program Educational Objectives and Student Outcomes of the NPS MSEE program can be found at:
G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

Summarize the Deficiencies, Weaknesses, or Concerns remaining from the most recent ABET Final Statement. Describe the actions taken to address them, including effective dates of actions, if applicable. If this is an initial accreditation, it should be so indicated.

ECE’s EAC of ABET Visitor found that ECE’s recently established process for evaluating Student Outcomes was lacking in that it did not evaluate all aspects of the Student Outcomes commonly referred to as Student Outcomes (a) through (k). In order to address this Concern, ECE implemented the following modifications to the assessment of Student Outcomes outlined in the 2013 Self-Study:

1. Instead of randomly choosing courses to be assessed for attainment of Student Outcomes (a) through (k), ECE established a process to assess these Outcomes for one third of the EC courses offered each Academic Year on a rotating schedule so that after three years all courses will have been assessed once, and after six years, each course will have been assessed twice.

2. Instead of allowing the instructor teaching the course to choose which Outcome he or she will assess, the ECE ABET Executive Committee now assigns which specific Outcome is to be assessed in a particular course.

3. The ECE ABET Executive Committee evaluates the assessments on an annual basis, after the conclusion of each Academic Year, in order to determine if any changes to improve the program are required.

4. Because this process was not established until after the EAC of ABET visit last September 2013, the first annual assessment did not take place until October 2014.
GENERAL CRITERIA FOR MASTER’S LEVEL PROGRAMS

STUDENTS AND CURRICULUM

For the sections below, attach any written policies that apply.

NOTE: "Post-secondary education and/or professional experiences" refers to intermediate and advanced academic and/or professional knowledge, skills and competencies leading to a first and/or second tertiary degree (such as a baccalaureate or master’s degree) or equivalent qualification.

I. Verification of Post-Secondary Education and Professional Experiences
Summarize the procedure that verifies that students in the program have had a post-secondary educational and/or professional experiences that

• supports that attainment of student outcomes as defined in the general criteria for baccalaureate programs, Criterion 3;
• includes at least one year of math and basic science, at least one-and-a-half years of engineering topics, and a major design experiences that meets the requirements in the general criteria for baccalaureate programs, Criterion 5;
• satisfies the curricular components of the baccalaureate level program criteria relevant to the master’s level program name.

Students earning a Master of Science in Electrical Engineering or a Degree of Electrical Engineer at NPS, must either have attained an ABET accredited undergraduate Electrical Engineering degree, or earned the equivalency of a Bachelor of Science Degree in Electrical Engineering. Some courses from the student’s undergraduate institution may count towards this equivalency, even though the final undergraduate degree may not have been in Electrical Engineering. Some courses taken at NPS may also be applied to meeting the undergraduate equivalency.

The Undergraduate Education Evaluation Form (see Exhibit 1) is used to document the completion of the BSEE equivalency. It ensures that students in the MSEE Degree Program at NPS have at least one year of math and basic science, at least one-and-a-half years of engineering topics, and a major design experience that meet the requirements in the general criteria for baccalaureate programs, Criterion 5, and satisfies the curricular components of the baccalaureate level program criteria relevant to the MSEE Degree Program.

The procedure used to verify that students in the MSEE Degree Program at NPS who are also working on completing their BSEE equivalency have attained student outcomes (a) through (k), and now student outcomes (1) through (7) as defined in the general criteria for baccalaureate programs, Criterion 3, is described below.

In the ECE Department, 2000 level courses are considered undergraduate courses, 3000 level courses are considered undergraduate/first-year graduate level courses, and 4000 level courses are considered graduate level courses. Prior to academic year 2018 (AY18),
one of our student outcomes was satisfying student outcomes (a) through (k) as defined in the general criteria for baccalaureate programs, Criterion 3. As a result, all 2000, 3000, and 4000 level courses were assessed to verify that student outcomes (a) through (k) were being covered.

Beginning with AY18, with the availability of the self-study report template for Master’s Level Programs (08.16.17), student outcomes (a) through (k) as one of our outcomes was replaced by Depth and Breadth of Study at the Master’s Level. As a result, in the Fall and Winter Quarters of AY18, only 2000 and 3000 level courses were assessed to verify that student outcomes (a) through (k) were being covered.

Because of the recent change of Criterion 3 student outcomes from (a) through (k) to (1) through (7) (10.20.17), beginning with Spring Quarter AY18, the ECE Department will now assess our 2000 and 3000 level courses to verify that student outcomes (1) through (7) are being covered.

In order to verify that student outcomes (1) through (7) are being covered in our 2000 and 3000 level courses, the following procedure is followed (this is the same procedure that was used to verify that student outcomes (a) through (k) were being covered):

Every academic quarter, four different courses are chosen (if possible) to be assessed by four different faculty members. Each course is assigned one outcome in particular to be assessed. The four courses chosen are a mix of 2000 and 3000 level courses. Each faculty member is required to answer the following seven questions in the ABET Criterion 3 Student Outcomes Assessment Form (see Exhibit 2):

1. How was the main idea of the outcome incorporated into the course or event?  
2. What additional aspects of the outcome were included in the course or event?  
3. Were techniques in addition to traditional testing used to provide learning and assessment opportunities related to the targeted outcome? If so, what were they?  
4. Is your course journal for this course complete and filed on SharePoint?  
5. Did the course adequately address the targeted outcome and why?  
6. Were course pre-requisites sufficient to prepare students for this course?  
7. Were there additional outcomes from the (1) through (7) criteria that were covered in the course? If so, what were they and how were they addressed?

Although each course is assigned one outcome in particular to be assessed, if additional outcomes from (1) through (7) were covered in the course, the faculty member is asked to assess how well the course addressed those outcomes as well (see Question 7 above).

At the end of each academic year (AY), at least sixteen different courses (if possible) would have been assessed by sixteen different faculty members. The goal is to ask a
faculty member to assess only one course in an AY in order to get the largest participation of faculty members. However, depending on teaching assignments, it may happen that a faculty member is asked to assess more than one course in an AY. Another goal is to assess each outcome from (1) through (7) at least once, ideally two or three times in an AY. This is not always possible because some outcomes are not covered in all courses.

At the end of each AY, the Academic Year 20XX ABET Assessment Plan is published. It summarizes the courses that were assessed, the faculty members who did the assessments, and the main outcomes that were assessed for each course (e.g., see Exhibit 3).

The complete lists of all 2000, 3000, and 4000 level courses that have been assessed for AY2015-AY2017 have been updated. In addition, all the Assessment Plans, the actual faculty course assessments, and the complete lists of courses at all levels that have been assessed for AY2015-AY2017 have been uploaded to the ECE Department’s SharePoint Website and the NPS ABET Sakai Website.

Beginning with AY18, only the complete lists of all 2000 and 3000 level courses that have been assessed for AY2015-AY20XX will be updated (e.g., see Exhibits 4 and 5). All the Assessment Plans, the actual faculty course assessments, and the complete lists of all 2000 and 3000 level courses that have been assessed for AY2015-AY20XX will be uploaded to the ECE Department’s SharePoint Website and the NPS ABET Sakai Website. All ECE faculty members have access to this information via the SharePoint Website.

At the end of each AY, the Technical Area Groups (TAGs) review the faculty assessments of the courses that fall under their purview. The TAGs document their review comments. This information is uploaded to the ECE Department’s SharePoint Website and the NPS ABET Sakai Website. All ECE faculty members have access to this information via the SharePoint Website.

If a TAG feels that changes need to be made to one or more of their courses (e.g., course content, labs, projects, prerequisites, etc.), then the recommended changes are forwarded to the ECE Curriculum Committee for discussion. If the ECE Curriculum Committee and the ECE Department Chairman agree with the proposed changes, then it must be decided which changes can be done internally (the course or courses are then updated), or sent to the NPS Academic Committee for approval. If the NPS Academic Committee approves the changes, the course or courses are then updated. This process is illustrated by the flow chart shown in Exhibit 6.

Exhibit 7 is a table that summarizes which student outcomes (1) through (7), as defined in the general criteria for baccalaureate programs, Criterion 3, are covered in the 2000 and 3000 level EC courses.
II. Student Program of Study and Educational Goals
Summarize the procedure by which a program of study and education goals are developed for each student, and how these will lead to a mastery of a specific field of study or area of professional practice (consistent with the program name) at an advanced (beyond baccalaureate) level. Describe how the procedure ensures that each student’s program of study at the master’s level includes one academic year of full-time study (equivalent to at least 30 semester hours) beyond the baccalaureate level program.


Each student in the MSEE Degree Program at NPS is required to fill out the Checklist for MSEE Degree (see Exhibit 8). In the checklist, each student is required to select one Focus Area, and two of the allowed Specialties within that Focus Area providing breadth of study at an advanced level (beyond baccalaureate). There are four required graduate level courses per Specialty providing depth of study at an advanced level (beyond baccalaureate). The checklist allows each student to personalize their program of study. Requiring each student to choose one Focus Area and two Specialties with four required graduate level courses per Specialty satisfies our student outcome Depth and Breadth of Study at an advanced level (beyond baccalaureate).

In addition, since each student in the MSEE Degree Program at NPS is required to write an acceptable Master’s thesis, each student is required to fill out the Thesis Proposal Approval Form (see Exhibit 9). Filling out this form helps students to focus their initial research ideas. For example, they must state a tentative thesis title, identify their thesis advisor and co-advisor (or second reader), discuss the research questions to be investigated, discuss the benefit of the study, provide a preliminary bibliography, provide a list of milestones, etc. (see Exhibit 9). The Thesis Proposal Approval Form supports our student outcome Independent Investigation.

III. Evaluating Student Performance
Summarize the process by which student performance is evaluated and student progress is monitored. Include information on how the mastery of an advanced field of study or area of professional practice is demonstrated by and evaluated for each student.

One of our student outcomes is Independent Investigation: Students will possess the ability to conduct and report the results of a technically-challenging, defense-relevant independent investigation.

Each student in the MSEE Degree Program at NPS is required to write an acceptable Master’s thesis in order to graduate. In order for students to write an acceptable thesis at an advanced level (beyond baccalaureate), they must also demonstrate that they have
satisfied our other student outcome **Depth and Breadth of Study:** Students will complete a course of study that includes appropriate depth and breadth for a masters-level student in an Electrical Engineering program by completing the graduate-level course requirements for one focus area and two specialty areas within the MSEE Degree Program at the Naval Postgraduate School.

The process that is used to monitor and evaluate the performance and mastery of an advanced field of study or area of professional practice for each student is described next.

Each student has regular meetings with his/her thesis advisor. The frequency of these meetings is determined by the advisor and student. At these meetings, the advisor can gauge the progress that a student is making, make suggestions as to what the student needs to do next, answer any questions, and to make sure that the student is on-track and not deviating from their research goals. Each student can also meet with his/her co-advisor (or second-reader) for help.

Once a student finishes writing his/her thesis, the quality of the thesis is evaluated three different ways for each student.

1) The thesis advisor, co-advisor (or second-reader), and ECE Department Chairman must fill out an [ECE Department Faculty Thesis Survey](#) (see Exhibit 10). This survey asks each evaluator to evaluate a thesis on Originality of Research, Technical Merit, Defense Relevance, Quality of Presentation, and Quality of Written Thesis. Each attribute can be rated as being poor (1), fair (2), satisfactory (3), excellent (4), or outstanding (5).

2) Each student must make a 15-20 minute thesis presentation in front of fellow students and faculty. They are expected to describe their thesis, explain their results, make recommendations for future research, and to answer any questions from the audience. As mentioned in item 1) above, the quality of the thesis presentation is evaluated on a scale of 1 (Poor) to 5 (Outstanding).

3) The thesis advisor and co-advisor (or second-reader) must fill out the [online NPS Thesis/Capstone Assessment Survey](#). This survey evaluates a student’s thesis on Student Learning Outcomes (five attributes), Thesis/Final Project Report Relevance (two attributes), and Potential For Publication (one attribute):

**Student Learning Outcomes**

- **Subject Matter Competence.** Student demonstrates graduate-level knowledge and competencies in their academic field.
- **Methods and Technical Merit.** Student demonstrates the ability to apply technical expertise and appropriate methodological rigor in conducting research and analysis.
- **Critical Thinking.** Student demonstrates the ability to apply critical thinking and logical reasoning to research questions and to implement
creative or innovative approaches to answer them.

- **Written Communication.** Student demonstrates proficiency in communicating and presenting the written results of their inquiry in a thesis or final project report appropriate to their academic program.

- **Oral Communication (optional).** Student demonstrates proficiency in communicating and presenting the results of their inquiry in a thesis or final project report in an oral presentation. **Note:** this dimension is optional – complete if it applies to your curriculum or department.

### Thesis/Final Project Report Relevance

- **Defense Relevance.** The thesis or final project addresses a problem of relevance in the defense or national security community.

- **Relevance to Curriculum.** The thesis or final project is closely aligned with the student’s assigned curriculum.

### Potential For Publication

The Student Learning Outcomes (five attributes) are graded on a scale of 1 (Acceptable) to 5 (Advanced), Thesis/Final Project Report Relevance (two attributes) are graded on a scale of 1 (Not Relevant) to 5 (Fully Relevant), and Potential For Publication (one attribute) is graded on a scale of 1 (No Potential) to 5 (High Potential).

The ECE Department Chairman will not sign a student’s thesis unless the ECE Department Faculty Thesis Survey and the NPS Thesis/Capstone Assessment Survey is included with the thesis.

Another way the ECE Department measures the quality of our students Master’s theses is to keep track of the number of students that publish their thesis results as authors or co-authors with faculty members (see Exhibit 11, Faculty Publications with Student Authors/Coauthors AY2014-AY2018). Of course, not every student thesis will result in a publication for a variety of reasons. This does not mean that the thesis is not of acceptable quality for graduation. Faculty also publish their research results without student authors/coauthors as well.

### IV. Graduation Requirements

Summarize the graduation requirements for the master’s level program and the process for ensuring and documenting that each graduate completes all graduation requirements for the program. State the name of the degree awarded (Master of Science in Chemical Engineering, Master in Computer Science, Master of Engineering in Electrical Engineering, etc.)

Students earning a **Master of Science in Electrical Engineering** at NPS must either have attained an ABET accredited undergraduate Electrical Engineering degree, or earned the equivalency of a Bachelor of Science Degree in Electrical Engineering. Some courses from the student’s undergraduate institution may count towards this equivalency,
even though the final undergraduate degree may not have been in Electrical Engineering. Some courses taken at NPS may also be applied to meeting the undergraduate equivalency.

In addition, a student must complete a minimum of 52 quarter credit hours of graduate level work by

1. Completing a minimum of 36 quarter credit hours of graded, graduate-level, course work at the 3000 and 4000 levels.
   a. At least 30 quarter credit hours must be in Electrical and Computer Engineering. Of the 30 quarter credit hours, at least four courses that total a minimum of 12 quarter credit hours must be at the 4000 level.
   b. The remaining 6 quarter credit hours must be in engineering, mathematics, physical science, and/or computer science.

2. Writing an acceptable thesis for a minimum of 16 quarter credit hours that must be presented to, and approved by, the ECE Department.

The graduation requirements for the degree Master of Science in Electrical Engineering can be found at:
https://my.nps.edu/web/ece/msee

The procedure used to ensure and document that each graduate completed all graduation requirements is summarized next.

Each student in the MSEE Degree Program at NPS is required to fill out the Checklist for MSEE Degree (see Exhibit 8). This checklist ensures that each student satisfies the required number of credit hours of graduate-level course work. The Checklist for MSEE Degree is discussed in detail in Section STUDENTS AND CURRICULUM, II. Student Program of Study and Educational Goals.

In addition, each student must write an acceptable thesis that is approved by the department. The quality of a student’s thesis is evaluated three different ways by using 1) the ECE Department Faculty Thesis Survey (see Exhibit 10), 2) a student’s thesis presentation, and 3) the online NPS Thesis/Capstone Assessment Survey. These three different ways of evaluation are discussed in detail in Section STUDENTS AND CURRICULUM, III. Evaluating Student Performance.

V. Transcripts of Recent Graduates
The program will provide transcripts from some of the most recent graduates to the visiting team along with any needed explanation of how the transcripts are to be interpreted. The program of study and educational goals for these graduates should accompany the transcripts. These transcripts and accompanying material will be requested separately by the Team Chair. State how the program and any program options are designated on the transcript. (See 2019-2020 APPM, Section I.E.4.a.).
PROGRAM EDUCATIONAL OBJECTIVES AND STUDENT OUTCOMES

This section refers to the requirements found in Section I.A.6.a of the 2019-2020 Accreditation Policy and Procedure Manual.

I. Program Educational Objectives
List the program educational objectives for the master’s level program and state where they may be found by the general public as required by APPM Section I.A.6.a.

The Program Educational Objectives of the NPS MSEE program represent the abilities that we expect our graduates to have three to five years after their completion of our program. They are the skills and abilities that the graduates have to contribute to the national security of the United States (or their home countries).

- Technical Leadership: Graduates in the several years following graduation will be known and respected for their technical leadership along diverse career paths in government service and/or the private sector.

- Technical Program Management: Graduates in the several years following graduation will possess the ability to handle assignments related to research, design, development, procurement, maintenance, and life cycle management of electronic systems for Naval and other military platforms.

- Operational Utilization: Graduates in the several years following graduation will possess the ability to understand the capabilities and limitations of military electronic systems and to effectively employ electronic systems in military operations.

The Program Educational Objectives of the NPS MSEE program can be found at: https://www.nps.edu/web/ece/msee-accreditation

II. Student Outcomes
List the student outcomes for the master’s level program and state where they may be found by the general public as required by APPM Section I.A.6.a. (For integrated baccalaureate-master’s programs, these will be in addition to the student outcomes defined in Criterion 3 of the baccalaureate level criteria.)

- It is suggested that one of the student outcomes reflect the requirement stated in the Students and Curriculum section of the master’s level program criteria: The master’s level engineering program must require each student to demonstrate a mastery of a specific field of study or area of professional practice consistent with the master’s program name and at a level beyond the minimum requirements of baccalaureate level programs.

- A second student outcome can be related to students meeting their specific educational goals.

- Any other student outcomes defined by the program can be included.

The Student Outcomes of the NPS MSEE program represent the knowledge, skills, and abilities that we expect our graduates to have at the time of completion of their MSEE program. These outcomes are expected to enable our graduates to achieve the Program
Educational Objectives that support enhancing the national security of the United States (or the students’ home countries).

- **Independent Investigation:** Students will possess the ability to conduct and report the results of a technically-challenging, defense-relevant independent investigation.

- **Depth and Breadth of Study:** Students will complete a course of study that includes appropriate depth and breadth for a masters-level student in an Electrical Engineering program by completing the graduate-level course requirements for one focus area and two specialty areas within the MSEE degree program at the Naval Postgraduate School.

The **Student Outcomes** of the NPS MSEE program can be found at: [https://www.nps.edu/web/ece/msee-accreditation](https://www.nps.edu/web/ece/msee-accreditation)
PROGRAM QUALITY

This section of your Self-Study Report should document your processes for regularly assessing, maintaining, and enhancing the quality of the program. Assessment is defined as one or more processes that identify, collect, and prepare the data necessary for evaluation.

I. Assessment Processes

Provide a description of the assessment processes used to gather the data upon which the evaluation of the program quality is based; include the frequency with which these assessment processes are carried out.

One of our student outcomes is Independent Investigation. In order to satisfy student outcome Independent Investigation, each student in the MSEE Degree Program at NPS is required to write an acceptable Master’s thesis at an advanced level (beyond baccalaureate) in order to graduate. In order for students to write an acceptable thesis at an advanced level (beyond baccalaureate), they must also demonstrate that they have satisfied our other student outcome Depth and Breadth of Study.

In order to assess our two student outcomes Independent Investigation and Depth and Breadth of Study (which is a critical component of Independent Investigation), the following data is collected for each student thesis:

1. The thesis advisor, co-advisor (or second-reader), and ECE Department Chairman must fill out an ECE Department Faculty Thesis Survey (see Exhibit 10). This survey asks each evaluator to evaluate a thesis on Originality of Research, Technical Merit, Defense Relevance, Quality of Presentation, and Quality of Written Thesis. Each attribute can be rated as being poor (1), fair (2), satisfactory (3), excellent (4), or outstanding (5).

2. Each student must make a 15-20 minute thesis presentation in front of fellow students and faculty. They are expected to describe their thesis, explain their results, make recommendations for future research, and to answer any questions from the audience. As mentioned in item 1) above, the quality of the thesis presentation is evaluated on a scale of 1 (Poor) to 5 (Outstanding).

3. The thesis advisor and co-advisor (or second-reader) must fill out the online NPS Thesis/Capstone Assessment Survey. This survey evaluates a student’s thesis on Student Learning Outcomes (five attributes), Thesis/Final Project Report Relevance (two attributes), and Potential For Publication (one attribute). The Student Learning Outcomes (five attributes) are graded on a scale of 1 (Acceptable) to 5 (Advanced), Thesis/Final Project Report Relevance (two attributes) are graded on a scale of 1 (Not Relevant) to 5 (Fully Relevant), and Potential For Publication (one attribute) is graded on a scale of 1 (No Potential) to 5 (High Potential). See Section STUDENTS AND CURRICULUM, III. Evaluating Student Performance, for a description of the eight attributes.
The data from the **ECE Department Faculty Thesis Surveys** are collected every academic quarter.

The data from the online **NPS Thesis/Capstone Assessment Surveys** are collected every academic quarter by the Institutional Research, Reporting & Analysis group at the Naval Postgraduate School.

Another way the ECE Department measures the quality of our students Master’s theses is to keep track of the number of students that publish their thesis results as authors or co-authors with faculty members (see Exhibit 11). This data is collected every academic year.

The ECE Department conducts exit interviews every academic quarter with graduating students. The students are interviewed as a group by only one faculty member who is an academic associate, and the program officer. The students are free to express their opinions about what they feel is good or bad about the MSEE Degree Program and to make recommendations for improvement. They also have the opportunity to speak privately with the academic associate and/or program officer. The graduating student exit interviews are documented and uploaded to the ECE Department’s SharePoint website and the NPS ABET Sakai website.

The ECE Department also keeps track of any NPS and/or professional organization (e.g., IEEE) awards received by students in the ECE Department, and any student testimonials expressing satisfaction with the MSEE Degree Program. Student awards and student testimonials are documented and uploaded to the ECE Department’s SharePoint website and the NPS ABET Sakai website.

Curriculum Reviews are held approximately every two years by our sponsor who is responsible for sending students into our MSEE Degree Program. Our sponsor evaluates the quality and relevance of our MSEE Degree Program to make sure it satisfies his needs and at the same time, academic requirements.

II. **Maintenance and Enhancement of the Program**

Describe how the results of assessment processes are used to maintain and enhance the program. Describe any changes that have been made for the purpose of enhancing the program and the results of those changes (whether or not effective) in those cases where re-assessment of the results has been completed. Indicate any significant future program improvement plans based upon recent assessments. Provide a brief rationale for each of these planned changes.

The data from the **ECE Department Faculty Thesis Surveys** are collected every academic quarter. The *average* scores for each of the five attributes of a good thesis (Originality of Research, Technical Merit, Defense Relevance, Quality of Presentation, and Quality of Written Thesis) are calculated for each academic year. Each attribute can be rated as being poor (1), fair (2), satisfactory (3), excellent (4), or outstanding (5). The average scores are analyzed, looking for both positive and negative trends in the five attributes.
In AY2017, there were nineteen faculty assessments documented. The average metrics were:

<table>
<thead>
<tr>
<th></th>
<th>AY2017 mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Originality of Research</td>
<td>4.17</td>
</tr>
<tr>
<td>Technical Merit</td>
<td>4.11</td>
</tr>
<tr>
<td>Defense Relevance</td>
<td>4.33</td>
</tr>
<tr>
<td>Quality of Presentation</td>
<td>4.28</td>
</tr>
<tr>
<td>Quality of Written Thesis</td>
<td>4.44</td>
</tr>
</tbody>
</table>

As can be seen from the table, all attributes were evaluated as being between excellent and outstanding. No changes to the MSEE thesis process or survey are recommended at this time.

In AY2018, there were 85 faculty assessments evaluating 34 MSEE theses. The average metrics were:

<table>
<thead>
<tr>
<th></th>
<th>AY2018 mean score</th>
<th>AY2017 mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Originality of Research</td>
<td>4.06</td>
<td>4.17</td>
</tr>
<tr>
<td>Technical Merit</td>
<td>4.07</td>
<td>4.11</td>
</tr>
<tr>
<td>Defense Relevance</td>
<td>4.31</td>
<td>4.33</td>
</tr>
<tr>
<td>Quality of Presentation</td>
<td>4.05</td>
<td>4.28</td>
</tr>
<tr>
<td>Quality of Written Thesis</td>
<td>4.00</td>
<td>4.44</td>
</tr>
</tbody>
</table>

As can be seen from the table, all elements were evaluated as being between excellent and outstanding. We were more successful at assessing and documenting the assessments in AY2018 as compared to AY2017. No changes to the MSEE thesis process or survey are recommended at this time.
The data from the online **NPS Thesis/Capstone Assessment Surveys** are collected every academic quarter by the Institutional Research, Reporting & Analysis (IRRA) group at the Naval Postgraduate School (NPS). The *average* scores for each of the eight attributes of a good thesis – Subject Matter Competence, Methods and Technical Merit, Critical Thinking, Written Communication, Oral Communication (optional), Defense Relevance, Relevance to Curriculum, and Potential for Publication – are calculated by the IRRA group at the NPS and made available to the department chairman. The average scores are analyzed within the ECE Department, looking for both positive and negative trends in the eight attributes.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject Matter Competence¹</td>
<td>4.00</td>
<td>4.13</td>
<td>4.04</td>
</tr>
<tr>
<td>Methods and Technical Merit¹</td>
<td>4.00</td>
<td>4.06</td>
<td>3.94</td>
</tr>
<tr>
<td>Critical Thinking²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Written Communication²</td>
<td>3.88</td>
<td>4.04</td>
<td>3.95</td>
</tr>
<tr>
<td>Oral Communication²</td>
<td>4.17</td>
<td>4.23</td>
<td>4.07</td>
</tr>
<tr>
<td>Defense Relevance³</td>
<td>4.38</td>
<td>4.52</td>
<td>4.42</td>
</tr>
<tr>
<td>Relevance to Curriculum⁴</td>
<td>4.38</td>
<td>4.43</td>
<td>4.42</td>
</tr>
<tr>
<td>Potential for Publication²</td>
<td>3.20</td>
<td>3.76</td>
<td>3.23</td>
</tr>
</tbody>
</table>

**AY2015 Observations:**  
There were eight assessments completed in AY2015 for ECE students.  
- **Subject Matter Competence:** ECE, GSEAS, and NPS average scores are all nearly the same at “excellent”.  
- **Methods and Technical Merit:** ECE, GSEAS, and NPS average scores are all nearly the same at “excellent”.  
- **Critical Thinking:** ECE, GSEAS, and NPS average scores are all nearly the same at “excellent”. However, ECE’s average (3.88) was lower than all but one of the eight GSEAS departments or academic groups. Space Systems Academic Group scored 3.58.  
- **Written Communication:** ECE and GSEAS average scores are both nearly the same at “nearing advanced”, but both averages are slightly lower than most other questions. ECE did score higher than two other GSEAS departments or academic groups.  
- **Oral Communication:** ECE, GSEAS, and NPS average scores are all nearly the same at “nearing advanced”.  
- **Defense and Curriculum Relevance:** ECE, GSEAS, and NPS average scores are all between “highly relevant” and “fully relevant”.  
- **Potential for Publication:** ECE and NPS average scores are nearly identical at “moderate potential” while GSEAS average score is closer to “significant potential”.

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¹ 5 = outstanding, 4 = excellent, 3 = satisfactory, 2 = fair, 1 = poor  
² 5 = advanced, 4 = nearing advanced, 3 = proficient, 2 = nearing proficient, 1 = acceptable  
³ This is an obvious error, copied from the NPS Capstone Assessment Report, AY2015.  
⁴ 5 = fully relevant, 4 = highly relevant, 3 = relevant, 2 = minimally relevant, 1 = not relevant  
⁵ 5 = high potential, 4 = significant potential, 3 = moderate potential, 2 = low potential, 1 = no potential
<table>
<thead>
<tr>
<th></th>
<th>ECE (AY2016)</th>
<th>ECE (AY2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject Matter Competence</td>
<td>5.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Methods and Technical Merit</td>
<td>4.50</td>
<td>4.00</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>4.50</td>
<td>3.88</td>
</tr>
<tr>
<td>Written Communication</td>
<td>4.00</td>
<td>3.83</td>
</tr>
<tr>
<td>Oral Communication</td>
<td>4.00</td>
<td>4.17</td>
</tr>
<tr>
<td>Defense Relevance</td>
<td>4.50</td>
<td>4.38</td>
</tr>
<tr>
<td>Relevance to Curriculum</td>
<td>4.50</td>
<td>4.38</td>
</tr>
<tr>
<td>Potential for Publication</td>
<td>4.00</td>
<td>3.20</td>
</tr>
</tbody>
</table>

**AY2016 Observations:**
There were two assessments completed in AY2016 for our MSEE students. While the ECE averages were available, the GSEAS averages were not.

Overall: The sample set is very small, so the averages are less meaningful than if the sample set were large. However, seven of the eight metric averages show improvement over the prior year’s averages and the one declining metric was only slightly lower than in AY2015.

- Subject Matter Competence: The ECE average is the maximum score possible.
- Methods and Technical Merit: The ECE average is improved from the prior year.
- Critical Thinking: The ECE average is improved from the prior year.
- Written Communication: The ECE average had a slight improvement from the prior year.
- Oral Communication: ECE average dropped 0.17 (on a 5.0 scale) from the prior year.
- Defense and Curriculum Relevance: The ECE average had a slight improvement from the prior year.
- Potential for Publication: The ECE average had a slight improvement from the prior year.
AY2017 Observations:
There were fourteen assessments completed in AY2017 for our MSEE students. While the ECE data is available, the GSEAS data is not.

Overall: All eight metrics are down from AY2016, but only four are down from AY2015. Also, all metrics are at or above the middle score (3). Also, there are freeform comments on three of the six assessments that lauded the thesis work as “exceptional”, “could lead to doctorate”, and “top 10 of 100 theses over my career”.

- Subject Matter Competence: The ECE average is down from AY2016, but up (slightly) from AY2015.
- Methods and Technical Merit: The ECE average is down from AY2016, but up from AY2015.
- Critical Thinking: The ECE average is down from AY2016, but up from AY2015.
- Written Communication: The AY2017 ECE average is unchanged from AY2016. The AY2017 ECE average is up slightly from AY2015.
- Oral Communication: The AY2017 ECE average is slightly up from AY2016. The AY2017 ECE average is slightly down from AY2015.
- Defense Relevance: The AY2017 mean is between the AY2016 and AY2015 means, which are high and nearly the same.
- Relevance to Curriculum: The AY2017 mean is equal to the AY2016 and slightly higher than the AY2015 mean.
- Potential for Publication: The ECE average is down slightly from AY2016, but up from AY2015.
<table>
<thead>
<tr>
<th></th>
<th>ECE (AY2018)</th>
<th>ECE (AY2017)</th>
<th>ECE (AY2016)</th>
<th>ECE (AY2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject Matter Competence</td>
<td>3.85</td>
<td>4.17</td>
<td>5.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Methods and Technical Merit</td>
<td>3.83</td>
<td>4.17</td>
<td>4.50</td>
<td>4.00</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>3.78</td>
<td>4.17</td>
<td>4.50</td>
<td>3.88</td>
</tr>
<tr>
<td>Written Communication</td>
<td>3.63</td>
<td>3.67</td>
<td>4.00</td>
<td>3.83</td>
</tr>
<tr>
<td>Oral Communication</td>
<td>3.79</td>
<td>3.60</td>
<td>4.00</td>
<td>4.17</td>
</tr>
<tr>
<td>Defense Relevance</td>
<td>4.35</td>
<td>4.33</td>
<td>4.50</td>
<td>4.38</td>
</tr>
<tr>
<td>Relevance to Curriculum</td>
<td>4.38</td>
<td>4.33</td>
<td>4.50</td>
<td>4.38</td>
</tr>
<tr>
<td>Potential for Publication</td>
<td>3.59</td>
<td>3.80</td>
<td>4.00</td>
<td>3.20</td>
</tr>
</tbody>
</table>

AY2018 Observations:

There were sixty assessments completed in AY2018 for our MSEE students. While the ECE data is available, the GSEAS data is not. The increase in assessments was undoubtedly due to a change whereby thesis advisors, co-advisors, and second readers were required to submit the assessment before the thesis would be accepted by the ECE department chair. This policy had not been effectively enforced before late AY2017.

Overall: Three AY2018 metric averages are up when compared with AY2017, while five were down. The largest change was 0.39 on the 5.00 scale. All AY2018 metric averages were between 3.59 and 4.38. There were eighteen freeform comments, of which fourteen were clearly positive (“outstanding”, “exceptional”, “being patented”, etc.), three were clearly negative (“weak”, “very poor”) and one was neutral (explained the thesis was classified).

- Subject Matter Competence: The ECE average is down 0.32 from AY2017.
- Methods and Technical Merit: The ECE average is down 0.34 from AY2017.
- Critical Thinking: The ECE average is down 0.39 from AY2017.
- Written Communication: The ECE average is down 0.04 from AY2017.
- Oral Communication: The ECE average is up 0.19 from AY2017.
- Defense and Curriculum Relevance: In AY2017, both are slightly up from AY2017.
- Potential for Publication: The ECE average is down 0.21 from AY2017.

For AY15, all elements assessed were rated above the middle rating (3) and the number of assessments completed is small (eight). No program changes are recommended at this time, but it is recommended that these ratings be compared to those of following years to determine if there are any consistent weaknesses.

For AY16, all elements assessed were rated at or above 4.00 and the number of assessments completed is very small (two). No program changes are recommended at this time, but it is recommended that these ratings be compared to those of following years to determine if there are any consistent weaknesses.

For AY17, all elements assessed were rated at or above 3.46 and the number of
assessments completed is fourteen. No program changes are recommended at this time, but it is recommended that these ratings be compared to those of following years to determine if there are any consistent weaknesses.

For AY2018, all elements assessed were rated at or above 3.59 and the number of assessments completed is sixty. The notable increase in number of assessments was undoubtedly due to a change whereby thesis advisors, co-advisors, and second readers were required to submit the assessment before the thesis would be accepted by the ECE department chair. No program changes are recommended at this time, but it is recommended that these ratings be compared to those of following years to determine if there are any consistent weaknesses.

Another way the ECE Department measures the quality of our students Master’s theses is to keep track of the number of students that publish their thesis results as authors or co-authors with faculty members (see Exhibit 11). This data is collected every academic year and various statistics are computed. The data and various statistics are analyzed, looking for both positive and negative trends in the number of students that publish their thesis results as authors or co-authors with faculty members. The ECE faculty/student publication rate can vary widely from year-to-year depending on the number of faculty, research funding levels, student enrollment, what percentage of faculty research is classified, journal and conference reviewing delays, and other factors.

The data presented in Exhibit 11 is summarized in the table below.

**Faculty/Student Publication Statistics Data Summary**

Academic Years 2014 through 2018
(October 1, 2013 through September 30, 2018)

<table>
<thead>
<tr>
<th>Statistic</th>
<th>AY2014</th>
<th>AY2015</th>
<th>AY2016</th>
<th>AY2017</th>
<th>AY2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of tenured and tenure-track faculty</td>
<td>26</td>
<td>26</td>
<td>25</td>
<td>23</td>
<td>26</td>
</tr>
<tr>
<td>Total number of unique papers published</td>
<td>17</td>
<td>34</td>
<td>28</td>
<td>51</td>
<td>45</td>
</tr>
<tr>
<td>Number of publications per faculty member</td>
<td>0.65</td>
<td>1.31</td>
<td>1.12</td>
<td>2.22</td>
<td>1.73</td>
</tr>
<tr>
<td>Percentage of faculty publications with student author/coauthor per graduate</td>
<td>16.9</td>
<td>62.1</td>
<td>80.0</td>
<td>42.9</td>
<td>65.6</td>
</tr>
<tr>
<td>Percentage of refereed journal papers with student author/coauthor per graduate</td>
<td>1.4</td>
<td>20.7</td>
<td>20.0</td>
<td>7.79</td>
<td>15.6</td>
</tr>
<tr>
<td>Percentage of refereed conference papers with student author/coauthor per graduate</td>
<td>12.7</td>
<td>37.9</td>
<td>60.0</td>
<td>35.1</td>
<td>50.0</td>
</tr>
</tbody>
</table>

As can be seen in the table above, there was an increase in the number of publications per faculty member from 0.65 in AY2014 to 1.73 in AY2018, with a peak of 2.22 papers per faculty member in AY2017, resulting in an increase in the percentage of publications
with student authors/coauthors from 16.9% in AY2014 to 65.6% in AY2018, with a peak of 80.0% in AY2016.

The ECE Department conducts exit interviews every academic quarter with graduating students. The students are free to express their opinions about what they feel is good or bad about the MSEE Degree Program and to make recommendations for improvement.

Several examples of Continuous Improvement in AY2016 are shown in Exhibit 12. In particular, the changes made in Spring AY2016 was in response to student comments made in an exit interview. All examples of Continuous Improvement and Student Testimonials expressing satisfaction with the MSEE program from AY2016 through AY2018 were documented and uploaded to the ECE Department’s SharePoint website and the NPS ABET Sakai website.

III. Additional Information
Copies of any of the assessment instruments or materials referenced in I. and II. must be available for review at the time of the visit. Other information such as minutes from meetings where the assessment results were evaluated and where recommendations for action were made could also be included.

See Exhibit 1 for the Undergraduate Education Evaluation Form.

See Exhibit 2 for the ABET Criterion 3 Student Outcomes Assessment Form.

See Exhibit 10 for the ECE Department Faculty Thesis Survey.

The NPS Thesis/Capstone Assessment Survey is an online survey.

All examples of Continuous Improvement and Student Testimonials from AY2016 through AY2018 were documented and uploaded to the ECE Department’s SharePoint website and the NPS ABET Sakai website.
**FACULTY**

**I. Faculty Qualifications**
Describe the qualifications of the faculty, demonstrating appropriate education and/or experience to teach master’s level courses. Describe how they are adequate to cover all the curricular areas of the master’s level program. This description should include the composition, size, credentials, and experience of the faculty. Complete Table M-1 (*). Include faculty resumes in Appendix B.

All NPS tenure-track faculty must be United States citizens to become tenured. To obtain a security clearance, they must also relinquish citizenship in a foreign country if they have dual citizenship. Roughly 70% of ECE faculty, including non-tenure track, hold SECRET clearances and approximately 59% are cleared at the TOP SECRET/SCI level. Some conduct research and teach at the classified level. ECE tenure-track faculty members have 19 years average teaching experience at NPS. Almost all ECE faculty have externally funded research projects. ECE faculty members are universally involved in research. A consequence of that research involvement is the desire to integrate the latest research into their courses, develop new courses, and involve students in their projects; thus, research drives a process that leads quite naturally to a more effective program. In 2018, ECE faculty, primarily tenure-track faculty, published nine journal papers, 29 conference papers, and one textbook.

ECE faculty members also served on journal editorial boards, conference steering committees, conference technical program committees, and as conference session chairs. Several ECE faculty members have joint appointments in the NPS Space Systems Academic Group, and some students in Space Systems Engineering pursue the MSEE. Space Systems faculty and students have designed and launched a number of satellites built at NPS and have developed experiments to fly on those satellites. Network intrusion software developed by an ECE faculty member is installed at the White House. NPS has been a partner in a CRADA involving another ECE faculty member that has led to the development of the world’s first mobile phased array weather radar. The ECE Department is home to the Center for Cyber Warfare, the Center for Multi-Intelligence Studies, and the Joint Services Electronic Warfare Center, each of which are pursuing highly relevant Department of Defense research in their respective areas. Much of the work they do is at the classified level. There are many other examples that demonstrate the engineering experience of the ECE faculty. Three members of the ECE faculty are licensed as Professional Engineers and six are IEEE Fellows.

**II. Faculty Workload (*)**
Complete Table M-2 (*), Faculty Workload Summary and describe this information in terms of workload expectations or requirements.

Most NPS tenure-track faculty members are employed on ten-month contracts, whereas the more recently hired faculty members are on nine-month contracts; however, on average, each NPS tenure-track faculty member is expected to cover at least three months of their yearly salary from reimbursable sources. The primary source of reimbursable funding is research grants; although, some reimbursable funding is related to delivery of
short courses, web-based course development, or reimbursable education (i.e., distance learning).

The normal workload for a tenure-track faculty member is four courses each academic year if the level of thesis advising and service is acceptable and salary for one month of the ten-month contract is covered from a reimbursable source. If these conditions are not met, then the faculty member will be assigned a fifth course or other duties. Faculty members who want to spend more time on research may buy out of courses if qualified instructors are available to replace them. Faculty members who serve as Academic Associates or Associate Chairs (Research, Instruction, and Students) are compensated for those duties and given release time. They may teach only three courses per year or they may teach four courses and use the extra compensation to cover their “reimbursable month”.

Non-tenure track faculty members are compensated by NPS only when they teach a course or have other work specifically assigned. Teaching and other work is on an as-needed basis; thus, the non-tenure track faculty comprise a pool of individuals who can be asked to teach if a tenure-track faculty member wants to buy out of a course.

III. Faculty Size
Discuss the adequacy of the size of the faculty and describe the extent and quality of faculty involvement in interactions with students in the master’s level program, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners including employers of students.

The ECE Department has 30 faculty; 22 civilian tenured/tenure-track faculty and eight civilian non-tenure track faculty (seven research, one teaching). The Department also has two Computer Science faculty members who have a joint appointment in ECE. In addition, the ECE Department normally has several military faculty members who are typically assigned for two or three years. At the present time, ECE has one Military Assistant Professor and one Military Lecturer. All tenure-track faculty hold Ph.D.s as do two of the eight non-tenure track faculty and the Military Assistant Professor. Amongst the tenure-track faculty there are one Assistant Professor, nine Associate Professors, and 14 Professors (including two joint appointments). Military officers temporarily assigned to the faculty must have Master’s degrees and sometimes hold a Ph.D.

In general, the faculty is professionally active and spends an average of 4-5 months per year on research. Tenure-track faculty members typically pay their own salaries with external funding for three or more months each academic year; thus, by virtue of their education and active engagement in research, faculty members are well qualified in their areas of expertise. A rather wide range of faculty expertise is represented as shown in Table M-1. This has resulted from conscious faculty recruiting decisions based on the needs of our Corporate Navy sponsor which are translated into Program Educational Objectives and Student Outcomes.

NPS programs are all shaped by Corporate Navy or other sponsor requirements, and
faculty recruiting is done in response to those requirements. This process has been in place at NPS and in the ECE Department for many years. As a result of this well-defined process, the faculty composition and competency required to cover the curricular areas of the MSEE Degree program is assured. The Department has experts in each of the major curricular areas who are recognized professionally at the national and international levels.

IV. Professional Development (*)

Provide detailed descriptions of professional development activities for each faculty member.

The ECE Department faculty is of sufficient number to accommodate professional development. About three-fourths of ECE Department faculty labor is paid from institutional funds and one-fourth is paid from reimbursable sources (primarily external grants). As a result, theoretically, faculty members have some institutionally funded time available for professional development; however, in practice, high workloads and the absence of institutional funding for travel leave faculty members responsible for funding their own professional development activities. Most faculty members fund professional development activities with their research funds in areas related to their research.

There is no fixed period before a tenure-track faculty member is eligible for a sabbatical or that must occur between sabbaticals. In general, the minimum time interval may be expected to approximate the traditional six years but may be shorter. The anticipated professional benefit from the sabbatical is more important than timing. Given the financial circumstances of the institution, it is unlikely that additional institutional funding for faculty professional development will become available in the foreseeable future.

One area where the institution has provided faculty development opportunities in recent years is instruction. The NPS Office of Continuous Learning has an active faculty development program and provides numerous opportunities for faculty to participate in seminars and courses related to instructional technology and distance learning.

The unique mission of the Naval Postgraduate School and the objectives of the MSEE Degree Program make interaction with the Navy and Department of Defense considerably more important than interaction with practitioners in industry; however, interactions with practitioners do occur, often with defense contractors in the context of research related to leading-edge defense systems.

We believe that ECE faculty numbers are adequate to permit the interactions necessary to maintain viable relationships consistent with MSEE Degree Program Educational Objectives. The official sponsor of the MSEE Degree Program is the Naval Sea Systems Command (NAVSEA). An organization under the command of NAVSEA is the Space and Naval Warfare Systems Center (SPAWAR). SPAWAR participates as the curriculum subject matter expert (SME). At the MSEE Degree Program level, the primary relationship with the Navy is with the SME, which is SPAWAR. The primary link with the sponsor is the Program Officer, but direct interaction between sponsor points of contact and ECE Department faculty also occur, both on campus and at SPAWAR.
Headquarters in San Diego, CA. These interactions are generally related to the MSEE Degree Program and supporting activities. There is a formal review of the MSEE Degree Program conducted by the NPS and SPAWAR every two years, the most recent being in April 2019.

Other interactions between the faculty, DoD and industry practitioners are generally related to research. As stated previously, approximately one-fourth of ECE Department faculty labor is covered with reimbursable funds, primarily external research grants. The necessary interactions are generally initiated and maintained by faculty on an individual basis. If a faculty member requires funding for time to prepare a proposal or travel to visit a potential sponsor, ECE Department support may be provided at the discretion of the ECE Chair.

ECE faculty submit proposals to and receive funding from many of the same agencies that provide engineering research funding to faculty at other universities; Office of Naval Research, Naval Research Laboratory, National Security Agency, National Reconnaissance Organization, Air Force Office of Scientific Research, Army Research Office, Defense Advanced Research Projects Agency, and National Science Foundation. The question of whether or not the faculty is of sufficient number to accommodate service activities can probably only be answered qualitatively since there always seems to be no limit to the number of service positions begging for takers. We believe that the faculty is of sufficient number to adequately cover the really important service work that must be done at our institution, and in particular, for our MSEE Degree Program.

Service is one of the elements (along with instruction and scholarship) used to evaluate faculty members when they are considered for promotion and tenure. As a result of this institutional expectation for faculty service, most ECE faculty are involved in internal and external service activities and this, along with thesis advising, is taken into account in the ECE Department’s faculty workload model.

V. Authority and Responsibility of Faculty

Describe the role played by the faculty with respect to course creation, modification, and evaluation, their role in the assessment, maintenance, and enhancement of the master’s level program. Describe the roles of others on campus, e.g., dean or provost, with respect to these areas.

There is a high degree of faculty-student interaction. ECE Department class size is typically no larger than 20 and averages ten students. This makes in-class interaction possible on a more personal level. Most of the Department’s courses have labs, and this provides another opportunity for faculty and students to interact. Outside class, most faculty post office hours or have an open door policy. The most important interaction between faculty and students occurs during the student’s thesis research. Students are introduced to graduate research and the faculty in EC3000, Introduction to Graduate Research. During the course of their research, students typically work on topics related to faculty research programs and interact closely with the faculty. Additionally, there is a quarterly reception for program graduates preceding the graduation exercises, a reception
for all graduates following graduation, and other social events that provide opportunities for faculty-student interaction.

NPS students are either U.S. and international military officers or U.S. and international civilian defense establishment employees. All students are assigned to a Program Officer based on the program they are pursuing. The ECE Department has two Academic Associates who work with the Program Officer to advise students regarding their MSEE Degree Program and to approve their individual program. In the case of military students, the Program Officer represents the interests of the Program sponsor (Space and Naval Warfare Systems Center for US Navy students), and the Academic Associates represent the ECE Department. The Academic Associates and the Program Officer work together with the students to assure that the needs of the sponsor are being met and that the students’ programs have the requisite academic rigor and integrity.

There are two Academic Associates for the MSEE Degree Program, one for US Navy students and one for all other students, including DL students. The Academic Associates advised about 74 students in AY18. Both have release time and are compensated (one course per year) for performing this administrative function. This system has been in place and has worked smoothly for all ECE students for many years. Faculty numbers are sufficient to accommodate MSEE Degree Program student advising and counseling requirements.
### Table M-1. Faculty Qualifications (*)

**Master of Science in Electrical Engineering**

<table>
<thead>
<tr>
<th>Faculty Name</th>
<th>Highest Degree Earned - Field and Year</th>
<th>Rank ¹</th>
<th>Type of Academic Appointment ²</th>
<th>FT or PT ³</th>
<th>Years of Experience</th>
<th>Professional Registration/Certification</th>
<th>Level of Activity ⁴</th>
<th>Professional Organizations</th>
<th>Professional Development</th>
<th>Consulting/summer work in industry</th>
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</thead>
<tbody>
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<td>Chad A. Bollmann</td>
<td>PhD, ECE, 2018</td>
<td>O</td>
<td>NTT</td>
<td>FT</td>
<td>11</td>
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<td>PhD, EE, 2010</td>
<td>O</td>
<td>N/A</td>
<td>N/A</td>
<td>29</td>
<td>15</td>
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<td>Roberto Cristi</td>
<td>PhD, EE, 1983</td>
<td>P</td>
<td>T</td>
<td>FT</td>
<td>35</td>
<td>35</td>
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<td>P</td>
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<td>FT</td>
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<td>ASC</td>
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<td>FT</td>
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<td>T</td>
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<td>Carson McAbee</td>
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<td>O</td>
<td>NTT</td>
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<td>John McEachen</td>
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<td>P</td>
<td>T</td>
<td>FT</td>
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<td>P</td>
<td>T</td>
<td>FT</td>
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<td>T</td>
<td>FT</td>
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<td>PhD, EE, 1997</td>
<td>ASC</td>
<td>T</td>
<td>FT</td>
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<td>Phillip Pace</td>
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<td>P</td>
<td>T</td>
<td>FT</td>
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<td>AST</td>
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<td>James W. Scrofani</td>
<td>PhD, EE, 2005</td>
<td>ASC</td>
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<td>Terry Smith</td>
<td>MSEE, 1984</td>
<td>I</td>
<td>NTT</td>
<td>PT</td>
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<tr>
<td>Preetha Thulasiraman</td>
<td>PhD, EE, 2010</td>
<td>ASC</td>
<td>T</td>
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<td>Weilian Su</td>
<td>PhD, ECE, 2004</td>
<td>ASC</td>
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<td>Murali Tummala</td>
<td>PhD, EE, 1984</td>
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<td>Todd Weatherford</td>
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<td>T</td>
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<td>Xiaoping Yun</td>
<td>D.Sc., Systems Science, 1987</td>
<td>P</td>
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<tr>
<td>Lawrence J. Ziomek</td>
<td>PhD, Acoustics, Minor EE, 1981</td>
<td>P</td>
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<td>FT</td>
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</table>

Instructions: Complete table for each member of the faculty in the program. Add additional rows or use additional sheets if necessary. Updated information is to be provided at the time of the visit.

1. Code: P = Professor    ASC = Associate Professor  AST = Assistant Professor  I = Instructor  A = Adjunct  O = Other
2. Code: T = Tenured      TT = Tenure Track   NTT = Non Tenure Track
3. FT = Full-Time Faculty or PT = Part-Time Faculty, at the institution
4. The level of activity, high, medium or low, should reflect an average over the year prior to the visit plus the two previous years.
Table M-2. Faculty Workload Summary (*)

Master of Science in Electrical Engineering

<table>
<thead>
<tr>
<th>Faculty Member (name)</th>
<th>PT or FT</th>
<th>Classes Taught (Course No./Credit Hrs.) Term and Year</th>
<th>Program Activity Distribution</th>
<th>% of Time Devoted to the Program</th>
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<tr>
<td>Chad A Bollmann</td>
<td>FT</td>
<td>EC2700 (3-3), Q4</td>
<td>25% 75% 0%</td>
<td>100%</td>
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<tr>
<td>James Calusdian</td>
<td>N/A</td>
<td>EC2440 (3-2), Q4 (AY17)</td>
<td>20% 10% 70%</td>
<td>100%</td>
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<tr>
<td>Roberto Cristi</td>
<td>FT</td>
<td>EC3400 (3-2) Q1, EC4480 (3-2) Q2, EC3130 (4-2) Q2</td>
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<td>100%</td>
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<tr>
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<td></td>
<td>EC4130 (4-2) Q3, EO3404 (3-2) Q2</td>
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<tr>
<td>Monique P. Fargues</td>
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<td>EC4440 (4), EC2410 (3.5), EO2402 (4.5), EC3410 (4),</td>
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<td>FT</td>
<td>EC2820 (3-2) Q1, EC3800 (3-2) Q2, EC4830 (3-2) Q3</td>
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<tr>
<td>David A. Garren</td>
<td>FT</td>
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<td>Tri Ha</td>
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<td>EC4550 (4) Q3, EC4580 (4) Q4, EO2500 (3-2) Q3,</td>
<td>70% 30%</td>
<td>100%</td>
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<td></td>
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<td>EO3525 (4-1) Q4</td>
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<tr>
<td>Robert G. Hutchins</td>
<td>FT</td>
<td>EC2300 (3-2), EC3310 (3-2), EC2300 (3-2) (AY17 Q2)</td>
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<td>David Jenn</td>
<td>FT</td>
<td>EC4630R (3-2) Q1, EC3600R (3-2) Q2, EC3600DL (3-2) Q2</td>
<td>50% 50%</td>
<td>100%</td>
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<td>EC3630R (3-2) Q3, EC3630DL (3-2) Q3</td>
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<tr>
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<td>Carson McAbee</td>
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<td>0% 100% 0%</td>
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<tr>
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<td>50% 40% 10%</td>
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<tr>
<td>James Bret Michael</td>
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<tr>
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<td>FT</td>
<td>EC3700(3-2) Q1, EC4640 (3-2) Q1</td>
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<tr>
<td>Ric A. Romero</td>
<td>FT</td>
<td>EO2652 (3-2) Q2, TS3003 (3-2) Q2, EC4610 (3-2) Q4</td>
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<td>Roth, John</td>
<td>FT</td>
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<td>Weilian Su</td>
<td>FT</td>
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<td>Murali Tummala</td>
<td>FT</td>
<td>EC4730 (3-2) Q1, EC2010 (3-1) Q2, EC4745 (3-2) Q3</td>
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<td>Todd Weatherford</td>
<td>FT</td>
<td>On sabbatical leave in AY2018</td>
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<td>Xiaoping Yun</td>
<td>FT</td>
<td>EC2320 (3-1) Q1, EC2300 (3-2) Q2, EC3320 (3-2) Q4, EC4350 (3-2) Q4</td>
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<tr>
<td>Lawrence J. Ziomek</td>
<td>FT</td>
<td>EO3402 (3-1) Q1, EO3402 (3-1) DL Q1, EC4450 (4-1) Q2, EC4450 (4-1) DL Q2</td>
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</table>

1. FT = Full-Time Faculty or PT = Part-Time Faculty, at the institution
2. For the academic year for which the Self-Study Report is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under "Other."
5. Out of the total time employed at the institution.
FACILITIES

I. Student Communication and Learning
Describe the system in place to allow effective communication with students in the master’s level program to provide an atmosphere conducive to learning and support student success in the program. This could include classroom and office facilities, remote learning systems, or other interactive resources.

Each ECE faculty member has an individual office, which at a minimum contains a computer connected to the NPS network and a printer or easy access to a networked printer. Research Faculty and Technical Staff may have offices which are part of a larger laboratory, and at a minimum each has a computer connected to the NPS network and a printer. There are 71 total offices available, which are sufficient for the current faculty and staff size. Students are provided spaces within various laboratories and other designated study spaces. The department has a general-purpose conference room (SP-433B) available to faculty and students for group meetings. Laboratory spaces are commonly used for project-related discussions and demonstrations between faculty and students. Faculty offices are the primary locations for one-to-one meetings between faculty and students. Classrooms may be reserved in advance for faculty-student group meetings. The department has a student lounge in SP-401 and a student study room in SP-404. The student study room is equipped with a digital display, a whiteboard, and table and chair arrangements for student collaboration. The Program’s Educational Technician is located in this area in SP-402. In addition to maintaining student records and providing administrative assistance to the Program Officer, Program Chair and the Program’s Academic Associates (student advisors), the Educational Technician also serves as a liaison and facilitates communication between students and faculty.

There are over 20 classrooms in Spanagel Hall with a total student capacity exceeding 750 students available for instructional purposes to support courses offered by the Department of Electrical and Computer Engineering. All classrooms are equipped with dry-erase boards or standard blackboards. All classrooms also are installed with computer network outlets where students and instructors may connect their computers to the school’s computer network and to the Internet. A campus-wide wireless network provides nearly 100% coverage of the campus, including classrooms, laboratories, and offices in academic buildings. All classrooms are equipped with ceiling-mounted LCD computer projectors, each of which is connected to a dedicated computer permanently located in these classrooms. The availability of LCD projectors in classrooms greatly improves the quality of instruction by allowing instructors to show PowerPoint slides, programming codes, real-time simulations, or laboratory demonstrations. Overall, the classroom facilities are up-to-date and are sufficient for instructional needs.

II. Laboratories
Describe the laboratory facilities available to support student success in the program. This can include remote access or virtual laboratories. Provide an assessment of these facilities in how they are representative of current professional practice.
The ECE Department has well-developed laboratories in each specialty area to serve the dual role of supporting the instructional and research activities of the department. The ECE Department has 22 laboratories and one center. Each of those 22 laboratories is described in more detail below. These laboratories are currently located in four buildings (Spanagel Hall, Watkins Hall, Halligan Hall, and Building 216). All laboratories (except the Calibration Repair Lab, Power Lab, and Flash X-ray lab) as well as student and faculty offices are housed in Spanagel Hall. Laboratories are available during normal working hours with staff Laboratory Directors on hand to assist, and may be opened at other times by special arrangement. Electrical and computer technologies have changed rapidly in the past several years. It is critical to keep laboratory equipment up-to-date. NPS has a school-wide laboratory recapitalization program that sets aside funds to support major laboratory equipment upgrades. The department’s share of the laboratory recapitalization was $94k in FY 2017 and $150k in FY 2018. Other sources of funding provided $160k in FY 2018. These funds were used for major laboratory equipment upgrades. Laboratory supplies and maintenance are supported by OPTAR funds provided to the ECE Department annually and by a central repair fund maintained for campus-wide use by all departments. The twenty two labs that support the teaching and research mission of the MSEE Program are delineated below:

**Lab Code:** EC01  
**Lab Name:** Microelectronics Lab  
**Location:** Spanagel 512  
**Faculty Lab Director:** Professor Todd Weatherford  
**Staff Lab Director:** Matthew Porter  
**Description:** This lab supports design and analysis of semiconductor devices, design and development of VLSI integrated circuits, and design, implementation and testing of microprocessor and VLSI systems. Major equipment of the lab includes: Semiconductor Parameterization Equipment, Capacitance-Voltage measurement equipment, Semi-automatic Probing station, High Speed Sampling Scopes, Logic Analyzers, Printed Circuit Assembly tools, Unix and PC workstations, Electronic Design Automation (EDA) software, TCAD simulation tools, Semiconductor Parameterization Equipment (high power capability), Manual Probing stations (2+), Wire-bonding equipment, and PC workstations. The lab supports courses and thesis research projects in the MSEE degree Electronics specialty.

**Lab Code:** EC02C  
**Lab Name:** Circuits & Signals  
**Location:** Spanagel 531  
**Faculty Lab Director:** Professor Sherif Michael  
**Staff Lab Director:** Jeffrey Knight  
**Description:** This lab provides support for instruction and research in the areas of fundamental circuit design, discrete component testing, and communication theory. CAD facilities capable of schematic capture, circuit simulation and fault detection are available. The lab utilizes various test equipment including oscilloscopes, signal generators, spectrum analyzers, multimeters and high speed data acquisition equipment. The laboratory supports BSEE equivalency fundamental courses and the MSEE degree Communication, and Power Systems specialties.
Lab Code: EC02D
Lab Name: Digital Systems Lab
Location: Spanagel 525
Faculty Lab Director: Professor Douglas Fouts
Staff Lab Director: L. Warren Rogers
Description: This lab provides support for instruction and research in the areas of digital logic design, microprocessing interfacing, assembly language programming and VLSI. The laboratory is equipped with microprocessor development systems for advanced course work and thesis research, CAD facilities capable of schematic capture, circuit simulation and fault detection. This lab supports courses and thesis research in the MSEE degree Computer specialty.

Lab Code: EC03
Lab Name: PC Lab (LRC-IT01)
Location: Spanagel Hall 431
Faculty Lab Director: Professor Douglas Fouts
Staff Lab Director: Robert Broadston
Description: This laboratory is the primary computational facility within the Department of Electrical and Computer Engineering and consists of Windows PCs. This lab is for unclassified computing. EC11 in SP-548 is for computing at the secret level. Higher level security computing is available in the SCIF. The Academic Computing Lab is first and foremost a teaching laboratory for accomplishing computer assignments that are assigned as a part of ECE courses. It is used for research-related computing only when such computing does not interfere with course work. Typically, research work is conducted after normal working hours. The laboratory serves approximately 350 students annually and supports all ECE courses and other curricula within GSEAS. In addition to the usual office productivity tools, the software installed in this laboratory includes applications for accomplishing engineering design, analysis, CAD, and simulation related to the disciplines of Electrical and Computer Engineering.

Lab Code: EC04
Lab Name: Optical Electronics Lab
Location: Spanagel 511
Faculty Lab Director: Professor Phillip Pace
Staff Lab Director: James Calusdian
Description: The Optical Electronics Laboratory provides educational and research support in the areas of fiber optics, lasers (including a fiber sigma laser), integrated optics and electro-optics. The laboratory has a variety of fiber optics instrumentation including an OTDR, optical spectrum analyzer, connector application equipment, an optical fiber amplifier, optical autocorrelator for pulse-width measurement, various diode laser controllers, RF and microwave instrumentation (signal synthesizer, microwave spectrum analyzer), and general purpose test instrumentation. A variety of detectors and imaging equipment is also available. The lab supports courses in communications and fiber optic technology, thesis students, and research in optical signal processing.
Lab Code: EC05
Lab Name: Electromagnetics Lab
Location: Spanagel 419, 604, 703
Faculty Lab Director: Professor David Jenn
Staff Lab Director: Robert Broadston
Description: This laboratory supports instruction and research in the area of microwave systems and technology. This is accomplished with a mix of hardware, instruments, test systems and software. Included in the lab inventory are scalar and vector microwave network analyzers, spectrum analyzers, electromagnetic software for simulating antennas on ships and aircraft, and a software design system for simulation of microwave circuits and systems. There is a fully automated anechoic chamber for antenna pattern measurements, as well as a table-top antenna measurement system. The lab supports courses and thesis research in the MSEE degree Sensors specialty.

Lab Code: EC06
Lab Name: Radar and Electronic Warfare Systems Lab
Location: Spanagel 543, 545, 612, & 616
Faculty Lab Director: Professor Phillip Pace
Staff Lab Director: Vacant
Description: The objective of the Radar and Electronic Warfare (EW) Systems Laboratory is to educate military officers and civilians in the technology and operational characteristics of electronic warfare. The Radar and Electronic Warfare Systems Laboratory supports both teaching and research. The hardware laboratory contains instrumented radar and electronic warfare equipment and has been in operation for over 35 years. Each radar system is well instrumented to operate as teaching tool. The equipment allows the student to experience hands-on knowledge of performance characteristics, conduct experimental research and reinforces concepts that are taught in the classroom. This lab supports courses and thesis research in the MSEE degree Sensors specialty.

Lab Code: EC07
Lab Name: Controls and Robotics Lab
Location: Spanagel 521
Faculty Lab Director: Professor Xiaoping Yun
Staff Lab Director: James Calusdian
Description: The Controls and Robotics Laboratory provides instructional support in the areas of Guidance, Navigation, Controls, and Robotics for Department of Electrical and Computer Engineering and MAE2801 for Department of Mechanical and Aerospace Engineering. Lab facilities include servo control stations and associated computers that are used to conduct simulations and physical experiments, modeling, analysis, and design of control systems, and multiple mobile robots. The lab supports thesis students, and research in shipboard sensor calibration, wireless and smart sensors, MEMS inertial/magnetic sensors and robotics. This lab supports courses and thesis research in the MSEE degree Guidance & Control specialty.
Lab Code: EC08
Lab Name: Power Systems Lab
Location: Watkins 119
Faculty Lab Director: Associate Professor Giovanna Oriti
Staff Lab Director: L. Warren Rogers
Description: The Power Systems Laboratory supports postgraduate education and thesis research related to the design, analysis, simulation and implementation of power converter and electric drive technology. Thesis research projects are closely coupled to current Department of Defense priorities including more-survivable power system architectures such as DC Zonal Electric Distribution, Integrated Power Systems and electric propulsion. In coursework and projects, students employ modern device technologies, hardware-in-the-loop synthesis tools, simulation packages, measurement devices and power converter and electric machine modules to assess component operation, develop feedback controls, and study evolving power system challenges. An emphasis is placed on prototyping and validating against detailed simulation models. This lab supports courses and thesis research in the MSEE degree Power specialty.

Lab Code: EC09
Lab Name: Digital Signal Processing Lab
Location: Spanagel 533
Faculty Lab Director: Professor Roberto Cristi
Staff Lab Director: Robert Broadston
Description: This laboratory supports instruction and research in the area of Digital Signal Processing. Research and thesis work include or have included work in acoustic data modeling and processing, image analysis and modeling, signal detection and classification, multi-rate processing, target tracking, and other areas. Lab facilities include Windows workstations and FPGA boards for real-time processing. This lab supports courses and thesis research in the MSEE degree Signal Processing specialty.

Lab Code: EC10
Lab Name: Computer and Wireless Networking Laboratory
Location: Spanagel 500 and 506
Faculty Lab Director: Professor Murali Tummala
Staff Director: Robert Broadston
Description: This laboratory supports instruction and research in the area of network design, engineering, and infrastructure development. Thesis work and research undertaken include modeling and simulation of high-speed wired and wireless networks and related protocols, traffic modeling, simulation and analysis, design and simulation of wide area networks, and related areas. Lab facilities include routers, LAN switches, video processing equipment, ATM switches, a channel simulator, wireless LAN infrastructure, network simulation packages, and Windows and Linux workstations. This lab supports courses and thesis research in the MSEE degree in the Networks and Cyber specialties.
Lab Code: EC11
Lab Name: Secure Computing Lab
Location: Spanagel 546 & 548
Faculty Lab Director: Professor Philip Pace
Staff Lab Director: Robert Broadston
Description: This laboratory contains computing facilities for both instructional and research activities involving classified materials up to the SECRET level. It consists of Windows computing platforms. The lab is used by students preparing classified documents including class presentations and theses.

Lab Code: EC12
Lab Name: Communications Research Lab
Location: Spanagel 423, 425, and 427
Faculty Lab Director: Associate Professor Frank Kragh
Staff Lab Director: Donna Miller
Description: The ECE department performs significant research in radio and cell phone communications systems specifically the physical layer properties. The lab provides hardware and software support in this area for research and thesis work. In addition, the Communications Research Lab maintains a hardware and software capability in software defined radio to support thesis research projects.

Lab Code: EC13
Lab Name: Flash X-ray Lab
Location: Bldg 216
Faculty Lab Director: Professor Todd Weatherford
Staff Lab Director: Matthew Porter
Description: The NPS Flash X-ray Facility located at the NPS Golf Course provides capability to irradiate with X-rays or electrons components for study of nuclear weapons effects. The facility includes a Pulserad 112A built by Physics International. The output of the unit is 20 nanoseconds X-ray pulses on the order of 500-1000 Rads(Si). The facility supports internal NPS research, external users and laboratories for classroom instruction. This lab supports courses and thesis research in the MSEE degree Electronics specialty.

Lab Code: EC15
Lab Name: Calibration Repair Lab
Location: Ha 106 and 107
Faculty Lab Manager: Franklin Blevins
Description: This lab is an NPS-wide Type 2 facility for the calibration of test equipment and repair of some equipment. The lab provides: 1) Calibration Service for all Electronics Test Equipment (TMDE) for all NPS as provided by Measweb; 2) General repair for all calibrated and NCR electronics test equipment for all NPS, as provided by Property Book Inventory and Measweb Active Inventory; and (3) Support for all specialized electronics devices for all ECE laboratories. This lab generally purchases parts for repairs, calibration manuals, periodic calibration of standards, and test equipment. This lab supports the electronic calibration requirements for all laboratories at NPS.
Lab Code: EC16
Lab Name: Network Attack Lab
Location: Glasgow B014
Faculty Lab Director: Professor John McEachen
Staff Lab Director: Carson McAbee
Description: Classified environment to investigate computer network system architectures for exploitation, protection, and/or attack. Supports thesis work with the DoD to reinforce realistic approaches for solving critical IO issues.

Lab Code: EC17
Lab Name: Center for Cyber Warfare (CCW) Lab
Location: Spanagel 400
Faculty Lab Director: CDR Chad Bollman, Military Assistant Professor
Staff Lab Director: Carson McAbee
Description: The CCW Lab investigates issues associated with cyber operations. Current areas of research include software-defined networks, cyber operations and vulnerabilities, wireless and telephony security and RF vulnerabilities, and covert communications. This lab supports courses and thesis research in the MSEE degree Cyber specialty.

Lab Code: EC18
Lab Name: Localization and Network Optimization Laboratory
Location: Spanagel 219
Faculty Lab Director: Professor Weilian Su
Description: This lab supports cross-research domain areas in networking, communications and signal processing/transmissions. Its aim is to improve the performance of the networked systems as well as provide advanced techniques in localization. Vulnerabilities of networking and communication protocols are studied. Major equipment of the lab includes: cluster computers, GPU systems, FPGA systems, sensor networks, signal analyzers and signal generators. The lab supports thesis research projects in the MSEE Networks and Cyber specialties.

Lab Code: EC19
Lab Name: Cognitive Sensing, Radio, and Radar Lab (CSR2 Lab)
Location: Spanagel 544B
Faculty Lab Director: Associate Professor Ric Romero
Description: This laboratory supports research pertaining to transmit centric sensor systems such as cognitive radios and cognitive radars, including receiver processing that is integrated with the transmitter strategy to create cognitive systems.

Lab Code: EC20
Lab Name: Free Space Optical Communications Lab
Location: Spanagel 608
Faculty Lab Director: Professor John McEachen
Staff Lab Director: Carson McAbee
Description: This laboratory supports research pertaining to the operation and optimization of free space optical communication systems.
Lab Code: EC21  
**Lab Name:** Engineering Enclave for Maritime Superiority  
**Location:** Spanagel 303  
**Faculty Lab Director:** CDR Chad Bollman, Military Assistant Professor  
**Staff Lab Director:** Carson McAbee  
**Description:** Lab supports research on RF and Cyber Security for maritime navigation, communication, radar and computer systems. It supports research into protocols and messages used in a maritime environment to understand the interaction of hardware and software used in the navigation and operation of naval vessels.

Lab Code: EC22  
**Lab Name:** Solar Energy Lab  
**Location:** Spanagel 518  
**Faculty Lab Director:** Professor Sharif Michael  
**Staff Lab Director:** Matthew Porter  
**Description:** Lab supports teaching and research into military applications of solar cell technology. The lab conducts significant solar UAV research. Lab equipment includes a solar simulator for bench testing of solar cells and panels and solar cell modeling and simulation software. This lab supports courses and thesis research in the MSEE degree Power specialty.

III. **Computing Resources**  
Describe any computing resources (workstations, servers, storage, networks including software) which are used by the students in the master’s level program to achieve their educational goals. Assess the availability and adequacy of these facilities to support the scholarly and professional activities of the students and faculty in the program.

The students in the master’s level program in the ECE Department have access to a Learning Resource Center (LRC) which is a dedicated computer room. The LRC contains individual desktop computers and a multifunction copier. The desktop computers are loaded with various software programs that support both ECE courses and thesis research. The LRC is supported by the Information Technology and Communications Services (ITACS) Department at the Naval Postgraduate School.

A detailed description of the computing resources available to all NPS students and faculty, provided by the Information Technology and Communications Services (ITACS) Department at the Naval Postgraduate School, can be found in Appendix D – Institutional Summary (*), 5. Non-academic Support Units.

IV. **Guidance**  
Describe how students in the master’s level program are provided with appropriate guidance regarding the use of the tools, equipment, computing resources, and laboratories.

The ECE Department has five DoD civilian laboratory directors who work extensively with both students and faculty. Students enrolled in a laboratory course receive a briefing from the applicable laboratory director at the beginning of each quarter about operation, procedures, and safety. In addition, the laboratory directors are available throughout the
quarter to assist the students in proper operation of various pieces of test equipment as the need arises.

V. Maintenance and Upgrading of Facilities
Describe the policies and procedures for maintaining and upgrading the tools, equipment, computing resources, and laboratories used by students and faculty in the master’s level program.

Funds are available on an annual basis for both laboratory recapitalization and maintenance. Each year the GSEAS Dean requests the departments provide a list of laboratory recapitalization requests. The requests for all of GSEAS are extensively discussed at a meeting of the GSEAS Dean and Department Chairs. The GSEAS Dean allocates available laboratory recapitalization funding to the departments based on these discussions. The amount of funding available varies from year to year depending on budget constraints. Typically, the amount available for laboratory recapitalization is generally less than identified needs but allows for adequate growth. The laboratory maintenance funds provided by the GSEAS Dean have been sufficient for ECE requirements.

VI. Library Services
Describe and evaluate the capability of the library (or libraries) to serve the master’s level program including the adequacy of the library’s technical collection relative to the needs of the program and the faculty; the adequacy of the process by which faculty may request the library to add physical and/or remotely accessible books, subscriptions, databases, and other resources; the library’s on-line search and retrieval system; and any other library services relevant to the needs of the program and faculty scholarship and professional development.

Students receive a briefing about Dudley Knox Library (DKL) Resources from a Research Librarian specifically assigned to the ECE Program as part of the EC3000 course. Available library resources are more than adequate to support ECE students and faculty in their coursework and research. Distance learning students have access to the same online databases using the NPS Virtual Private Network. Multiple terminals are available throughout the library for accessing the catalog, electronic documents and databases, and journals. These terminals are networked to a number of printers permitting students and faculty to make print copies of information. Many library resources are available to any computer connected to the NPS Intranet. There is a fully-staffed reference desk. Individuals at the desk are widely knowledgeable of sources of information and are capable of finding even obscure references. The library participates in national interlibrary loan collaborations, so it is rare that desired information cannot be obtained. These services are available to students as well as faculty. As there is limited on-campus study space for students, the library provides a large number of carrels for individual research and study, as well as rooms that can be reserved for student meetings and group study.

The library has a limited budget and a large constituency. Its collections are limited to subjects matching departmental offerings and the majority of faculty research interests. It
makes up for this limitation by its connections to other libraries and its interlibrary loan program. Nevertheless, the library does an outstanding job at satisfying the needs of the department’s students and its faculty members. The Dudley Knox Library consistently receives the highest customer satisfaction ratings (>90%) of all NPS services (based on results from quarterly student exit surveys and biennial faculty/staff surveys).

A detailed description of the library services available to all NPS students and faculty, provided by the Dudley Knox Library at the Naval Postgraduate School, can be found in Appendix D – Institutional Summary (*), 5. Non-academic Support Units.

VII. Overall Comments on Facilities
Describe how the program ensures the facilities, tools, and equipment used in the program are safe for their intended purposes (See the 2019-2020 APPM I.E.5.b.(1)).

Because of the significant amount of electrical and computer engineering equipment, safety is a major concern within the department. NPS has two branches of safety; one is the Naval Support Activity Monterey (NSAM) Safety which is responsible for the building, grounds and personnel. Examples of our NSAM safety programs include Electrical Safety, HAZMAT, Ergonomics, CPR, First Aid, and Automated External Defibrillators. The other branch of safety is the Naval Postgraduate School Research Safety which is responsible for laboratories, equipment, personnel and field work. Our Research Safety programs include Laser Safety, RF Safety, and X-ray Safety.

To oversee safety issues, each department has assigned an individual as the Safety Coordinator. The Safety Coordinator reports directly to the Program Chair and is the central point of contact for all safety issues within the department. The responsibility of the Safety Coordinator is to ensure that each Laboratory Director and/or PI, as appropriate, in charge of a laboratory and the laboratory meets all safety requirements. The Safety Coordinator also makes sure the non-laboratory areas and personnel are also compliant with safety regulations. (Faculty, Staff, and offices, etc.)

1Include information concerning facilities at all sites where program courses are delivered.
INSTITUTIONAL SUPPORT

I. Leadership
Describe the leadership of the master’s level program and discuss its adequacy to ensure the quality and continuity of the program and how the leadership is involved in decisions that affect the program.

The leadership of the program includes the Program Chair and the Associate Chairs for Instruction, Students, Research, and Operations. The various Associate Chairs are appointed by the Program Chair. The Program Chair is recommended by the Department and confirmed by the GSEAS Dean, Provost, and President. The typical appointment for a Program Chair is three years, and the current Program Chair is in his first term. The Associate Chairs are appointed for a year at a time, and generally serve multiple terms. The Associate Chairs form an executive committee to advise the Program Chair on issues as needed.

II. Program Budget and Financial Support
1. Describe the process used to establish the program’s budget and provide evidence of continuity of institutional support for the master’s level program. Include the sources of financial support including both permanent (recurring) and temporary (one-time) funds.
2. To the extent not described above, describe how resources are provided to acquire, maintain, and upgrade the infrastructures, facilities, and equipment used in the master’s level program.
3. Assess the adequacy of the resources described in this section with respect to the students in the program being able to attain their educational goals.

From the top down, the Navy provides the school an amount that varies each year based on budget pressures at the Federal level. It is not tied to student enrollments yet the school is expected to take all Naval (US Navy and USMC) officers assigned to the campus. Students from other US services are funded at the “marginal” cost of admitting one additional student, and those funds are provided on a per-capita basis by their services. Officers from other nations are funded either by their country or the US State Department.

NPS receives mission funding for active duty Navy and Marine Corps officers. Those funds are allocated to departments for instruction by the GSEAS Dean after extensive discussions with the GSEAS Department Chairs in committee. The mission funds provided cover instruction, thesis advising, institutional service, and institutionally funded research.

At NPS there are no teaching assistants or graders. There is a delineation of the various ECE laboratories in FACILITIES, Section II. Each lab is supported by a member of the Technical Staff, who provides support to both students and faculty.

As previously described in FACILITIES, Sections II and V, there is an annual Laboratory Recapitalization program wherein NPS provides funding for laboratory upgrades.
Analogous to the department budget, the GSEAS Dean meets with the GSEAS Department Chairs to discuss the laboratory recapitalization requests from each department. The GSEAS Dean distributes the available Laboratory Recapitalization funds based on the results of the meeting. The ECE budget has always been adequate to fund the program tenure-track faculty and staff.

III. Staffing
Describe the adequacy of the staff (administrative, instructional, and technical) and institutional services provided to the master’s level program. Discuss methods used to retain and train staff.

The department has adequate staffing to fulfill its mission. The department staff includes administrative staff, technical staff to maintain laboratory equipment, and instructional support staff. As described in Appendix D, support to the program is provided across campus. All aspects of the institutional services and support personnel are considered adequate.

IV. Faculty Hiring and Retention (*)
1. Describe the process for hiring of new faculty.
2. Describe strategies used to retain current qualified faculty.

The process for hiring new faculty begins when the ECE Search Committee finds a need for tenure-track faculty in a specific area of expertise. Based on this recommendation, the request to hire a new faculty member is submitted to the GSEAS Dean and subsequently to the NPS Provost. Upon approval, advertisements are placed both online and on the NPS website as well as in traditional publications such as IEEE Spectrum. Candidates are reviewed by the ECE Search Committee and selected candidates are invited for an on-campus interview. The successful candidate is offered a position with the ECE Department. The ECE Department offers faculty the opportunity to teach and engage highly qualified, mature, and motivated students in a typically small classroom environment as well as the opportunity to engage in research highly relevant to the US Department of Defense. Due to the almost universal success of our faculty in obtaining reimbursable research funding, virtually all tenure-track faculty secure sufficient additional funding to support their salary all twelve months of the year. As a result, the ECE Department does not have any difficulty in attracting and retaining qualified faculty.

V. Support of Faculty Professional Development (*)
Describe the adequacy of support for faculty professional development, how such activities such as sabbaticals, travel, workshops, seminars, etc., are planned and supported.

There is adequate support for professional development activities.

New tenure-track faculty members receive generous research initiation funds provided through the Dean of Research for the first two years of employment. The research initiation funds provide funding for labor for a research quarter in each of the two years, equipment, and travel. The consequence of new faculty receiving research initiation funds is that they are not required to obtain external reimbursable funding for their first
two years; however, it is not uncommon for new faculty to obtain external funding within the first two years of joining the NPS faculty.

Every new member of the faculty takes the instructional design course offered by the campus Center for Educational Design, Development, and Delivery.

The department has a seminar series for its faculty and graduate students. NPS has a guest speaker program that brings distinguished speakers to campus about five times per quarter to lecture students and faculty. Departments notify each other of their seminar speakers and all are invited.

NPS has a sabbatical program, for which tenured faculty are eligible to apply for annually.

Research programs provide funds to support travel to professional meetings and conferences. In the last six years in the ECE department, funding has been available for every reasonable faculty travel request for professional development.

The faculty workload model also provides tenure-track faculty with some institutionally funded research time.

Non-tenure track faculty without a doctoral degree can enroll in NPS doctoral programs at no cost; all faculty are free to take any course on campus at no cost.

In general, support of faculty professional development is considered adequate.
Undergraduate Education Evaluation Form

The Department of Electrical and Computer Engineering at the Naval Postgraduate School is accredited at the Master of Science degree level through the Accreditation Board for Engineering and Technology. Students earning a Master of Science in Electrical Engineering or a Degree of Electrical Engineer at NPS, must either have attained an ABET accredited undergraduate Electrical Engineering degree, or earned the equivalency of a Bachelor of Science Degree in Electrical Engineering. Some courses from the student’s undergraduate institution may count towards this equivalency, even though the final undergraduate degree may not have been in Electrical Engineering. Some courses taken at NPS may also be applied to meeting the undergraduate equivalency. This evaluation form is provided to document the completion of this equivalency.

Name of Student: _____________________________ Email Address: _____________________________
Enrollment Date: _____________________________ Intended Graduation Date: ________________

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1 Skip the rest of the form if you have an ABET accredited BSEE degree.

I certify the information on all pages of this form is complete and correct.

Signature of Student: _____________________________ Date: ________________

We certify this student has met the minimum requirements for the undergraduate equivalence to a BSEE Degree.

ECE Department Academic Associate, Date
ECE Associate Chair for Students, Date

Program Officer, Date
I. Mathematics

I.A A minimum of 24 quarter credit hours or 16 semester credit hours of college-level mathematics is required. College-level mathematics consists of mathematics that requires a degree of mathematical sophistication at least equivalent to that of introductory calculus. **List all college-level mathematics courses passed with a grade of C- or better in chronological order from least recently taken to most recently taken.** For each course, indicate the college or university where the course was taken, the course number, the course title, and the number of credit hours.

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<th>University</th>
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<th>Qtr Credits</th>
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</table>

**Qtr Credits Subtotal:** __________  **Sem Credits Subtotal:** __________

**Total Credits (Qtr Credits + (1.5 x Sem Credits)):** __________

I.B For each of the following mathematics subjects that has been studied, **indicate the college or university where the subject was studied, the course number, and the course title.** All courses must have been passed with a grade of C- or better.

<table>
<thead>
<tr>
<th>Subject</th>
<th>University</th>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Differential Calculus</td>
<td></td>
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<tr>
<td>Integral Calculus</td>
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<tr>
<td>Differential Equations</td>
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<tr>
<td>Linear Algebra</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Complex Variables</td>
<td></td>
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<td></td>
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<tr>
<td>Discrete Mathematics</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Probability</td>
<td></td>
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<td></td>
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<tr>
<td>Statistics</td>
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</tbody>
</table>
II. Sciences

II.A Basic Science

A minimum of 24 quarter credit hours or 16 semester credit hours of college-level basic science is required. Basic sciences consist of chemistry and physics and other natural sciences including life, earth, and space sciences. **List all college-level basic science courses passed with a grade of C- or better in chronological order from least recently taken to most recently taken.** For each course, indicate the college or university where the course was taken, the course number, the course title, and the number of credit hours.

<table>
<thead>
<tr>
<th>University</th>
<th>Number</th>
<th>Title</th>
<th>Qtr Credits</th>
<th>Sem Credits</th>
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<tr>
<td>Qtr Credits Subtotal:</td>
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<td>Sem Credits Subtotal:</td>
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<tr>
<td>Total Credits (Qtr Credits + (1.5 x Sem Credits)):</td>
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</tbody>
</table>

II.B Physics

A two-course sequence in calculus based college-level physics is required. **List a sequence of Physics courses at least two courses long. Course must have been passed with a grade of C- or better.** For each course, indicate the college or university where the course was taken, the course number, the course title, and the number of credit hours.

<table>
<thead>
<tr>
<th>University</th>
<th>Number</th>
<th>Title</th>
<th>Qtr Credits</th>
<th>Sem Credits</th>
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</tbody>
</table>

II.C Computing Science

A knowledge of computing science is required. **List at least one college-level computing science course passed with a grade of C- or better.** Indicate the college or university where the course was taken, the course number, the course title, and the number of credit hours. Currently approved NPS courses meeting such requirement are: AE/EC2440, EC2820, EC2840, EC2700, and CS2020. Any other NPS course must have the **advanced approval** of the ECE Academic Associate and Chairperson.

<table>
<thead>
<tr>
<th>University</th>
<th>Number</th>
<th>Title</th>
<th>Qtr Credits</th>
<th>Sem Credits</th>
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</tbody>
</table>
III. Engineering Science and Engineering Design

III.A A minimum of 72 quarter credit hours or 48 semester hours of engineering science and design is required. At least 54 quarter credit hours or 36 semester credit hours must be in Electrical Engineering science and design. **List all Electrical Engineering courses passed with a grade of C- or better** in chronological order from least recently taken to most recently taken. For each course, indicate the college or university where the course was taken, the course number, the course title, and the number of credit hours.

<table>
<thead>
<tr>
<th>University</th>
<th>Number</th>
<th>Title</th>
<th>Qtr Credits</th>
<th>Sem Credits</th>
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Qtr Credits Subtotal: ___________________  Sem Credits Subtotal: ___________________

Total Credits (Qtr Credits + (1.5 x Sem Credits)): ___________________
III.B A minimum of 72 quarter credit hours or 48 semester hours of engineering science and design is required. **List all non Electrical Engineering courses passed with a grade of C- or better** in chronological order from least recently taken to most recently taken. For each course, indicate the college or university where the course was taken, the course number, the course title, and the number of credit hours.

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<tr>
<th>University</th>
<th>Number</th>
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<th>Qtr Credits</th>
<th>Sem Credits</th>
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Qtr Credits Subtotal: ___________  Sem Credits Subtotal: ___________

Total Credits (Qtr Credits + (1.5 x Sem Credits)): ___________

III.C Sum of Total Credits from Part A and Part B (in Qtr Credits):

III.D A major design experience at the advanced undergraduate level that is based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints is required. **Briefly describe your major design experience and include associated course number(s). Include brief description of specific engineering standards and multiple constraints considered.** This requirement can be satisfied at the NPS by completing a course with a major design experience that has been previously approved by the NPS ECE Department Curriculum Committee, such as EC2220.

| Incorporated within design experience | Attach a short summary of the project including a description of engineering standards and constraints used in the work at the back. |
| Engineering standards | |
| Multiple realistic constraints | |

Additional comments: ________________
IV. General Education

A minimum of 24 quarter credit hours or 16 semester credit hours is required in general education courses that complement the technical curriculum and are consistent with program and institution objectives. **List all courses in subjects other than mathematics, basic science, computer science, and engineering passed with a grade C- or better.** List courses in chronological order from least recently taken to most recently taken. For each course, indicate the college or university where the course was taken, the course number, the course title, and the number of credit hours. Examples of topics in these areas include philosophy, fine arts, sociology, psychology, political science, anthropology, economics, and foreign languages.

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Qtr Credits Subtotal: ____________  Sem Credits Subtotal: ____________
Total Credits (Qtr Credits + (1.5 x Sem Credits)): ____________
V. Overall Evaluation of Academic Background

Section to be filled out by Academic Associate during final student interview after reviewing the student academic background

<table>
<thead>
<tr>
<th>Student has demonstrated that he/she has:</th>
<th>Satisfied by (Check all that apply)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Course Work</td>
</tr>
<tr>
<td>An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.</td>
<td></td>
</tr>
<tr>
<td>An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.</td>
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<tr>
<td>An ability to communicate effectively with a range of audiences.</td>
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<tr>
<td>An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.</td>
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<tr>
<td>An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.</td>
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<tr>
<td>An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.</td>
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<tr>
<td>An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.</td>
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</tbody>
</table>

Additional comments:
Naval Postgraduate School  
Department of Electrical and Computer Engineering  
List of Undergraduate Level ECE Courses

**General Purpose**  
EC1010 Introduction to MATLAB, P/F only (1.5 quarter credits)  
EC/AE2440 Introduction to Scientific Programming (4 quarter credits)  
EC2010 Probabilistic Analysis of Signals and Systems (3.5 quarter credits)

**Circuits and Electronics**  
EC2100 Circuit Analysis (4 quarter credits)  
EC2110 Circuit Analysis II (4 quarter credits)  
EC2200 Introduction to Electronics Engineering (4.5 quarter credits)

**Controls**  
EC2300 Control Systems (4 quarter credits) (or ME2801 which is cross-listed with EC2300)  
EC2320 Linear Systems (3.5 quarter credits)

**Signal Processing**  
EC2400 Discrete Systems (3.5 quarter credits)  
EC2410 Analysis of Signals and Systems (3.5 quarter credits)  
EC2450 Accelerated Review of Signals and Systems - offered online and P/F only. *Only available as a refresher for students who covered these concepts in their undergraduate program, not available for students who did not cover concepts before, credits will not count towards undergraduate equivalency.* (4 quarter credits)

**Communications**  
EC2500 Communications Systems (4 quarter credits)

**Electromagnetics**  
EC2650 Fundamentals of Electromagnetic Fields (4.5 quarter credit)

**Computers**  
EC2820 Digital Logic Circuits (4 quarter credits)  
EC2840 Introduction to Microprocessors (4 quarter credits)

**Design**  
EC2220 Electrical Engineering Design; ABET Design Project in Electrical Engineering (5 quarter credits), *required for students without an undergraduate degree in Engineering*

EC2700 Introduction to Cyber Systems (4.5 quarter credits)  
*Note: EC2700 cannot be used to meet requirements for knowledge of concepts in any of the areas listed above.*
ABET accreditation at the Master’s Level requires verification that students in our MSEE program have had post-secondary education and/or professional experiences that support(s) the attainment of student outcomes (1) through (7) as defined in the general criteria for baccalaureate programs, Criterion 3.

In order to verify the extent to which student outcomes (1) through (7) are being attained by students in our MSEE program, the NPS ECE department targets a minimum of four courses per quarter (a mix of 2000 and 3000 level courses). Each course is assigned a student outcome for assessment and evaluation of the extent to which it was covered in the course.

Faculty assigned to complete an assessment must provide a written description of the way ideas and aspects from the assigned outcome were incorporated into the course.

**Instructions:** Fill out the top portion of this form based on the assignment for the given quarter and answer the following questions as thoroughly as possible.

Your feedback will be reviewed annually by an appropriate Technical Area Group (TAG). Important issues will be forwarded to the ECE Department Curriculum Committee.

**Response Questions:**

1. How was the main idea of the outcome incorporated into the course or event?
2. What additional aspects of the outcome were included in the course or event?
3. Were techniques in addition to traditional testing used to provide learning and assessment opportunities related to the targeted outcome? If so, what were they?
4. Is your course journal for this course complete and filed on SharePoint?
5. Did the course adequately address the targeted outcome and why?
6. Were course pre-requisites sufficient to prepare students for this course?
7. Were there additional outcomes from the (1) through (7) criteria that were covered in the course? If so, what were they and how were they addressed?
Exhibit 3  Academic Year 2018 ABET Assessment Plan

Academic Year 2018 ABET Assessment Plan

<table>
<thead>
<tr>
<th>Fall AY18 Courses</th>
<th>Faculty</th>
<th>ABET Student Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC2650</td>
<td>Parker</td>
<td>✓</td>
</tr>
<tr>
<td>EC2820</td>
<td>Fouts</td>
<td>✓</td>
</tr>
<tr>
<td>EC3230</td>
<td>S. Michael</td>
<td>✓</td>
</tr>
<tr>
<td>EC3500</td>
<td>Kragh</td>
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</table>

<table>
<thead>
<tr>
<th>Winter AY18 Courses</th>
<th>Faculty</th>
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</tr>
</thead>
<tbody>
<tr>
<td>EC2220</td>
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<td>✓</td>
</tr>
<tr>
<td>EC2300</td>
<td>Yun</td>
<td>✓</td>
</tr>
<tr>
<td>EC3310</td>
<td>Hutchins</td>
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</tr>
<tr>
<td>EC3760</td>
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</table>

| Total number of assessments per outcome | 1 | 1 | 1 | 2 | 1 | 0 | 0 | 1 | 0 |

<table>
<thead>
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<th>Spring AY18 Courses</th>
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<table>
<thead>
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<th>Summer AY18 Courses</th>
<th>Faculty</th>
<th>ABET Student Outcomes</th>
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<tbody>
<tr>
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<tr>
<td>EC2700</td>
<td>Bollmann</td>
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<tr>
<td>EC3410</td>
<td>Fargues</td>
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</table>

| Total number of assessments per outcome | 2 | 2 | 1 | 0 | 0 | 2 | 0 |
## Exhibit 4  2000 Level Courses That Have Been Assessed

### 2000 Level Courses That Have Been Assessed

<table>
<thead>
<tr>
<th>EC Courses</th>
<th>AY15</th>
<th>AY16</th>
<th>AY17</th>
<th>AY18</th>
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<tbody>
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<tr>
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<tr>
<td>2110</td>
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<td>(e) Oriti</td>
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<td>2200</td>
<td>(a) Michael</td>
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<td>(c) Parker</td>
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<td>(h) Oriti</td>
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<td>(c) Hutchins</td>
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<td>(6) Ha</td>
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<td>(e) Morgan</td>
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<td>(j) Calusdian</td>
<td>(2) Boleman</td>
<td></td>
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<tr>
<td>2820</td>
<td></td>
<td></td>
<td>(c) Fouts</td>
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### Exhibit 5  3000 Level Courses That Have Been Assessed

#### 3000 Level Courses That Have Been Assessed

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Exhibit 6  ABET Criterion 3 Course Assessment Procedure

Course Descriptions

ABET Course Assessments

Technical Area Groups (TAGs)

Changes Recommended

No  Stop

Yes  ECE Curriculum Committee  ECE Department Chairman

Changes Approved

No  Stop

Yes  Internal Changes

Yes  Stop

No  NPS Academic Council

Changes Approved

No  Stop

Yes
### Exhibit 7  Student Outcomes (1) Through (7) Covered in the 2000 and 3000 Level EC Courses

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<th>Course</th>
<th>(1) Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics</th>
<th>(2) Apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and social, environmental, and economic factors</th>
<th>(3) Communicate effectively with a range of audiences</th>
<th>(4) Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts</th>
<th>(5) Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives</th>
<th>(6) Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions</th>
<th>(7) Acquire and apply new knowledge as needed, using appropriate learning strategies</th>
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Exhibit 8 Checklist for MSEE Degree

Checklist for MSEE Degree

The program leading to the Master of Science in Electrical Engineering at NPS is accredited at the advanced level through the Accreditation Board for Engineering and Technology. This accreditation is based on degree requirements set forth by the Electrical and Computer Engineering Department at NPS and approved by the NPS Academic Council. This checklist is provided to document the completion of these degree requirements.

Student name: ____________________________ email: ____________________________

Month/year enrolled: ____________________ Graduation date: ____________________

I certify that 1) the information contained on this form is correct; and 2) courses included in this checklist are not included in the requirements towards another Master degree.

Student: ____________________________ Date: ____________________________

-- USN Students only (For P-codes issues)--

Final Checklist: Please attach Copy of Thesis Title & Abstract at the back

We certify that this student has met the minimum requirements for the MSEE degree.

Signatures:

_________________________________ ________________________________
Academic Associate, Date ECE Assoc. Chair for Students, Date
ECE Department

_________________________________ ________________________________
Program Officer, Date ECE Department Chair, Date

ECE Department
1. **BSEE Degree/Equivalence** requirement satisfied by (fill in one):
   - BSEE degree from: __________________________ Month/year: ____________________
   - BSEE equivalence from NPS. Date: ____________________

2. **Thesis:**
   - Number of thesis credits (16 minimum): ______________
   - Advisor: __________________
   - Presentation date: _______________ Where? (ECE Seminar?) __________________
   - Completed EC3000 during (specify quarter) ____________________

   The remaining requirements must be met exclusive of thesis requirements.

3. **Program of Study:**
   (Select **exactly two specialties contained within one focus area**, and check courses taken in those specialties):

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<tr>
<th>Focus Areas</th>
<th>Communications &amp; Information Engineering</th>
<th>Cyber Engineering (For USN students selecting this focus area: “Cyber” is required as one of the two specialties)</th>
<th>Nano-electronics &amp; Energy Engineering</th>
<th>Sensor &amp; Control Engineering</th>
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   **Focus Area selected:** __________________________________________

   **Specialties selected:** (1) ________________________ & (2) ________________________

   **USN students only: Final Checklist - Please attach Copy of Thesis Title & Abstract at the back**

---

For administrative use only – **Subspecialty Code Assignment for US NAVY only**

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### List of Specialties (each specialty has 4 required courses)

#### Communications Systems

**Required Courses:**
- EC 3500 Analysis of Random Signals (4-0)
- EC 3510 Communications Engineering (3-1)
- EC 4550 Digital Communications (4-0)
- EC 4580 Error Correction Coding (4-0)

#### Computer Systems

**Required Courses:**
- EC 3800 Microprocessor Based System Design (3-2)
- EC 3840 Introduction to Computer Architecture (3-2)
- EC 4820 Advanced Computer Architecture (3-2)
- EC 4830 Digital Computer Design (3-2)

#### Cyber Systems

**Required Courses:**
- EC3730 Cyber Network & Physical Infrastructures (3-2)
- EC3740 Reverse Engineering in Electronic Syst. (3-2)

AND select either the Classified or Unclassified set:

**Classified:** (US only, with appropriate security clearance)
- EC 3760 Information Operations Systems (3-2)
- EC 4765 Cyber Warfare (3-2)

**Unclassified:**
- EC 4730 Covert Communications (3-2)
- EC 4770 Wireless Communications Network Security (3-2)

#### Power Systems

**Required courses:**
- EC 3130 Electrical Machinery Theory (4-2)
- EC 3150 Solid State Power Conversion (3-2)
- EC 4130 Advanced Electrical Machinery Systems (4-2)
- EC 4150 Advanced Solid State Power Conversion (4-1)

#### Electronics

**Required courses:**
- EC 3200 Advanced Electronics Engineering (3-2)
- EC 3220 Semiconductor Device Technologies (3-2)
- EC 4220 Introduction to Analog VLSI (3-1)
- EC 4230 Reliability Issues for Military Electronics (3-1)

#### Signal Processing Systems

**Required Courses:**
- EC 3400 Digital Signal Processing (3-2)
- EC 3410 Discrete-Time Random Signals (3-2)
- EC 4440 Statistical Digital Signal Processing (3-2)
- EC 4480 Image Processing and Recognition (3-2)

#### Guidance, Control & Navigation Systems

**Required Courses:**
- EC 3310 Optimal Estimation: Sensor & Data Association (3-2)
- EC 3320 Optimal Control Systems (3-2)
- EC 4330 Navigation, Missile, & Avionics Systems (3-2)
- EC 4350 Nonlinear Control Systems (3-2)

#### Network Engineering

**Required Courses:**
- EC 3710 Computer Communications Methods (3-2)
- EC 4725 Adv. Telecommunication Systems Eng. (3-2)
- EC 4745 Mobile Ad Hoc Wireless Networking (3-2)
- EC 4785 Internet Engineering (3-2)

#### Sensor Systems Engineering

**Required Courses:**
- EC 3600 Antennas & Propagation (3-2)
- EC 3630 Radiowave Propagation (3-2)

And select either the RADAR or EW set:

**RADAR:**
- EC 4610 Radar Systems (3-2)
- EC 4630 RCS Prediction & Reduction (3-2)

**EW:**
- EC 3700 Joint Network-Enabled Electronic Warfare I (3-2)
- EC 4680/90 Joint Network-enabled Electronic Warfare II (3-2)
### List of ECE courses not included above

#### Communications Systems
- EC 4500: Adv. Topics in Communications (3-0)
- EC 4510: Cellular Communications (3-0)
- EC 4530: Soft Radios (3-2)
- EC 4560: Spread Spectrum Communications (3-2)
- EC 4570: Signal Detection and Estimation (4-0)
- EC 4590: Communications Satellite Systems Eng. (3-0)

#### Computer Systems
- EC 3800: Microprocessor Based System Design (3-2)
- EC 3820: Computer Systems (3-2)
- EC 4800: Adv. Topics in Computer Eng. (3-1)
- EC 4830: Digital Computer Design (3-2)
- EC 4870: VLSI Systems Design (3-2)

#### Electronics Systems
- EC 3230: Space Power & Radiation Effects (3-1)
- EC 3240: Renewable Energy at Military Bases (3-2)
- EC 3280: Adv. Topics in Computer Eng. (3-1)
- EC 4950: Emerging Nanotechnology (3-1)
- EC 4280: MEMS Design II (2-4)

#### Guidance & Control Systems
- EC 4300: Adv. Topics in Modern Control Systems (3-1)
- EC 4310: Fundamentals of Robotics (3-2)
- EC 4320: Design of Robust Control Systems (3-2)

#### Machine Power Systems
- EC 3110: Electrical Energy (3-2)

#### Sensor Systems
- EC 3210: Intro to Electro-Optics Systems Eng. (4-1)
- EC 3610: Microwave Engineering (3-2)
- EC 4210: Electro-Optics Systems Engineering (3-0)
- EC 4640: Airborne Radar Systems (3-2)

#### Signal Processing Systems
- EC 3460: Machine Learning for Signal Analytics (3-2)
- EC 4400: Adv. Topics in Signal Processing (3-0)
- EC 4450: Sonar Systems Engineering (4-1)
- EC 4910: DSP for Wireless Communications (3-2)

#### Network Engineering
- EC 4430: Multimedia Info. & Communications (3-1)
- EC 4710: High-Speed Networking (3-2)

#### Cyber Systems
- EC 3750: SIGINT Systems I *(C)* (3-2)
- EC 4715: Cyber System Vulnerabilities & Risk Assessment (3-2)
- EC 4747: Data Mining in Cyber Applications (3-2)
- EC 4755: Network Traffic, Activity Detection, & Tracking (3-2)

*(C)* classified course
3. **Course credit requirements**

List all graduate courses taken in approved engineering, mathematics, physical science, and/or computer science.

1) EC3000 must be part of the program matrix but **do not** include EC3000 in the list below;
2) Lab credits count as half credits;
3) Only one instance of EC4900 may be counted towards meeting minimum degree requirements;
4) Do not include any graduate courses already counted for the BSEE equivalence in the Table below.

**Note:** course credit numbers are periodically re-evaluated and may have changed since you took a course. *Only the credits shown on your student transcripts will be counted to satisfy minimum requirements.*

<table>
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<th>3000-level courses</th>
<th>Credits (X-X)</th>
<th>4000-level courses</th>
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ECE Dept Graduate Academic Certificate Enrollment Form

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<th>Contact Phone:</th>
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A. Curriculum no.
- 590
- 591
- 525
- 533
- 592
- (other, specify)

B. NPS Degree enrolled:
- [ ] Graduation date: _______________

C. Quarter enrolled: _______________

I wish to enroll in: Academic Certificate (check all that apply, see entrance requirements below)

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<th>Specific courses required:</th>
<th>Quarter planned or taken</th>
<th>For administrative use only</th>
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- [ ] Guidance, Navigation & Control Systems
  - [ ] EC3310
  - [ ] EC3320
  - [ ] EC4350
  - [ ] EC4330
  - [ ] Y [ ] N
  - [ ] AA: __________
  - [ ] Y [ ] N

- [ ] Fault Tolerant Computing
  - [ ] EC3800
  - [ ] EC4810
  - [ ] CS4920
  - [ ] Restricted to offerings focusing on fault tolerant computing topics only, requires approval from AA
  - [ ] Y [ ] N
  - [ ] AA: __________
  - [ ] Y [ ] N

- [ ] Reconfigurable Computing
  - [ ] EC3840
  - [ ] EC3820
  - [ ] EC4820
  - [ ] Y [ ] N
  - [ ] AA: __________
  - [ ] Y [ ] N

- [ ] Digital Communications
  - [ ] EC3500
  - [ ] EC3510
  - [ ] EC4550
  - [ ] EC4580
  - [ ] Y [ ] N
  - [ ] AA: __________
  - [ ] Y [ ] N

- [ ] Cyber Warfare
  - [ ] EC3760
  - [ ] EC4765
  - [ ] Select One out of AND satisfy 12 credit hours (check): 0 DA3105
  - [ ] EC3730; [ ] EC3750
  - [ ] EC4730; [ ] EC4755
  - [ ] CS4558; [ ] EC3970
  - [ ] Y [ ] N
  - [ ] AA: __________
  - [ ] Y [ ] N

- [ ] Signal Processing
  - [ ] EC3400
  - [ ] EC4440
  - [ ] Select One out of (check):
    - [ ] EC3460; [ ] EC4430
    - [ ] EC3940; [ ] EC4450
    - [ ] EC4400; [ ] EC4480
    - [ ] EC4910
  - [ ] Y [ ] N
  - [ ] AA: __________
  - [ ] Y [ ] N

- [ ] Electric Ship Power Systems
  - [ ] EC3130
  - [ ] EC3150
  - [ ] EC4130
  - [ ] EC4150
  - [ ] Y [ ] N
  - [ ] AA: __________
  - [ ] Y [ ] N

- [ ] Electronic Warfare (EW) Engineer
  - [ ] EC3600
  - [ ] EC3630
  - [ ] EC3700
  - [ ] Y [ ] N
  - [ ] AA: __________
  - [ ] Y [ ] N

Effective date: 04/21/15; last update: 05/03/18
Please read Privacy Advisory at [www.nps.edu/Footer/PrivacyPolicy.html](http://www.nps.edu/Footer/PrivacyPolicy.html)
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<td>N</td>
<td>EC4680</td>
<td>AA:</td>
<td>N</td>
</tr>
<tr>
<td>Network Engineering</td>
<td>EC4710</td>
<td>Y</td>
<td>N</td>
<td>EC4745</td>
<td>Y</td>
<td>N</td>
<td>AA:</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Cyber Systems</td>
<td>EC3710</td>
<td>Y</td>
<td>N</td>
<td>EC3730</td>
<td>N</td>
<td>Y</td>
<td>EC3740</td>
<td>AA:</td>
<td>N</td>
</tr>
<tr>
<td>Wireless Network Security</td>
<td>EC4715; EC4730</td>
<td>Y</td>
<td>N</td>
<td>EC4745</td>
<td>Y</td>
<td>N</td>
<td>EC3860; EC4735</td>
<td>AA:</td>
<td>N</td>
</tr>
</tbody>
</table>

Select at least One out of AND satisfy 12 credit hours (check):
- EC4430; EC4710
- EC4725; EC4785
- EC4715; EC4730
- EC4755; EC4770
- EC4790
- EC3860; EC4735
- EC4755; EC4795

Application Process:

For NPS Resident Students only: Students must turn in the completed enrollment form to the ECE Department Education Technician NLT the end of the second week of their graduating quarter. They must include a copy of their Python transcripts showing scheduled certificate courses and associated grades to insure they are awarded the certificate. Further information is available at https://www.nps.edu/ece/Academics/Certificates.html.

For DL Students only: Individuals must apply to NPS online at www.nps.edu.

Certificate Award Entrance Requirements for NPS Students: Students must be already enrolled in one of the degree programs already offered by the ECE Department, or be accepted by the ECE Department if not currently enrolled in any of the degree programs currently offered by the ECE Department.

Certificate Award Requirements: The academic certificate program must be completed within 3 years of taking the first certificate course. Minimum CQPR is 3.0.

Double Counting Courses: Courses taken as part of an academic certificate may be applied to a degree at NPS; there is no bar on “double counting” certificate courses for degree purposes. Courses may not be double counted for multiple certificates. Only NPS courses will be counted towards meeting certificate requirements. Transferred courses are NOT eligible to meet certificate requirements.
### Exhibit 9 Thesis Proposal Approval Form

<table>
<thead>
<tr>
<th><strong>Thesis Proposal Approval Form</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name:</td>
</tr>
<tr>
<td>A. Curriculum no.</td>
</tr>
<tr>
<td>□ 590, □ 591, □ 525, □ 533, □ (other)</td>
</tr>
<tr>
<td>D. Tentative Thesis Title:</td>
</tr>
<tr>
<td>E. Thesis Advisor:</td>
</tr>
<tr>
<td>F. Thesis Co-advisor:</td>
</tr>
<tr>
<td>G. Anticipated Funding Requirements (If any):</td>
</tr>
<tr>
<td>H. Anticipated Classification Level:</td>
</tr>
</tbody>
</table>

I. **Human Subjects Research Involved:** Read Section "R" to identify whether your thesis project requires Institutional Review Board (IRB) approval. If so, approval must be secured BEFORE starting research.

**Project requires IRB approval:** □ Y □ N

J. **Mandatory Graduate Writing Center (GWC) Workshops:** The following 4 GWC workshops are required for all MSEE Degree students. Please indicate completion dates for each:
1) Basic of Academic Writing, level 2 (___________) 2) Technical Writing (___________)
3) Strategies for Active Writing (___________) 4) Paraphrasing and Quoting Like a Pro (___________)

K. **Plagiarism/Cheating**
   ➢ The student needs to be aware of the fact that the thesis represents the work of the author alone. It is the student responsibility to insure that material taken from other sources is acknowledged appropriately.
   ➢ The student will be familiar with the NPS Honor Code Instruction (NPSINST 5370.4C) and the ECE Information handout about plagiarism and cheating.
   ➢ By turning in this thesis approval form, the student acknowledges having read, understood and agreed to abide by the guidelines specified in the above documents.

L. **Thesis Extensions:** (please, read)
   ➢ A Student who detaches from NPS before completing his/her thesis for the master's degree will be granted an extension of one year upon filling out the thesis extension request form.
   ➢ A student may apply for up to two additional one-year thesis extensions. Requests for these extensions should include a progress report, endorsement from the thesis advisor and any other relevant information. Students are reminded that requests for 3rd thesis extension will be granted only if the student has made SIGNIFICANT progress towards completion of the thesis, as certified by their thesis advisor.
   ➢ The student bears full responsibility for maintaining the viability of his/her candidacy. If a student's extension expires, the candidacy lapses and the degree cannot be awarded at any time in the future.
   ➢ Students must complete their thesis requirements within 3 years of the date of detachment from the School.

Please answer items M through S shown on next page.

<table>
<thead>
<tr>
<th>Advisory committee</th>
<th>Approve (check box ☑)</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advisor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-advisor/2nd reader</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic Associate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department Chair:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Noted/Date:</td>
<td>Program Officer:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Last modified 05/04/18  Please read Privacy Advisory at www.nps.edu/Footer/PrivacyPolicy.html
Research Questions
This section should include the primary research question and subsidiary research questions to be investigated in the thesis. The primary research questions should be broad enough that it covers the entire spectrum of the research activity. Subsidiary research questions subdivide the primary research question into manageable research segments. This section should include a very explicit statement of the questions the research will seek to answer. While the questions may be redefined later as the research progresses, the initial objective should be made very specific.

Discussion of Topic
This section should describe the main thrust of the study, what areas will be specifically investigated and what areas will be excluded; put boundaries around the study; identify what the study will be (e.g., a computer simulation, an experiment, an electronic design and implementation, a system study); discuss any limitations of the study.

Tentative Chapter Outline
This section should list tentative chapter headings and provide a brief discussion of chapter content. (Note: This can change).

Benefit of Study
This section should present the contribution expected from research efforts, what individuals/organizations may be expected to use the results of the thesis (if known) and what problems/issues will be addressed/resolved.

Preliminary Bibliography
This section should include a listing of representative materials consulted during preliminary literature search. This should include references to the problem or issue to be studied, prior thesis work, literature references, or other sources of information. The final bibliography will probably be much more extensive.

Milestones
This section should include a tentative list of target dates for completion of the successive stages of the project. You will not be held strictly to this schedule; it is a means of conveying to others when major milestones of the study are expected to be completed. The list should include dates during which the following activities are expected to be accomplished:

1. Literature Review
2. Construct Research Approach
3. Conduct Research/Travel
4. Analyze Data
5. Draft Thesis
6. Final Thesis Submission/Signature

Human Subject Research (this section must filled and be turned in with the proposal)
For an activity to be considered human subjects research it must be all of the following:
(i) a systematic investigation
(ii) designed to develop or contribute to generalize knowledge
(iii) involve human subjects or their personally identifiable information

Please answer the following questions about the attached research proposal.

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the activity part of a systematic investigation?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For example: Is it part of a planned and structured research investigation? Or, Are you testing a hypothesis or theory?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Is the information you are gathering designed to contribute to generalize knowledge?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For example: Is it possible that the knowledge that you develop could be applied to another domain or another population? Is it possible that another researcher be interested advancing your research? Would another researcher be interested in replicating your study with another population?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>a) Does this activity involve intervention or interaction with individuals?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For example: Does it involve surveys, interviews, online interaction, experiments, audio/video recordings, or equipment testing involving subjects or</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>b) Is the data you are gathering individually identifiable?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For example, can the identity of the subjects be readily ascertained by the investigator?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

In order for a project to be considered human subjects research, question 1 and 2 and at least one part of question 3 must be answered in the affirmative, in which case it may require review and approval by the IRB before the research may commence. If you think the attached protocol may involve human subjects research or if there is any doubt about whether it involves human subjects research please visit the IRB website and contact the POC for the Board activities.
Faculty Assessment of Student Outcome: Independent Investigation

AY18 winter

Evaluator Name: __________________________

Evaluator’s role: ☐ Advisor ☐ Co-advisor ☐ Reader ☐ Chair

Student Name: __________________________

Thesis Title: __________________________

<table>
<thead>
<tr>
<th>Q1 Originality of Research</th>
<th>Poor</th>
<th>Fair</th>
<th>Satisfactory</th>
<th>Excellent</th>
<th>Outstanding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2 Technical Merit</td>
<td>Poor</td>
<td>Fair</td>
<td>Satisfactory</td>
<td>Excellent</td>
<td>Outstanding</td>
</tr>
<tr>
<td>Q3 Defense Relevance</td>
<td>Poor</td>
<td>Fair</td>
<td>Satisfactory</td>
<td>Excellent</td>
<td>Outstanding</td>
</tr>
<tr>
<td>Q4 Quality of Presentation</td>
<td>Poor</td>
<td>Fair</td>
<td>Satisfactory</td>
<td>Excellent</td>
<td>Outstanding</td>
</tr>
<tr>
<td>Q5 Quality of Written Thesis</td>
<td>Poor</td>
<td>Fair</td>
<td>Satisfactory</td>
<td>Excellent</td>
<td>Outstanding</td>
</tr>
</tbody>
</table>

Comments: __________________________
Exhibit 11  Faculty Publications with Student Authors/Coauthors  
AY2014-AY2018

Academic Year 2014  
(October 1, 2013 - September 30, 2014)

Statistics
Number of unique publications:  17  
Number of unique publications with student authors/coauthors:  11 (64.7%)  
Number of student authors/coauthors:  12  
Number of graduates in AY2014:  71  
Average number of papers with student author/coauthor per graduate:  12/71 = 16.9%  
Average number of journal papers with student author/coauthor per graduate:  1/71 = 1.4%  
Average number of conference papers with student author/coauthor per graduate:  9/71 = 12.7%  

Publications Listed by Author  
(Some publications listed more than once.)  
Student authors/coauthors highlighted in yellow.  

Cristi, Roberto

Conference Proceedings

Conference Proceeding (Published)  

Other Intellectual Contributions


Garren, David A.  

Conference Proceedings

Conference Proceeding (Published)  

**McEachen II, John C.**

*Conference Proceedings*

**Conference Proceeding (Published)**


**Conference Proceeding (Published)**


**Conference Proceeding (Published)**


**Conference Proceeding (Published)**


**Conference Proceeding (Published)**


**Conference Proceeding (Published)**

Conference Proceeding (Published)


Conference Proceeding (Published)


Pace, Phillip E.

Refereed Journal Articles

Journal Article (Published)


Scrofani, James W.

Conference Proceedings

Conference Proceeding (Published)


Conference Proceeding (Published)


Conference Proceeding (Published)


Conference Proceeding (Published)


Conference Proceeding (Published)


Conference Proceeding (Published)


Conference Proceeding (Published)


Other Intellectual Contributions

Technical Report (Published)


Tummala, Murali

Conference Proceedings

Conference Proceeding (Published)


Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)
Faculty Publications with Student Authors/Coauthors

Academic Year 2015
(October 1, 2014 - September 30, 2015)

Statistics

Number of unique publications: 34
Number of unique publications with student authors/coauthors: 18 (52.9%)
Number of student authors/coauthors: 12
Number graduates in AY2015: 29
Average number of papers with student author/coauthor per graduate: 18/29 = 62.1%
Average number of journal papers with student author/coauthor per graduate: 6/29 = 20.7%
Average number of conference papers with student author/coauthor per graduate: 11/29 = 37.9%

Publications Listed by Author
(Some publications listed more than once.)
Student authors/coauthors highlighted in yellow.

Cristi, Roberto (Professor)

Conference Proceedings

Conference Proceeding (Published)

McEachen II, John C. (Professor)

Refereed Journal Articles

Journal Article (Published)

Journal Article (Published)
Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Pace, Phillip E. (Professor)

Non-Refereed Journal Articles

Journal Article (Published)
Romero, Ric (Assistant Professor)

Refereed Journal Articles

Journal Article (Published)

Journal Article (Published)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Scrofani, James W. (Associate Professor)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)
Conference Proceeding (Published)

Conference Proceeding (Published)

Thulasiraman, Preetha (Assistant Professor)

Refereed Journal Articles

Journal Article (Published)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Tummala, Murali (Professor)

Refereed Journal Articles

Journal Article (Published)
Journal Article (Published)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Yun, Xiaoping (Distinguished Professor)

Technical Reports

On-Line publication (Published)
Faculty Publications with Student Authors/Coauthors

Academic Year 2016
(October 1, 2015 - September 30, 2016)

Statistics

Number of unique publications: 28
Number of unique publications with student authors/coauthors: 20 (71.4%)
Number of student authors/coauthors: 20
Number graduates in AY2016: 25
Average number of papers with student author/coauthor per graduate: 20/25 = 80%
Average number of journal papers with student author/coauthor per graduate: 5/25 = 20%
Average number of conference papers with student author/coauthor per graduate: 15/25 = 60%

Publications Listed by Author
(Some publications listed more than once.)
Student authors/coauthors highlighted in yellow.

Cristi, Roberto (Professor)

Conference Proceedings

Conference Proceeding (Published)

Jenn, David C. (Professor)

Refereed Journal Articles

Journal Article (Published)

McEachen II, John C. (Professor)

Conference Proceedings

Conference Proceeding (Published)

*Conference Proceeding (Published)*


http://dx.doi.org/10.1109/sysose.2016.7542914

*Conference Proceeding (Published)*


*Conference Proceeding (Published)*


*Conference Proceeding (Published)*


*Conference Proceeding (Published)*


*Conference Proceeding (Published)*


Michael, Sherif N. (Professor)

*Non-Refereed Journal Articles*

*Journal Article (Published)*


http://dx.doi.org/10.4236/msa.2016.712063

87
Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Oriti, Giovanna M. (Associate Professor)

Refereed Journal Articles

Journal Article (Published)

Scrofani, James W. (Associate Professor)

Conference Proceedings

Conference Proceeding (Published)
image fusion and target classification for improved maritime domain awareness. 
*2016 19th International Conference on Information Fusion (FUSION)* (pp. 1170-1177).

**Conference Proceeding (Published)**


**Conference Proceeding (Published)**


**Conference Proceeding (Published)**


**Staples, Zachary H. (Military Associate Professor)**

**Conference Proceedings**

**Conference Proceeding (Published)**


**Thulasiraman, Preetha (Assistant Professor)**

**Refereed Journal Articles**

**Journal Article (Published)**


**Journal Article (Published)**

Conference Proceedings

Conference Proceeding (Published)

Tummala, Murali (Professor)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)
http://dx.doi.org/10.1109/sysose.2016.7542914

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)
Faculty Publications with Student Authors/Coauthors

Academic Year 2017
(October 1, 2016 - September 30, 2017)

Statistics

Number of unique publications: 51
Number of unique publications with student authors/coauthors: 33 (64.7%)
Number of student authors/coauthors: 22
Number graduates in AY2017: 77
Average number of papers with student author/coauthor per graduate: 33/77 = 42.9%
Average number of journal papers with student author/coauthor per graduate: 6/77 = 7.79%
Average number of conference papers with student author/coauthor per graduate: 27/77 = 35.1%

Publications Listed by Author
(Some publications listed more than once.)
Student authors/coauthors highlighted in yellow.

Ashton, Robert W. (Associate Professor)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)
Cristi, Roberto (Professor)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Garren, David A. (Associate Professor)

Conference Proceedings

Conference Proceeding (Published)

Ha, Tri T. (Professor)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)
Conference Proceeding (Published)
Su, W., Ng, W., Ha, T. (2017). Maximizing Available Diversity in a MIMO Fading Channel. IEEE CCWC.

McEachen II, John C. (Professor)

Refereed Journal Articles

Journal Article (Published)

Journal Article (Published)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Michael, Sherif N. (Professor)

Refereed Journal Articles

Journal Article (Published)

Non-Refereed Journal Articles

Journal Article (Published)

**Conference Proceedings**

*Conference Proceeding (Published)*

*Conference Proceeding (Published)*

*Conference Proceeding (Published)*

*Conference Proceeding (Published)*

*Conference Proceeding (Published)*

*Conference Proceeding (Published)*

*Conference Proceeding (Published)*

*Conference Proceeding (Published)*
Conference Proceeding (Published)

Oriti, Giovanna M. (Associate Professor)

Conference Proceedings

Conference Proceeding (Published)

Pace, Phillip E. (Professor)

Refereed Journal Articles

Journal Article (Published)

Journal Article (Published)

Conference Proceedings

Conference Proceeding (Published)

Romero, Ric (Associate Professor)

Conference Proceedings

Conference Proceeding (Published)
Roth, John D. (Assistant Professor)

**Refereed Journal Articles**

*Journal Article (Published)*


*Journal Article (Published)*


Scrofani, James W. (Associate Professor)

**Refereed Journal Articles**

*Journal Article (Published)*


**Conference Proceedings**

*Conference Proceeding (Published)*


*Conference Proceeding (Published)*


Su, Weilian (Associate Professor)

**Conference Proceedings**

*Conference Proceeding (Published)*

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Conference Proceeding (Published)

Thulasiraman, Preetha (Associate Professor)

Conference Proceedings

Conference Proceeding (Published)

Tummala, Murali (Professor)

Refereed Journal Articles

Journal Article (Published)

Journal Article (Published)

Conference Proceedings

Conference Proceeding (Published)
Conference Proceeding (Published)
Faculty Publications with Student Authors/Coauthors

Academic Year 2018
(October 1, 2017 - September 30, 2018)

Statistics

Number of unique publications: 45
Number of unique publications with student authors/coauthors: 21 (46.7%)
Number of student authors/coauthors: 18
Number graduates in AY2018: 32
Average number of papers with student author/coauthor per graduate: $21/32 = 65.6\%$
Average number of journal papers with student author/coauthor per graduate: $5/32 = 15.6\%$
Average number of conference papers with student author/coauthor per graduate: $16/32 = 50.0\%$

Publications Listed by Author
(Some publications listed more than once.)
Student authors/coauthors highlighted in yellow.

Ashton, Robert W. (Associate Professor)

Other Intellectual Contributions

Technical Report (Published)

Technical Report (Published)

Cristi, Roberto (Professor)

Refereed Journal Articles

Journal Article (In Preparation; Not Yet Submitted)

Conference Proceedings

Conference Proceeding (Published)

Julian, Alexander L. (Associate Professor)

**Conference Proceedings**

*Conference Proceeding (Published)*


Kragh, Frank E. (Associate Professor)

**Conference Proceedings**

*Conference Proceeding (Published)*


*Conference Proceeding (Accepted)*


Oriti, Giovanna M. (Associate Professor)

**Refereed Journal Articles**

*Journal Article (Published)*


*Conference Proceeding (Published)*

Pace, Phillip E. (Professor)

Conference Proceedings

Conference Proceeding (Published)

Romero, Ric (Associate Professor)

Refereed Journal Articles

Journal Article (Published)

Journal Article (Published)

Conference Proceedings

Conference Proceeding (Published)

Conference Proceeding (Published)

Rosner, Hardi S. (Faculty Associate - Research)

Other Intellectual Contributions

Technical Report (Published)
Scrofani, J. W., Stefanou, M. S., Shifflett, D. S., Rosner, H. S. UNDERSTANDING PREVAILING GRADUATE DATA SCIENCE CURRICULA: AN INFORMAL SURVEY WITH AN EYE TO DEPARTMENT OF THE NAVY NEEDS.
Scrofani, James W. (Associate Professor)

**Conference Proceedings**

*Conference Proceeding (Published)*

**Other Intellectual Contributions**

*Technical Report (Published)*
Scrofani, J. W., Stefanou, M. S., Shifflett, D. S., Rosner, H. S. *UNDERSTANDING PREVAILING GRADUATE DATA SCIENCE CURRICULA: AN INFORMAL SURVEY WITH AN EYE TO DEPARTMENT OF THE NAVY NEEDS*.

Shifflett, Deborah S. (Faculty Associate - Research)

**Other Intellectual Contributions**

*Technical Report (Published)*
Scrofani, J. W., Stefanou, M. S., Shifflett, D. S., Rosner, H. S. *UNDERSTANDING PREVAILING GRADUATE DATA SCIENCE CURRICULA: AN INFORMAL SURVEY WITH AN EYE TO DEPARTMENT OF THE NAVY NEEDS*.

Thulasiraman, Preetha (Associate Professor)

**Conference Proceedings**

*Conference Proceeding (Published)*

*Conference Proceeding (Published)*

*Conference Proceeding (Accepted)*
Other Intellectual Contributions

Book Chapter (Published)

Weatherford, Todd R. (Professor)

Refereed Journal Articles

Journal Article (Published)

Williamson III, William (Research Associate Professor)

Conference Proceedings

Conference Proceeding (Published)
Exhibit 12  Examples of Continuous Improvement in AY2016

Continuous Improvement – Guidance, Control, and Navigation Systems
Spring AY2016

During the March 2016 Graduating Student Exit Brief conducted by Prof. Fargues, students complained about overlapping material in EC2300 (Control Systems) and EC2320 (Linear Systems).

In response to the students’ complaints, the Guidance, Control, and Navigation Systems TAG (technical area group), with members Profs. Cristi, Hutchins, and Yun, met during Spring Quarter AY2016 to discuss the problem.

The TAG decided to do the following:

1. Keep the two courses separate as they are now, that is, EC2300 is not a prerequisite for EC2320.

2. The amount of overlapping material will be significantly reduced by changing course content.

3. At present, EC2320 contains introductory material that is identical with material that is taught in EC2300, typically analysis of the time and frequency responses of a 2nd-order system. Starting with the next offering, the introductory material in EC2320 will be presented differently, in line with the state space approach of the course. This will require the students to perform fundamental manipulations of 2x2 matrices, which will have the added benefit of having to do matrix computations by hand (rather than with Matlab). This will make the two courses distinct and independent of each other.

Continuous Improvement – Cyber Systems and Network Engineering
Spring AY2016

Since Prof. Thulasiraman has changed the course content of EC3740 Reverse Engineering in Electronic Systems to a certain extent in the last couple of years, she has updated the course description and changed the prerequisite (from EC3730 or consent of instructor) to EC2700 Introduction to Cyber Systems. The proposed changes will need to be approved by the ECE Department’s Curriculum Committee and the NPS Academic Council before being instituted.
### I. Routing Information

<table>
<thead>
<tr>
<th>From: (include signature approval)</th>
<th>R. Clark Robertson</th>
<th>Chair, Department of:</th>
<th>Electrical and Computer Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Via: (include signature approval)</td>
<td>Clyde Scandrett</td>
<td>Dean, School of:</td>
<td>Graduate School of Engineering and Applied Sciences (GSEAS)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Via:</th>
<th>Academic Council Recording Secretary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Via:</td>
<td>Vice Provost for Academic Affairs</td>
</tr>
<tr>
<td>To:</td>
<td>Chair, Course Review Committee</td>
</tr>
<tr>
<td>Copy:</td>
<td>Office of Academic Administration, All Departments, Program Offices, and Deans</td>
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</table>

### II. General Information

<table>
<thead>
<tr>
<th>Requestor's Name:</th>
<th>Preetha Thulasiraman</th>
<th>Date:</th>
<th>May 10, 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Course Action:</td>
<td>☑ Substantive Modification*</td>
<td>☑ Minor Modification</td>
<td></td>
</tr>
</tbody>
</table>

*Substantive modification requires supporting documentation. Refer to Chapter 8.0 of the Academic Policy Manual for requirements.

<table>
<thead>
<tr>
<th>Department:</th>
<th>Electrical and Computer Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Coordinator:</td>
<td>Preetha Thulasiraman</td>
</tr>
<tr>
<td>Course Catalog Number:</td>
<td>EC3740</td>
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</tbody>
</table>

### III. Requested Changes (Choose all that apply)

<table>
<thead>
<tr>
<th>Change Name (Title)</th>
<th>Current:</th>
<th>New:</th>
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</thead>
<tbody>
<tr>
<td>☒ Change Status</td>
<td>☐ Retire an active course</td>
<td>☐ Reactivate a retired course</td>
</tr>
<tr>
<td>☐ Change Lecture Hours</td>
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<tr>
<td>☐ Change Lab Hours</td>
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<tr>
<td>☒ Change Course Number</td>
<td>(If there is a preference, provide the new number in this box.)</td>
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<tr>
<td>☐ Change Security Clearance</td>
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<tr>
<td>☒ Change Prerequisites</td>
<td>EC2700</td>
<td></td>
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<tr>
<td>☐ Change Corequisites</td>
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<td>☐ Change Quarters Offered</td>
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<table>
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<tr>
<th>Change Description</th>
<th>Current: Presents fundamental, systems-level concepts for developing an understanding of system functionality without a prior access to the system’s design specifications. Considers generalized approaches to developing a set of specifications for a complex system through orderly examination of specimens of that system. Illustrates procedures for identifying the system's components</th>
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<tbody>
<tr>
<td></td>
<td>New: This course presents fundamental, systems-level concepts for developing an understanding of system functionality without a prior access to the system's design specifications. It considers generalized approaches to developing a set of specifications for a complex system through orderly examination of components of that system. The course illustrates procedures for</td>
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</tbody>
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and their interrelationships. Demonstrates methods for creating representations of the system in another form or at a higher level of abstraction. Presents fundamental definitions for forward engineering, reverse engineering, design recovery, restructuring and reengineering. Basic analysis techniques such as impulse response will be introduced. System identification techniques such as parameter estimation, Markov models and linear time-invariant (LTI) theory will be used to build dynamical models from observed data. Case studies from several domain areas will be presented to include: integrated circuit (IC) and circuit board analysis, communications protocol analysis, software disassembly, and programmable logic verification. Prerequisites: EC3730 or consent of instructor.

identifying the system's components and their interrelationships. The course is divided into two parts. The first part focuses on software reverse engineering where students perform elementary reverse engineering on basic programs using assembly language and software disassembly. Topics related to software reverse engineering including obfuscation techniques and malware analysis will be discussed. The second part of the course will focus on hardware reverse engineering by studying integrated circuit (IC) and circuit board analysis using SPICE and black box techniques. Other tools that aid in hardware reverse engineering such as JTAG will be studied in depth. Analysis of reverse engineering using mathematics, including power analysis will also be studied. Prerequisite: EC2700.

### IV. Impact on Resources

**ACPM 8.1.3 Justification:** This is to be a free-form discussion on the rationale for adding new course or changing an existing one. This must include:

- Whether the course is required to satisfy a degree requirement or Educational Skill Requirement, or is an elective.
- Whether the course is a prerequisite or a terminal course.
- Justification for the level of classification of the course.

EC3740 is a required course for the Cyber Specialty in the ECE department and a core class requirement within the CSO curriculum. The course is designed to cover the general theory of reverse engineering and is a pre-requisite for more advanced courses in vulnerability analysis of cyber systems (EC4715). The ECE department developed EC2700 to be the pre-requisite for ECE cyber courses (EC3730 and EC3740). Therefore, EC3730, formerly in the pre-requisite list, is unnecessary as basic topics required in EC3740 are now introduced in EC2700. The course description was slightly modified to more accurately reflect the balanced exposure to hardware and software reverse engineering.

**ACPM. 8.1.4 Duplication:** A list of courses covering similar topics must be provided. If applicable, a justification of course duplication is also required. If no existing course at NPS covers a similar set of topics, a no-duplication statement must be included.

No existing course at NPS covers similar topics as EC3740.
Continuous Improvement Summer AY2016

The ECE Department held a department meeting on Tuesday, 20 September 2016, to discuss how to satisfy the new undergraduate requirement “computing science” that replaces the old requirement “computer science” for ABET 2016-2017 Program Criteria – 1. Curriculum.

If an ECE student does not have a “computing science” course in his undergraduate background, the ECE Faculty voted in favor of allowing a student to take one of the following courses in order to satisfy the “computing science” requirement:

AE/EC2440 Introduction to Scientific Programming

EC2700 Introduction to Cyber Systems

EC2820 Digital Logic Circuits

EC2840 Introduction to Microprocessors

CS2020 Introduction to Programming

If a student wants to satisfy the “computing science” requirement by taking some other course, the student would need the approval of both the ECE Academic Associate and the ECE Department Chairman.
APPENDICES

Appendix A-1 – Course Syllabi for Master’s Level Courses

1. EC3000 Introduction to Graduate Research

2. Credits: 1
   Contact hours (lecture-lab): 1-0

3. Course Coordinator: F. Kragh

4. Text book:

5. Specific course information:
   a. Description: This course is designed to prepare students to undertake graduate research and to write a thesis or dissertation. The first part of the course provides an overview of
      i. the NPS Department of Electrical and Computer Engineering, the Department's research program and its faculty,
      ii. the NPS's Research Program and the organization and functions of the NPS Research Office,
      iii. NPS library electronic resources,
      iv. an overview of S&T planning in the DoD, and
      v. guidance on the thesis process.
      In the second part of the course, research opportunities are presented by the faculty. A broader view of the field of electrical and computer engineering is gained through student attendance at ECE Department seminars delivered by outside speakers. In the third part of the course, students are exposed to thesis research currently being carried out in the ECE Department by attending thesis presentations delivered by graduating students.
   b. Prerequisites: EC2200 and EC2410
   c. required

6. Specific goals for the course:
   a. The objective of this course is to prepare the student for graduate research.

7. Brief list of topics to be covered:
   a. Overview of ECE Department, the department’s research program and faculty,
   b. Overview of NPS research program, NPS Research Office organization and functions,
   c. Introduction to NPS library resources,
d. Overview of S&T planning in the Department of Defense,
e. Introduction to the thesis process,
f. Introduction to critical thinking,
g. Ethics in science and engineering,
h. Introduction to MathType,
i. Plagiarism, cheating and consequences,
j. Overview of thesis research opportunities (ECE faculty),
k. Overview of recent student research (Graduating student thesis presentations).
1. EC3110 Electrical Energy: Present and Emerging Technologies

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: Giovanna Oriti

   a. IEEE conference and journal articles
   b. Commercial software Matlab

5. Specific course information:
   a. Description: This course presents electrical energy topics for on shore facilities, expeditionary and ship applications divided into three categories; generation, distribution and consumption. For these three categories the current state of the art is presented first and then expounded with emerging technologies including renewable energy sources, energy harvesting, smart grid, micro-grids, smart metering, energy management systems, flexible AC transmission systems (FACTS), battery management systems, all electric and hybrid transportation systems, more efficient loads such as lighting, motors and power converters.
      a. Prerequisites: EC2100 or EO2102
      b. Elective or selected elective

6. Specific goals for the course:
   a. Knowledge of how electrical energy is generated, distributed and consumed.
   b. Knowledge of how alternative and renewable energy sources contribute to electrical energy generation.
   c. Knowledge of state of the art technologies that effect efficiency, reliability and security of power systems.
   d. Knowledge of how electrical energy is used by DoD and learn how to reduce its consumption.
   e. Design micro-grids.

7. Brief list of topics to be covered:
   a. Electrical energy generation: present and emerging technologies
   b. Review conventional energy sources: coal, natural gas, hydroelectric, etc.
   c. Alternative energy sources: wind, solar, fuel cells, ocean, energy harvesting.
   d. Electrical energy distribution: present and emerging technologies
   e. High voltage transmission and lower voltage distribution
   f. Power systems in conventional and all electric ships
   g. Micro-grids for installation and expeditionary applications
   h. Elements of smart grids and energy security
   i. Electrical energy consumption: present and emerging technologies
   j. Conventional and high efficiency motors
   k. Power converters for consumer electronics and variable speed drives
   l. LED-driving circuits and power quality and stability issues
1. EC3130 Electrical Machinery Theory

2. Credits: 5  
   Contact hours (lecture-lab): 4-2

3. Course Coordinator: Roberto Cristi

   a. Lecture Notes

5. Specific course information:  
   a. Description: This course is an introduction to the analysis of magnetically-coupled circuits, dc machines, induction machines, and synchronous machines. The course will include explicit derivations of torque, voltage, and flux linkage equations, formulation of steady-state circuits, development of reference frame theory, and the basics of machine simulation as required in shipboard electric drive analysis  
   b. Prerequisites: EC2110 (may be taken concurrently)  
   c. Elective or selected elective

6. Specific goals for the course:  
   a. Review of Fundamentals of Magnetism and Magnetically Coupled Circuits  
   b. Electromechanical Energy Conversion  
   d. Reference Frames, “abc” to “qd0” transformations and properties  
   e. Three Phase Induction Motors: abc and qd0 models, Torque  
   f. Steady State Circuit Equivalent Model  
   g. Multiple Poles machines  
   h. Estimation of Induction Machines parameters from observations  
   i. Torque and rotor angular velocity control  
   j. Three Phase Synchronous Machines: abc and qd0 models  
   k. Steady state models for generators.

7. Brief list of topics to be covered:  
   a. Electromechanical energy conversion  
   b. Magnetic flux, inductances and voltage equations  
   c. Reference frames qd0 for three phase machines  
   d. Induction motor analysis in abc and qd0 reference frame  
   e. Synchronous generator analysis in abc and qd0 reference frame
1. EC3150 Power Electronics

2. Credits: 5  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: Giovanna Oriti

4. Textbook:  

5. Specific course information:  
   a. Description: A detailed analytical approach is presented for the operation, performance, and control of the important types of power electronics converters found in naval shipboard power systems. The course reviews the characteristics of power semiconductor switching devices and introduces DC-DC converters, single-phase and three-phase line-frequency diode and thyristor rectifiers, PWM inverters and switch-mode power supplies.  
   b. Prerequisites: EC2110, Co-requisite: EC2200

6. Specific goals for the course:  
   a. This course presents the basics of switch-mode power converters, beginning with DC-DC converters and power supplies. Topologies and control methods are analyzed and modeled using physics-based equations.  
   b. Students learn that pulse width modulation (PWM) is the most popular method to control the switching devices in most power converter topologies.  
   c. Rectifier circuits and inverters are also analyzed and modeled, focusing on power quality and compliance to military standards for shipboard applications.  
   d. Laboratory assignments give students additional experience working with prototypes of the power converters studied in class.  
   e. Students learn to relate the analysis and modeling work done in class to the experimental waveforms acquired in the laboratory.

7. Brief list of topics to be covered:  
   a. Review of Electrical Circuit Concepts  
   b. Simulation using Matlab/Simulink  
   c. Characteristics of Power Semiconductor Devices: Diodes and thyristors, Controllable switches, Wide bandgap devices  
   d. DC-DC Switch-Mode Converters: Buck converter, Forward converter operation and control, Boost converter, Buck-boost and full-bridge converters  
   e. Line- Frequency Diode Rectifiers: Basic rectifier concepts, Single-phase diode bridge rectifiers, Three-phase, full bridge rectifiers, Harmonics and power quality  
   f. Line- Frequency Phase-Controlled Rectifiers: Basics of thyristor rectifiers, Single-phase, phase controlled rectifiers, Three-phase, phase controlled rectifiers  
   g. Voltage Source Inverters: Basic concepts of switch mode inverters, Pulse width modulation (PWM)
1. EC3200 Advanced Electronics Engineering

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: S. Michael

   a. Lecture notes

5. Specific course information:
   a. Description: Characteristics of differential and multistage amplifiers. Transistors frequency response, including Bipolar Junction Transistors (BJT), Junction Field Effect Transistors (JFET), and Metal Oxide Semiconductor Field Effect Transistors (MOSFET); characteristics and design consideration. Integrated circuit OPAMP applications; analysis and design of non-ideal OPAMPS. Applications of BJTs and Complementary Metal Oxide Semiconductors (CMOS) in integrated circuits, and different biasing techniques. Analysis and design of digital circuits, including Transistor Transistor Logic (TTL), Emitter Coupled Logic (ECL), and CMOS logic families. Application and design feedback amplifiers and operational amplifiers applications in analog filters and oscillators.
   b. Prerequisites: EC2200
   c. Required or elective

6. Specific goals for the course:
   a. To understand the operating characteristics of higher order models of basic electronic devices.
   b. To apply this understanding to the analysis and design of BJT, JFET, CMOS, GaAs transistors and OP AMP analog networks, as well as to logic circuit applications.
   c. To comprehend the frequency response characteristics of discrete transistor amplifiers. To analyze the operational amplifier and study OPAMP applications and design.

7. Brief list of topics to be covered:
   a. Integrated circuit OPAMP applications.
   b. Frequency Response and bode plot review.
   c. Analysis and design of non-ideal OPAMPS.
   d. Differential amplifier and multistage amplifier.
   e. Applications of FET, MOS, and CMOS IC biasing and logic circuits.
   f. BJT and MOS amplifier frequency response characteristics and design considerations.
   g. BJT digital applications TTL and ECL logic families.
   h. Oscillators, filters and feedback applications
1. **EC3210 Introduction to Electro-Optical Engineering**

2. **Credits: 5**  
   Contact hours (lecture-lab): 4-1

3. **Course Coordinator: P. E. Pace**

   a. Lecture notes;  
   b. Included software;

5. **Specific course information:**  
   a. **Description:** An introduction to electro-optical imaging systems and tracking systems is presented. The focus begins with a discussion on optical radiation including the radiation quantities and units. The concept of a black body radiator is presented along with a discussion of Planck’s radiation formula. Radiation from a surface and a point source are discussed. External radiation sources: sun, lamps, lasers and targets of opportunity in an electronic warfare environment are presented. Atmospheric transmission concepts such as temperature, pressure, and manmade constituents are included. Atmospheric turbulence and adaptive optics is covered. The treatments of spectral, spatial and temporal variations in the background are considered. Detection and discrimination in electro-optical sensors is presented including the detection process. Electro-optical system design and performance equations are discussed. Many numerical examples are given. Electro-optical systems applications are introduced and include infrared search and tracking systems using scanning and staring sensors.  
   b. **Prerequisites:** Some knowledge of probability theory.  
   c. **Elective or selected elective**

6. **Specific goals for the course:**  
   a. Understand the quantities of radiation and the concept of a blackbody radiator;  
   b. Calculate the surface irradiance at the entrance aperture of a sensor;  
   c. Compare the target radiation signature for various targets of opportunity including missile seeker domes, aircraft surfaces, jet engine nozzles etc.;  
   d. Define and quantify the optical properties of the atmosphere including Rayleigh, aerosol scattering effects and turbulence;  
   e. Define the background spectral radiance properties including the reflection and emissivity characteristics for identification;  
   f. Calculate the detection performance of an infrared sensor for both an analog processor and a digital processor including the probability of false alarm and the probability of detection;  
   g. Develop the signal to noise relationship starting with the fundamental properties of the targets and the parameters of the system design;  
   h. Use the detectivity of a detector to define the wavelength band of interest that must be targeted;
i. Calculate numerical examples of minimum resolvable temperature. (10) Design
an infrared search and track system using electro-optical scanning and staring
sensors;
j. Consider shipboard, airborne and space based search and track system designs;

7. Brief list of topics to be covered:
   a. Quantities of radiation;
   b. Surface irradiance;
   c. Surface reflectivity;
   d. Target radiation signatures;
   e. Atmospheric transmission coefficients;
   f. Rayleigh and aerosol scattering;
   g. Turbulence;
   h. Background spectral radiance;
   i. Emissivity;
   j. Limitations on measurement data;
   k. Detection process in infrared sensor systems;
   l. Detector detectivity;
   m. Noise equivalent flux density;
   n. Minimum resolvable temperature;
   o. Shipborne, airborne and space based electro optical systems;
1. EC3220 Semiconductor Device Technologies

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course coordinator: T.R. Weatherford

4. Text book:  

5. Specific course information  
   a. Description: This course is intended to familiarize the student with solid state device operation and fabrication of present day semiconductors and transistor technologies. Topics include: fundamental theory of charge transport properties of semiconductors, bandgap engineering and semiconductor device manufacturing technology. Use of Technology Computed Aided Design (TCAD) tools are used to visualize carrier transport and to virtually fabricate devices. Measurement labs utilize wafer probe measurements  
   b. Prerequisites: EC2100.  
   c. Elective, or selected elective course

6. Specific goals for the course  
   a. Understanding of carrier transport in semiconductors  
   b. Demonstrate knowledge of current voltage relationships of various semiconductor junctions.  
   c. Ability to develop Beta of a Bipolar device from first principles.  
   d. Ability to develop the Threshold Voltage of a FET from first principles.

7. Brief list of topics to be covered:  
   a. Semiconductor electronic properties  
   b. Use of TCAD tools  
   c. Semiconductor Junctions  
   d. Bipolar Junction Transistors  
   e. MOS Field Effect Transistors
1. EC3230 Space Power and Radiation Effects

2. Credits: 3.5  
   Contact hours (lecture-lab): 3-1

3. Course Coordinator: S. Michael

4. Text book:  
   b. *Solar Cell Array Design Handbook*, Volume 1 & 2,  
   e. Selected Papers and Class Notes

5. Specific course information:  
   a. Description: Fundamentals of different power systems utilized in spacecraft; photovoltaic power technology; solid-state physics, silicon solar cells, solar cell measurement and modeling, gallium arsenide cells and II-V compounds in general, array designs and solar dynamics. Radiation effects on solid state devices and materials. Survivability of solar cells and integrated circuits in space environment and annealing method. Other space power systems including chemical and nuclear (radioisotope thermoelectric generators and nuclear reactors). Energy storage devices and power conversion. Spacecraft power supply design.  
   b. Prerequisites: EC2200 or SS2001  
   c. Required or elective

6. Specific goals for the course:  
   a. To acquire a qualitative understanding of the Fundamentals of different power systems utilized in spacecraft; photovoltaic power technology; solid state physics, silicon solar cells, solar cell measurement and modeling, gallium arsenide cells and II-V compounds in general, array designs and solar dynamics.  
   b. To examine radiation effects on solid state devices and materials. Survivability of solar cells and integrated circuits in space environment and annealing method.  
   c. Other space power systems including chemical and nuclear (radioisotope thermoelectric generators and nuclear reactors).  
   d. Energy storage devices and power conversion. Spacecraft power supply design.

7. Brief list of topics to be covered:  
   a. Spacecraft power systems  
   b. Solar power:  
   c. Solid state physics  
   d. Silicon solar cell and photovoltaic power  
   e. Solar cells measurements and modeling  
   f. Array design  
   g. Space environment and radiation effects
h. Other state-of-the-art solar cells  
i. Solar Dynamics  
j. Spacecraft alternative power systems  
k. Space nuclear power  
l. Energy storage systems  
m. Power conditioning and processing  
n. A project for designing a complete satellite power system
1. EC3240 Renewable Energy; At Military Bases and for the Warfighter

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: S. Michael

   a. Lecture notes

5. Specific course information:
   a. Description: The course will introduce participants to current energy use at military bases as well as mobile platforms power sources. Participants will be introduced to state-of-the-art renewable energy systems that would be utilized at military installations. This will include; detailed study of Photovoltaic & Solar Energy use, overview of wind energy & other renewable energy sources, as well as energy storage systems. Cost saving comparisons and environmental impact will be conducted. The course will also investigate the use of some of the above renewable systems in mobile platforms for the warfighters and expeditionary forces personal use
   b. Prerequisites: EC2100 or EO2102
   c. Elective or selected elective

6. Specific goals for the course:
   a. The Course will provide the basic information regarding current energy generation systems utilized in US Military bases, and will introduce participants to state-of-the-art Renewable Energy Resources that would greatly benefit Military installations.
   b. The course will also provide modern techniques that can be utilized to power mobile systems which will enhance the capability of the warfighters and Expeditionary forces.

7. Brief list of topics to be covered:
   a. Introduction; present energy use at Military Bases and the warfighter
   d. Energy Storage systems & Batteries for fixed & mobile applications.
   e. Renewable Energy modeling software “HOMER” use and application.
   f. Other Renewable Energy: Geothermal, Bio-power, Hydro, Ocean etc.
   g. Renewable Mobile Energy (Expeditionary and Autonomous Vehicles app.)
   h. Design Examples for fixed and mobile Renewable Energy Systems.
1. EC3280 Introduction to MEMS Design

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course coordinator: T.R. Weatherford


5. Specific course information
   a. Description: This is the first course in Micro Electro Mechanical Systems Design (MEMS). Topics include material considerations for MEMS and microfabrication fundamentals; surface and bulk micromachining; forces and transduction; forces in micro- nano- domains and actuation techniques. The laboratory work includes exercises to become proficient in computer aided engineering (CAE) software for the design of MEMS devices.
   b. Prerequisites: EC2200 or MS2201 or PH1322 or consent of instructor
   c. Elective, or selected elective course

6. Specific goals for the course
   a. The student should develop an understanding of design, modeling, fabrication, and characterization techniques for MEMS devices.
   b. How to best apply this technology to military applications

7. Brief list of topics to be covered:
   a. Introduction to MEMS
   b. Microfabrication Fundamentals Materials for MEMS
   c. Forces and Transduction
   d. MEMS Design and Case Studies
1. EC3310 Optimal Estimation: Sensor and Data Association

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: R. G. Hutchins

   a. Lecture Notes

5. Specific course information:
   a. Description: The subject of this course is optimal estimation and Kalman filtering with extensions to sensor fusion and data association. Main topics include the theory of optimal and recursive estimation in linear (Kalman filter) and nonlinear (extended Kalman filter) systems, with applications to target tracking. Topics directly related to applications, such as basic properties of sensors, target tracking models, multihypothesis data association algorithms, reduced order probabilistic models and heuristic techniques, are also discussed. Examples and projects will be drawn from radar, EW, and ASW systems.  
   b. Prerequisites: EC2320, EC2010, MA2043 or Consent of Instructor  
   c. Elective or Selected Elective

6. Specific goals for the course:
   a. Theory of Least Squares Estimation in Linear Models  
   b. Kalman Filter Theory: Optimal Estimation in Linear Dynamic Systems  
   c. Extended Kalman Filter Theory in Nonlinear Dynamic Systems  
   d. Applications of the theory in Sensor Fusion and Target Tracking

7. Brief list of topics to be covered
   a. Review of mathematical techniques  
   b. Review of linear systems and construction of linear dynamic models for target tracking.  
   c. Linear least squares estimation  
   d. Recursive least squares and the Kalman filter in discrete time  
   e. Review of probability and statistics  
   f. Statistical derivation of the discrete time Kalman filter  
   g. Nonlinear estimation and the extended Kalman filter.  
   h. The continuous time Kalman filter and noise models  
   i. Multiple model estimation techniques
1. EC3320 Optimal Control Systems

2. Credits: 4, Contact hours (lecture-lab): 3-2

3. Course coordinator: X. Yun


5. Specific course information
   a. Catalog description: This course addresses the problem of designing control systems which meet given optimization criteria. The student is exposed to the development of the theory, from dynamic programming to the calculus of variation, and learns how to apply it in control engineering.
   b. Prerequisites: EC2300, EC2320.
   c. Required

6. Specific goals for the course
   a. To express control performance requirements as a cost function
   b. To learn techniques for designing optimal control systems using calculus of variations
   c. To understand Pontryagin’s minimum principle and apply it for optimal control design
   d. To learn how to design optimal control using dynamic programming.

7. Brief list of topics to be covered
   a. Mathematical modeling of linear and nonlinear control systems in state space
   b. Physical constraints imposed on the state variables and control input
   c. Performance criteria
   d. Calculus of variations and fundamental theory for minimization
   e. Variation approach to optimal control problems
   f. Linear quadratic regulator (LQR) problem
   g. Linear quadratic tracking problem
   h. Pontryagin’s minimum principle
   i. Minimum-time control
   j. Dynamic programming, principle of optimality, Hamilton-Jacobi-Bellman (HJB) equation.
1. EC3400 Digital Signal Processing

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: Roberto Cristi


5. Specific course information:
   a. Description: The foundations of one-dimensional digital signal processing techniques are developed. Topics include Fast Fourier Transform (FFT) algorithms, block convolution, the use of DFT and FFT to compute convolution, and design methods for non-recursive and recursive digital filters. Multirate signal processing techniques are also introduced for sampling rate conversion, efficient analog to digital, digital to analog conversion, time frequency decomposition using filter banks and quadrature mirror filters. Computer-aided design techniques are emphasized.
   b. Prerequisites: EC2410 or EC2400
   c. Elective or selected elective

6. Specific goals for the course:
   a. frequencies, digital frequencies, aliasing.
   b. Digital to Analog Conversion and signal reconstruction
   c. Frequency Response of Digital Filter
   d. DTFT, DFT and properties
   e. DFT for Spectral Estimation and Convolution
   f. DCT for Signal Compression
   g. Fast Fourier Transform (FFT)
   h. Digital Filters: Ideal and Non Ideal
   i. Finite and Infinite Impulse Response Filters: design methods and applications
   j. Introduction to Multirate DSP
   k. Analysis of DownSampling and UpSampling
   l. Sampling Rate Conversion by a Rational factor
   m. Multistage Implementation of Downsampling
   n. Efficient Implementation of Multirate Systems
   o. DFT Filter Banks
   p. Introduction to MP3

7. Brief list of topics to be covered:
   a. Sampling, reconstruction and aliasing
   b. Design of FIR and IIR filters from specifications
   c. FFT for spectral estimation and convolution
   d. DCT for signal compression
   e. Multirate signal processing
   f. Applications to digital communications
1. EC3410 Discrete Time Random Signals

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: M. Fargues

   b. Lecture notes

5. Specific course information:  
   a. Description: Fundamentals of random processes are developed with an emphasis on discrete time for digital signal processing, control, and communications. Parameter estimation concepts are introduced, and impact of uncertainty in parameter evaluation (estimated moments and confidence intervals) are presented. Random processes are introduced. DKLT and applications to image processing and classification problems are considered. Impact of linear transformations to linear systems is discussed. FIR Wiener, and matched filters are introduced. IIR Wiener filter introduced, time permitting. Applications to signal and system characterization in areas such as system identification, forecasting, and equalizations are considered to illustrate concepts discussed during the course.  
   b. Prerequisites: EC2410 (may be concurrent), and EC2010  
   c. Elective or selected elective

6. Specific goals for the course:  
   a. Develop the ability to characterize, analyze and extract information from random signals.  
   b. Learn to be able to characterize stationary random processes from a second moment viewpoint in the time domain and frequency domains as they are processed through linear systems. Develop an understanding for Gaussian white noise for 1- and N-dimensional random vectors.  
   c. Learn to characterize random signals from a second moment viewpoint as they are processed through discrete linear systems.  
   d. Learn how to evaluate the behavior of signals and how multiple signals are related to each other using (cross) correlation and (cross) covariance information.  
   e. Learn how to deal with uncertainty in estimated parameters via confidence intervals.  
   f. Understand the principle of orthogonality and learn to apply it to problems involving linear mean-square estimation.  
   g. Learn the principles of Wiener optimal filtering and be able to design FIR and/or IIR Wiener filters in applications such as estimation, prediction, channel equalization, or system identification.
h. Learn the principles of matched filter and be able to design a matched filter for a communication and/or radar signal detection application.

7. Brief list of topics to be covered:
   d. Review of random concepts and basic pdfs, random variable, statistical independence, transformation of random variables, concepts of correlation, cross-correlation and covariance
   e. Central limit theorems
   f. Random processes: Bernouilli, random walk, Gaussian processes (1- and N-dimensional)
   g. Estimators: mean and variance
   h. Normality check, applications to signal analysis and characterization
   i. Confidence interval definition and applications of the confidence interval concept to verify/accept/reject hypotheses
   j. Statistical characterization of random signals: IID, stationary & wide sense stationary (wss) concepts, jointly wss, ergodicity, periodicity, cyclostationarity
   k. Correlation function and matrix, white & colored noise definition
   l. Power spectral density
   m. Principal Component Analysis & applications (face recognition, network anomaly detection)
   n. Linear transformations of random processes
   o. Matched Filter (applications to radar/communication scenarios)
   p. FIR Wiener optimal filtering (applications to communication system detectors, communication channel equalization, system identification, noise cancellation, spatial filtering for smart antennas).
   q. IIR Wiener filtering (time permitting)
1. EC3450 Fundamentals of Ocean Acoustics

2. Credits: 4
   Contact Hours (lecture-lab): 4-0

3. Course Coordinator: L. J. Ziomek


5. Specific course information:
   a. Catalog Description: Introduction to various mathematical techniques (both exact and approximate), special functions (e.g., Bessel functions, Hankel functions, and Legendre polynomials), orthogonality relationships, etc., that are used to model and solve real world problems concerning the propagation of sound in the ocean. Topics include, for example, reflection and transmission coefficients, ocean waveguide pulse-propagation models based on normal mode and full-wave theory, the WKB approximation, three-dimensional ray acoustics, and the parabolic equation approximation.
   b. Prerequisites: Standard undergraduate sequence of calculus and physics courses for engineering and science students.
   c. Elective or selected elective

6. Specific goals for the course:
   a. Knowledge of various mathematical techniques (both exact and approximate) that can be used to model and solve real world problems involving the propagation of sound in the ocean medium.
   b. Ability to compute important acoustical quantities such as SPL, SL, and TL; reflection and transmission coefficients; the total number of propagating normal modes in the ocean along with their corresponding group speeds, travel times, and angles of propagation; time-average radiated power of sound sources; ray paths and their important acoustical parameters; etc.

7. Brief list of topics to be covered:
   a. Fundamental Acoustical Quantities: time-average intensity vector, time-average power, sound-pressure level, source level, and transmission loss.
   b. Wave Propagation in the Rectangular Coordinate System: solution of the linear three-dimensional homogeneous wave equation; three-dimensional free-space propagation including group speeds, phase speeds, wavelengths, and attenuation coefficients; plane-wave velocity-potential, acoustic-pressure, time-average intensity, and time-average power reflection and transmission coefficients including ideal rigid and pressure-release boundaries, normal incidence, grazing and critical angles of incidence, and the angle of intromission; the time-independent free-space Green's function; solution of the linear three-dimensional inhomogeneous wave equation with arbitrary source distribution; integral representations of the time-independent free-space Green's function in rectangular
coordinates; target strength including bistatic and monostatic scattering, scattering function, and differential scattering cross-section; sound-pressure level and transmission loss at a receiver for a bistatic scattering problem

c. Wave Propagation in the Cylindrical Coordinate System: solution of the linear three-dimensional homogeneous wave equation; integral representations of the time-independent free-space Green's function in cylindrical coordinates; waveguide models of the ocean: normal mode solutions for pressure-release surfaces and rigid and fluid bottoms; waveguide model of the ocean: full-wave solution including ray integrals and eigenrays

d. Wave Propagation in the Spherical Coordinate System: solution of the linear three-dimensional homogeneous wave equation; three-dimensional free-space propagation including radiation from a vibrating sphere in the monopole mode of vibration

e. Wave Propagation in Inhomogeneous Media: the WKB approximation including the WKB amplitude function and phase integral, and turning points; ray acoustics including the solution of the eikonal, ray, and transport equations, focal points, and caustics; the parabolic equation approximation including split-step Fourier transform algorithms for homogeneous and inhomogeneous media
1. EC3460 Introduction to Machine Learning for Signal Analytics

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: M. Fargues

4. References:
   d. A. Ng, CS229 Course Notes, ECE Department, Stanford University, CA.
   f. Class notes

5. Specific course information:
   a. Description: This course introduces basic concepts and tools needed to detect, analyze, model, and extract useful information from digital signals by finding patterns in data. It covers some of the fundamentals of machine learning as they apply in signal and information processing. The emphasis in the course is on practical engineering applications rather than theoretical derivations to give participants a broad understanding of the issues involved in the learning process. Supervised learning tools such as the Bayes estimator, neural networks and radial basis functions, support vector machines and kernel methods are presented. Unsupervised learning tools such as k-means and hierarchical clustering are discussed. Data transformation and dimensionality reduction are introduced. Performance measures designed to evaluate learning algorithms are introduced. Concepts presented are illustrated throughout the course via several application projects of specific interest to defense related communities. Application topics may include target/signal identification, channel equalization, speech/speaker recognition, image classification, blind source separation, power load forecasting, and others of current interest.
   b. Prerequisites: knowledge of probability and random variables (EC2010, or OS2080, or OA3101, or equivalent), linear systems (EC2410 or equivalent), linear algebra (MA2043 or equivalent), ability to program in MATLAB, or consent of instructor.
   c. Elective or selected elective

6. Specific goals for the course:
   a. To learn what the learning problem is, and what its limitations are.
   b. To be able to select a supervised or unsupervised approach to investigate the problem considered.
   c. To be able to extract features characterizing class structures for classification applications.
d. To be able to design a Bayes classifier and apply it to a specific problem.
e. To be able to select a specific back-propagation neural network configuration to address a specific problem considered.
f. To be able to implement a back-propagation learning algorithm, train, and test the network.
g. To be able to apply principal component analysis to reduce the number of class features.
h. To be able to implement a radial basis function network to a classification or function approximation task.
i. To be able to apply the apply Kernel PCA to a classification problem.
j. To be able to select a given kernel type and apply it to a support vector machine algorithm.
k. To be able to apply an unsupervised learning method such as k-means or hierarchical clustering method to extract patterns present in signals.
l. To be able to select and apply a performance measure to evaluate and compare learning algorithms applied to a specific problem.
m. To be able to apply approaches introduced to specific applications of interest to defense related communities.

7. Brief list of topics to be covered:
   a. The learning problem: when it is feasible and what its limitations are
   b. Concepts of training versus testing
   c. Concepts of overfitting and generalization
   d. Bayes classifier: Bayesian decision theory – the 2-class case; Minimax Criterion; Neyman-Pearson criterion; Application: radar detection problem
   e. Linear model: Linear classification, dealing with non-separable data
   f. Nonlinear transformation, what does it buy us?
   g. Supervised and unsupervised learning: Supervised learning – training versus testing; Unsupervised learning – concept of clustering
   h. Principal component analysis
   i. Linear discriminant analysis
   j. Error surfaces and optimum points. Introduction to basic performance optimization schemes (steepest descent and variants)
   k. Multilayer Back-propagation Neural Networks
   l. Radial Basis Function Networks
   m. Kernel Methods: Concept of support vector machine (SVM); The Kernel trick
   n. Unsupervised learning: K-means algorithm; Hierarchical clustering; Choosing the number of clusters
   o. Performance measures: Confusion matrix; Receiver Operating Characteristics (ROC); Area under the Curve (AUC); Comparisons of measures.
1. EC3500 Analysis of Random Signals

2. Credits: 4
   Contact hours (lecture-lab): 4-0

3. Course Coordinator: F. Kragh

4. Text book:

5. Specific course information:
   a. Description: Fundamental concepts and useful tools for analyzing non-deterministic signals and noise in military communication systems and networks, and control, computer, and signal processing systems are developed. Topics include properties of random processes, correlation functions, energy and spectral densities, linear systems and mean square estimation, noise models, and Markov processes and queuing theory.
   b. Prerequisites: EC2500 (may be concurrent) and EC2010

6. Specific goals for the course:
   a. An understanding of random processes sufficient for graduate work in communications, network, control, computer, and signal processing engineering.

7. Brief list of topics to be covered:
   a. Review of random variables: distribution and density functions, expectations, functions of random variables, second order joint moments, the law of large numbers, central limit theorem.
   b. Random processes: definitions, stationary processes, systems with stochastic inputs, ergodicity, correlations and spectra.
   c. Applications: thermal noise, Poisson counting and point processes, product device for modulation, bandlimited processes, cyclostationary processes, matched filters, noise in AM, FM, and BPSK.
   d. Mean square estimation: the orthogonal principle, filtering and prediction, Wiener filters.
   e. Queuing Theory: Markov processes, birth-death processes, Little’s formula, M/M/1, M/M/c and M/M/1/K queues, Burke’s and Jackson’s theorems, Aloha protocol
1. EC3510 Communications Engineering

2. Credits: 3.5 credits
   Contact hours (lecture-lab): 3-1

3. Course Coordinator: Clark Robertson


5. Specific course information
   a. The influence of noise and interference on the design and selection of digital and analog communications systems is analyzed. Topics include link budget analysis and signal-to-noise ratio calculations, receiver performance for various analog and digital modulation techniques, and bandwidth and signal power trade-offs. Examples of military communications systems are included.
   b. EC3500 or EC3410
   c. Required for Communications Engineering Specialty, otherwise elective

6. Specific goals for the course
   a. To obtain an understanding of the capabilities and limitations digital communications systems in wideband noise.
   b. To understand various digital modulation schemes
   c. To be able to implement and analyze (via computer-aided-design simulations) communications systems and understand various trade-offs
   d. To obtain an understanding of the link budget and parameters that affect link margin analysis.

7. Brief list of topics to be covered
   a. Review of signals and systems, noise analysis, detection theory.
   b. Link budget analysis.
   c. Baseband and passband waveforms, signal bandwidth, and baseband line codes.
   d. Binary digital communications: BPSK, ASK, BFSK, DPSK, coherent demodulators for binary signaling and performance in AWGN.
   e. Noncoherent demodulators for binary signaling and performance in AWGN.
   f. Intersymbol interference.
   g. Bandwidth efficient digital communications: CPFSK, QPSK, OQPSK, and MSK waveforms, transmission bandwidth, receiver structure, performance in AWGN, comparison with binary signaling schemes.
   h. Carrier and symbol synchronization: Costas loops, open loop symbol synchronizers, delay-locked loops.
1. EC3600 Radar Systems

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Jenn

   a. Lecture notes
   b. Commercial software ANSYS Savant and CST Microwave Studio

5. Specific course information:
   a. Description: A fundamental understanding of antennas, scattering, and propagation is developed. Characteristics and design principles of common antenna types such as dipoles, arrays, horns, reflectors and micro strip patches, are considered. Concepts of antenna gain and effective area are used to develop power link equations. Scattering theory is introduced and propagation phenomena are considered for real-world scenarios. Design applications include phased, Yagi and log-periodic arrays, as well as shaped-beam reflector antennas, side lobe suppression, radar target scattering, stealth principles, surface waves, HF and satellite communications.
   b. Prerequisites: EC2650
   c. Elective or selected elective

6. Specific goals for the course:
   a. Explain the behavior of antenna fields in the near-zone, Fresnel-zone and far-zone
   b. Compute far-fields due to simple current distributions
   c. Explain relationships between impedance, complex power and energy
   d. Compute effective length, power gain and effective area of various antennas
   e. Design phased arrays to provide specified patterns and main beam direction
   f. Design Yagi array antennas to provide specified gain and front-to-back ratio
   g. Design Log-Periodic array antennas to provide specified gain and bandwidth
   h. Use “reciprocity” to relate antenna transmission and receiving performance
   i. Use “equivalence” to evaluate fields radiated from aperture antennas and reflector antennas using equivalent aperture currents
   j. Evaluate received power in terrestrial and satellite communication systems
   k. Explain dominant physical mechanisms of EM scattering as frequency is varied
   l. Evaluate scattered fields and find received power using the radar cross section
   m. Describe important properties of surface-waves, VLF--ELF propagation, and HF ionospheric propagation including take-off angle for elevated antennas

7. Brief list of topics to be covered:
   a. Potentials and fields, current element
   b. Basic antenna parameters, far-field concept, current loop, thin-wire antenna
   c. Common wire antennas, baluns, matching, introduction to phased arrays
d. Array synthesis, Yagi-Uda arrays

e. Log-periodic arrays, long-wire antennas, equivalence principle

f. Horn, reflector and microstrip antennas

g. Reciprocity, effective length, Friis formula

h. Electromagnetic scattering, radar equation

i. Refractive point-to-point propagation, surface waves, HF propagation

j. Environmental attenuation VLF--ELF propagation
1. EC3610 Microwave Engineering

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: R. Romero

   a. Lecture notes
   b. Laboratory materials, hardware and software

5. Specific course information:
   a. Description: This course provides an overview of the circuits and devices used in microwave, radar, communications, and electronic warfare systems. The course covers network analysis using scattering parameters, transmission media, selected circuits, and RF filter design. Circuits and devices are studied in the laboratory using both hardware and computer simulation.
   b. Prerequisites: EC2650
   c. Elective or selected elective

6. Specific goals for the course:
   a. The initial goal of the course to review electromagnetic field theory.
   b. For students to be able analyze transmission lines and calculate losses due to reflection and attenuation constant.
   c. For students to learn how to mitigate transmission line reflections through matching techniques via tuning analysis or Smith Chart.
   d. For students to learn and how signals propagate through various kinds of transmission such as waveguides and circuit board lines.
   e. To learn RF system analyses via matrix models such as scattering parameters and signal flow theory.
   f. For students to learn to analyze, how to design, and use microwave resonators.
   g. For students to learn to analyze, how to design, and use multiport networks such as power dividers and couplers.
   h. For students to analyze, how to design, and use RF filters.

7. Brief list of topics to be covered:
   a. Maxwell’s equations, boundary conditions, and wave propagation.
   b. Transmission line analysis.
   c. Waveguide analysis.
   d. Microwave network analysis.
   e. Impedance matching and tuning.
   f. Microwave resonators.
   g. Microwave filters.
1. EC3630 Radiowave Propagation

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. C. Jenn

   a. Lecture notes
   b. Commercial simulation software ANSYS Savant and AREPS

5. Specific course information:
   a. Description: This course treats the effects of the earth and its atmosphere on the propagation of electromagnetic waves at radio frequencies. Topics covered include ground waves, sky waves, ducting, reflection, refraction, diffraction, scattering, attenuation, and fading. Basic theory is covered and computer models are introduced where appropriate. Emphasis is placed on determination of the transmission loss between transmitting and receiving antennas. Computer laboratory exercises are used to illustrate the propagation characteristics of various indoor and outdoor environments, and their effects on system performance.
   b. Prerequisites: EC2650 or consent of instructor
   c. Elective or selected elective

6. Specific goals for the course:
   a. Understand the various mechanisms contributing to the non-free space propagation of radiowaves.
   b. Be able to incorporate various environmental conditions in the practical design of electronic warfare, radar and communication systems.
   c. Compute propagation characteristics (loss, dispersion, depolarization, etc.) for the following conditions and environments: multipath, ground waves, troposcatter paths, ionospheric paths, refraction, diffraction, and urban and indoor areas.
   d. Through the use of software laboratories, understand the capabilities and limitations of propagation simulation software.

7. Brief list of topics to be covered:
   a. Considerations: Transmission in free space; noise, noise figure, antenna noise temperature; classification of electromagnetic media; reflection of plane waves from lossy boundaries, Fresnel zones, surface roughness, and propagation factor.
   b. Role of the Terrain: Dipole over spherical earth; low antennas, surface waves, and mixed path propagation; elevated antennas, divergence factor, height gain.
   c. Role of the Ionosphere: Sky wave propagation, the ionosphere and its refractive index, refraction, maximum usable frequency, attenuation, effect of the earth's magnetic field, and solar activity.
d. Role of the Troposphere: standard atmosphere and the effective earth radius, anomalies and ducting, troposcatter links, atmospheric absorption, over-the-horizon propagation, parabolic equation, attenuation due to rain, snow, hail, and fog.

e. Effect of Obstacles: treatment of hills and buildings, knife-edge diffraction, and indoor and outdoor propagation issues for mobile radio.

f. Special Topics: radiation hazards, urban and indoor propagation, ray tracing (geometrical optics and geometrical theory of diffraction) and diversity and combining techniques.
1. EC3700 Joint Services Electronic Warfare System I

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: P. E. Pace

   a. Lecture notes;
   b. Included software;

5. Specific course information:
   a. Description: The concept of information operations (IO) and the critical role for electronic warfare (EW) are examined. The net-enabled force transformation is presented emphasizing how network-enabled EW technology provides a force multiplier for this transformation. Important EW technology components of SeaPower-21 are emphasized. The network space – battlespace duality and the Global Information Grid are also analyzed (FORCEnet). Metrics are presented to quantify the information value from wireless networks of distributed sensors and weapons. A direct assessment of the value of the network (information superiority) to the combat outcome (battlespace superiority) is presented. Integrated air defense suppression examples are studied using game theory to demonstrate the concepts. The role of intelligence also is emphasized. Sensor technologies and their use in the battlespace are presented. Mathematical models for electronic attack (EA) techniques are developed including those against GPS, RF and IR sensors. Off-board EA techniques including chaff, towed and rocket decoys, and digital image synthesizers are emphasized for counter-surveillance, counter-targeting and counter-terminal. High-power microwave and laser-based directed energy weapons are examined. Sensor protection techniques are discussed including an introduction to the new area of counter-electronic support. Students do a research project on a topic of interest from the Force Transformation Roadmap. Laboratory exercises are also conducted in the Radar and Electronic Warfare Laboratory.
   b. Prerequisites: Some knowledge of radar systems;
   c. Elective or selected elective

6. Specific goals for the course:
   a. Understand the new emission requirements for low probability of intercept (LPI) emitters;
   b. Learn how to achieve ultra-low antenna sidelobes and what the tradeoffs are;
   c. Identify the various scan patterns used by LPI emitters;
   d. Understand the modulations that can be interleaved for achieving a large processing gain and identify the origin of LPI radar;
   e. Compare the interception range with the LPI radar detection range;
   f. Understand and generate the different LPI phase, frequency and hybrid radar
modulations;
g. Calculate the periodic autocorrelation function and periodic ambiguity function of each modulation;
h. Identify within a case study, whether a LPI anti-ship seeker can detect a low radar cross section ship in the presence of a high sea state;
i. Understand what digital RF memories are and how they are used for electronic attack;

7. Brief list of topics to be covered:
   a. LPI antenna considerations;
   b. LPI transmitter considerations;
   c. Power management concepts;
   d. Radar detection range;
   e. Receiver interception range;
   f. Periodic autocorrelation function;
   g. Periodic ambiguity function;
   h. Frequency modulation continuous waveforms;
   i. Phase shift keying modulations;
   j. Frequency shift keying modulations;
   k. Noise modulations;
   l. Case Study: Anti-ship LPI seekers;
1. **EC3710 Computer Communications Methods**

2. **Credits:** 4.0  
   **Contact hours (lecture-lab):** 3-2

3. **Course Coordinator:** M. Tummala

   a. Lecture notes  
   b. Selected RFCs form IETF

5. **Specific course information:**  
   a. **Description:** The course objective is to develop an understanding of computer communications networks with emphasis on the requirements of military environments and the US Navy's combat platforms. Coverage includes the essential topics of network topology, connectivity, queuing delay, message throughput, security and performance analysis. The layered network architectures, such as the seven-layer OSI model and DoD's TCP/IP protocol suite, are covered. The techniques and protocols used in these layers are discussed. Local area networking technologies, such as Ethernet and Wi-Fi, and wide area technologies are covered. Principles of networking devices (hubs, switches, and routers) are presented. Some distributed applications are presented briefly.  
   
   b. **Prerequisites:** EC2010 and 2500  
   
   c. **Required for Network Engineering or selected elective**

6. **Specific goals for the course:**  
   a. The student will be able to list the widely used data communications protocols and standards organizations and expand commonly used data communications acronyms.  
   b. The student will be able to list the various transmission media and line coding and modulation techniques, define point-to-point and point-to-multipoint links, and delineate the line duplexity and mode of transmission (synchronous and asynchronous).  
   c. The student will be able to list the tenets of information security and provide examples of how these tenets are addressed at each layer of the network architecture.  
   
   d. Given the parameters of the window length and file size, the student will be able to develop a flow control scheme and illustrate its function with the help of schematic diagrams.  
   
   e. Given a CRC polynomial and a data sequence, the student will be able to compute the frame check sum and determine if a received sequence of bits have any errors.  
   
   f. The student will be able to create a model of the network in OPNET and run a simulation to experiment with the various parameters of the scheme.
g. Given the transmission capacity of the channel, its physical distance, and the frame size, the student will be able to determine the line utilization (with and without error control) of the Ethernet and Token Ring LANs.

h. Given a local area network topology, the student will be able to select the appropriate networking devices (hubs, bridges, switches and routers) in order to build a data network.

i. Given a wide area network topology, the student will be able to select the appropriate WAN technology and protocols (HDLC, PPP).

j. Given an address range, the student will be able to design an addressing scheme for an IP based network.

k. Given the packet size and network frame size limitations, the student will be able to develop a fragmentation and reassembly scheme for TCP/IP implementations.

7. Brief list of topics to be covered:
   g. Transport Protocols: Transport services. TCP and UDP. Fragmentation and reassembly.
1. EC3730 Cyber Network and Physical Infrastructures

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: J. McEachen

   a. Lecture notes
   b. Open source software: OpenPLC, Wireshark, mininet.

5. Specific course information:
   a. Description: Cyber infrastructure systems and technologies of interest to the military. Copper and fiber media networks, telecommunication networks and signaling, the Internet, enterprise networks, industrial control systems (ICS) and Supervisory Control and Data Acquisition (SCADA) systems. Implementations of virtualization to include cloud services. Terrestrial wireless networks: cellular networks, local area and long haul data networks (WiFi, GSM, LTE). Heterogeneous networks: end-to-end communication, protocols, design and performance analysis. Control and overlay networks such as Software Defined Network (SDN), Supervisory Control and Data Acquisition (SCADA) systems and the National power grid. Cyber defense infrastructure.
   b. Prerequisites: EC2700; U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.
   c. Elective or selected elective

6. Specific goals for the course:
   a. Describe a layered defense approach to computer network security.
   b. Compare and contrast different forms of transmission media.
   c. Discuss how the Internet is connected and how information is routed across the Internet.
   d. List common protocols used to implement the Internet.
   e. Describe client-server application protocols such as HTTP, SMTP and FTP.
   f. Provide examples of different methods of virtualization
   g. Discuss how virtualization is used to implement cloud-based services
   h. Identify the critical components of an industrial control system.
   i. List and discuss various ICS communications protocols and when to use them effectively
   j. Identify cyber defense components used in an enterprise network

7. Brief list of topics to be covered:
   a. Introduction: Internet architecture, virtualization, industrial control networks, cyber security.
   b. Network infrastructure: Physical layer; transmission media. Optical networking. Link layer, multiple access protocols, medium access control, error detection. Network layer, Routing, DHCP, NAT, ICMP. Transport layer, TCP, UDP, SCTP.
c. Applications and Web Infrastructures: Application layer; Client server versus peer to peer, HTTP, proxy, FTP, SMTP, domain name service, active directory. Peer to peer networks. Social networks.

d. Industrial Control System Infrastructures: Industrial control systems; supervisory control and data acquisition, distributed control systems, process control systems. Power grid; smart grid, smart metering. Protocols; Modbus, DNP3, OLE, AMI.

e. Cloud Infrastructures: Virtualization architecture, virtual machine, CPU virtualization, memory virtualization, server virtualization, I/O virtualization, virtual networking. Data centers; data center virtualization.


h. Cyber Defense: Cyber threats and defense. Domain name service protection. Route security. Web based attacks. Botnet attacks and defensive techniques
1. EC3740 Reverse Engineering in Electronic Systems

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: P. Thulasiraman

   a. Lecture notes and slides
   b. Supplemental readings from published literature
   c. IDA Pro Freeware

5. Specific course information
   a. Description: This course presents fundamental, systems level concepts for developing an understanding of system functionality without a prior access to the system's design specifications. It considers generalized approaches to developing a set of specifications for a complex system through orderly examination of components of that system. The course illustrates procedures for identifying the system's components and their interrelationships. The course is divided into two parts. The first part focuses on software reverse engineering where students perform elementary reverse engineering on basic programs using assembly language and software disassembly. Topics related to software reverse engineering including obfuscation techniques and malware analysis will be discussed. The second part of the course will focus on hardware reverse engineering by studying integrated circuit (IC) and circuit board analysis using SPICE and black box techniques. Other tools that aid in hardware reverse engineering such as JTAG will be studied in depth. Analysis of reverse engineering using mathematics, including power analysis will also be studied.
   b. Prerequisites: EC2700
   c. Required for Cyber Specialty, Selected Elective

6. Specific goals for the course:
   a. Be able to discuss and understand reverse engineering taxonomy
   b. Identify general reverse engineering procedures
   c. Understand the fundamentals behind software reverse engineering, including the process of disassembly
   d. Identify software obfuscation mechanisms given an assembly program
   e. Understand the fundamentals behind hardware reverse engineering with an emphasis on black box techniques and printed circuit board analysis
   f. Identify basic reverse engineering analysis techniques and evaluate static vs dynamic analysis
   g. Identify and evaluate reverse engineering countermeasures

7. Brief list of topics to be covered
   a. Basic reverse engineering concepts and taxonomy
b. Instruction Set Architecture (i.e., x86), including stack operations
c. Software obfuscation techniques
d. Malware and basic security primitives
e. Packed malware analysis from a dynamic and static perspective
f. Joint Test Action Group (JTAG) standard and its use in reverse engineering
g. RFID Reverse Engineering
h. Security competency of hardware
i. Non-invasive and invasive attacks against hardware
j. Different and Simple Power analysis for reverse engineering cryptographic suites
k. Hardware fault injection
l. Hardware Trojan identification
m. Reverse engineering using an unstructured netlist
n. Structural/functional and behavioral analysis of a black box system
o. Fit, form and function
p. Component level hardware analysis using SPICE
1. EC3750 Introduction to SIGINT Engineering

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Garren

   a. Lecture notes
   b. Laboratory materials, hardware and software

5. Specific course information:
   a. Description: An introduction to the technology of signals intelligence systems, with particular emphasis on the means for accessing signals of intelligence value. Covers the three major branches of SIGINT: communications intelligence, electronic intelligence, and foreign instrumentation signals intelligence.
   b. Prerequisites: EC3410 or EC3500 or EO3512
   c. Elective or selected elective
   d. U.S. citizenship and Top Secret clearance with eligibility for SCI access

6. Specific goals for the course:
   a. Explain the general history of space-based reconnaissance
   b. Examine the types for orbits, including specific orbital parameters.
   c. Calculate properties involving specific spacecraft orbits.
   d. Perform computations in involving receiver link equation based upon specific antenna properties
   e. Calculate the specific properties of the coverage area for particular signal types and collection scenarios
   f. Understand concepts of time difference of arrival and frequency difference of arrival in enabling estimates of signal position
   g. Utilize software which estimate uncooperative signal position based upon different signal intelligence collector properties
   h. Understand the properties of our national technical means systems for collecting valuable and classified signals and imagery intelligence
   i. Examine the properties of operational signals intelligence collection systems, including all stages of processing
   j. Determine whether a linear shift register is maximal length based upon a specific set of tap positions.
   k. Understand the concepts of spread spectrum signals with relevance to uncooperative signals collection

7. Brief list of topics to be covered:
   a. History of signals intelligence
   b. Properties of our national technical means collection systems
   c. Orbital regimes, parameters, and trajectory calculations
d. Antenna properties and relevance to signals collection
e. Link equation
f. Signal coverage on the earth
g. Signal geolocation based upon time difference of arrival
h. Signal geolocation based changing signal collector position
i. Signal geolocation based upon frequency difference of arrival
j. Target detection and false alarm rates for signals intelligence
k. Encryption and cryptography, including the RSA algorithm
l. Linear shift registers
m. Digital signal processing sampling
n. Spread spectrum signal techniques
1. EC3760 Information Operations Systems

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: J. McEachen

   a. Lecture notes
   b. Commercial software: HexRays IDAPro, Microsoft WinDbg, Rapid7 Metasploit, VMWare vSphere, ESX.
   c. Open source software: Wireshark, zenmap/nmap, hunt.

5. Specific course information:
   a. Description: This course examines the Network-centric Environment that is the focus of the Information Operations (IO) infrastructure with emphasis on current and future implementation models. A Signals Intelligence (SIGINT) approach is taken in which the adversary’s computer network system architecture is examined and evaluated for the purpose of exploitation, protection, and/or attack. A thorough review of the fundamentals of communications, computer networks, and advanced digital technologies is discussed. This course works closely with the Department of Defense to reinforce realistic approaches for solving critical IO issues within the community.
   b. Prerequisites: EC2700; U.S. citizenship and TOP SECRET clearance with eligibility for SCI access.
   c. Elective or selected elective

6. Specific goals for the course:
   a. The student will describe a layered defense approach to computer network security.
   b. The student will describe a variety of hierarchical computer network attack strategies.
   c. The student will identify Department of Defense components involved in Information Operations (IO) and Computer Network Operations (CNO).
   d. The student will address the importance of SIGINT in executing IO and CNO.
   e. The student will demonstrate a working knowledge of the current tools used for offensive and defensive computer network operations.
   f. The student will demonstrate a detailed understanding of the topology of a network-centric environment.
   g. The student will identify communications industry standards related to network-centric environments.
   h. The student will differentiate between wide area, metropolitan area, and local area networks and discuss hardware and communications issues associated with each.
   i. The student will be able to discuss the concepts of internetworking and layered architectures.
j. The student will identify the components of the Transmission Control Protocol/Internet Protocol (TCP/IP) architecture.

k. Given a TCP/IP protocol, students will identify the dependencies the protocols on other underlying protocols.

7. Brief list of topics to be covered:
   a. Fundamentals of Data Communications
   b. Legal aspects of Information Operations
   b. National SIGINT assets
   c. TCP/IP protocols and operation
   d. The EVAPI+ penetration testing model
   e. Systems for enumeration and system identification
   f. Systems for vulnerability identification
   g. Access vectors to vulnerable systems
   h. Fundamentals of privilege escalation
   i. Implant structure and fundamentals
   l. Computer network attack and defend tools
1. EC3800 Microprocessor-Based System Design

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Fouts


5. Specific course information:
   a. Description: This course teaches the design and analysis of microprocessor-based computer systems for embedded and real-time computing applications. Microprocessor systems are widely used in military hardware for sensing and data collection, data analysis, system control, data encryption/decryption, and communications. Topics covered include processor architecture, memory subsystem design, input/output subsystem design, high-level language and assembly language programming for embedded and real-time applications, operating systems and process control for embedded and real-time processing, and security and reliability for embedded and real-time processing. Laboratory assignments focus on the integration of hardware, software, and sensors and other I/O devices using an ARM-based single-board computer.
   b. Prerequisites: EC2820
   c. Required

6. Specific goals for the course:
   a. The student will learn how to select an appropriate processor for embedded and real-time computing applications
   b. The student will learn how to design a memory subsystem for use in embedded and real-time computing applications
   c. The student will learn how to design an input/output subsystem for use in embedded and real-time computing applications
   d. The student will learn the software development process for embedded and real-time computing applications
   e. The student will learn how to select an appropriate operating system and process scheduling algorithm for embedded and real-time computing applications
   f. The student will understand the basics of computer security and reliability for embedded and real-time computing systems

7. Brief list of topics to be covered:
a. Processor architectures and instruction sets for embedding and real-time computing, including RISC and CISC
b. Special-purpose processor architectures and instruction sets for embedding and real-time computing, including architectures for single-chip microcontrollers and digital signal processors
c. Assembly language programming of RISC processors for embedded and real-time applications

a. High-level language programming and the role of the compiler for embedded and real-time applications
b. Memory subsystem architecture, including main memory, cache memory, and virtual memory
c. Memory subsystem implementation, including the use of static and dynamic RAM, ROM, PROM, and Flash technology
d. The effect of memory subsystem design on the performance of embedded and real-time systems
e. Basic and advanced input/output devices and their interface to the processor
f. Input/output subsystem design, including buses and bus bridges
g. The effect of input/output subsystem design on the performance of embedded and real-time applications
h. Operating systems for embedded and real-time computing
i. Process control and real-time scheduling
j. Reliability and security of embedded and real-time computing systems
1. EC3820 Computer Systems

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Fouts


5. Specific course information:
   a. Description: The course presents a unified approach for the design of computer systems stressing the interacting processes implemented in hardware, software, and firmware. General features of operating systems are studied as well as specific features of an existing system. The elements of a multiprogramming system are introduced.
   b. Prerequisites: EC2840 or EC2820
   c. Elective

6. Specific goals for the course:
   a. The student will be able to explain the components of a typical operating system and how they interact with each other
   b. The student will be able to understand programs written in the C programming language and will be able to write basic C programs
   c. The student will understand basic inter-process communication mechanisms
   d. The student will be able to describe in detail the action and relative merits of the various methods used for process scheduling
   e. The student will be able to determine the allocation of processor memory when various allocation schemes are used, both with and without the use of virtual memory
   f. The student will understand the file structures of typical operating systems
   g. The student will be able to bound I/O transaction times when given the characteristics of a data block and the I/O device used
   h. The student will be able to describe the operation of common methods used to prevent deadlocks
   i. The student will be able to describe in detail the methods commonly used by operating systems to protect executing processes from each other
   j. The student will be able to describe in detail the methods commonly used by operating systems to protect allocated memory from processors not authorized to access it
   k. The student will be able to describe in detail the methods commonly used by operating systems to protect the operating system processes and the memory used by the operating system from user processes

7. Brief list of topics to be covered:
   a. Introduction to operating systems
b. Files and file systems

c. Introduction to the C programming language

d. Introduction to compilers and compiler-operating system interaction

e. The structure of executable files

f. Processes, process control, and inter-process communication

g. Process scheduling and deadlock including real-time scheduling

h. Memory management without virtual memory

i. Virtual memory, including multi-level virtual memory, and memory management with virtual memory

j. Input/output processes

k. Process and memory protection for the operating system

l. Process and memory protection for user processes
1. EC3830 Digital Computer Design Methodology

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Fouts

   a. Reference: Instructor’s Notes

5. Specific course information:
   a. Description: A design and project-oriented course covering basic principles, theories, and techniques for practical design of digital systems. Emphasizes an integrated viewpoint combining essential elements of classical switching theory with a thorough understanding of modern computer aided design tools. Current military and commercial systems are used as design examples.
   b. Prerequisites: EC2820
   c. Elective

6. Specific goals for the course:
   a. To acquaint students with the basic principles, theories, and techniques for the practical design of digital systems and computers, in keeping with the essential elements of classical switching theory.
   b. To develop familiarity with state-of-the-art computer aided design tools.
   c. To develop the ability to implement digital systems and computers using state-of-the-art implementation technologies and CAD tools, including FPGAs and ASICs

7. Brief list of topics to be covered:
   a. Combinational Circuit Design
   b. FPGAs
   c. Carry Save Adders
   d. Array Multipliers
   e. Synchronous Sequential Machine Design, including Mealy and Moore Machines
   f. Feedback Sequential Machines (Fundamental Mode Asynchronous Sequential Machines)
   g. Synchronizers
   h. Algorithmic State Machines
   i. Digital System Design
   j. Residue Number Systems
   k. Applications for Residue Number Systems in Digital Hardware
1. EC3840 Introduction to Computer Architecture

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Fouts


5. Specific course information:
   a. Description: This course presents the fundamental principles of computer architecture and processor design, including the influences of implementation technology, cost, performance, and the historical development of computer architecture. Levels of abstraction and instruction set/architecture design are also taught. Processor design and implementation is covered, including the data path and the control unit. Computer design, including buses, the memory hierarchy, and the input/output subsystem are discussed. Factors effecting performance and performance measurement, evaluation, and comparison are discussed. The effects of embedded military applications on computer architecture are also covered.
   b. Prerequisites: EC2800
   c. Required

6. Specific goals for the course:
   a. The student will understand how computer architecture is influenced by implementation technology, cost, performance, and the historical evolution of computer architecture.
   b. Given one or more processors and/or computer systems, the student will be able to design, conduct, and evaluate tests to determine performance and to compare performance results between different processors and/or systems.
   c. The student will understand the different levels of abstraction used in the design of processors and computer systems.
   d. The student will understand the roles of assembly language and machine language for a computer and how the machine language is interpreted by the instruction set/architecture.
   e. Given a computational problem, the student will be able to design an instruction set/architecture capable of solving the problem with suitable programming.
   f. Given a specification for an instruction set/architecture, the student will be able to design a processor at the register transfer level, including both the data path and the controller.
g. Given the specification for a processor controller, the student will be able to evaluate the engineering tradeoffs between the use of microprogrammed control and finite state machine control.

h. Given the design for a processor, the student will be able to evaluate different implementation alternatives, including discrete components, programmable logic devices, and VLSI.

i. The student will understand the operation of the memory hierarchy, including virtual memory and cache memory.

j. Given a specification for a memory subsystem, the student will be able to design, at the register transfer level, a cache memory, the main memory, the memory bus, and to evaluate their performance.

k. Given the specification for an input/output subsystem, the student will be able to design I/O controllers, the I/O bus, and to evaluate their performance.

l. The student will understand the application of imbedded computers in military systems and the importance of reliability and radiation tolerance.

7. Brief list of topics to be covered:
   a. The historical evolution of computer architecture.
   b. The influences on computer architecture of implementation technology, cost, performance, and the historical evolution of computer architecture.
   c. Factors effecting cost and performance, performance measurement and evaluation, and performance comparisons.
   d. Levels of abstraction, instruction set/architecture design, machine language, assembly language, and the role of assemblers and compilers.
   e. Processor design, including the data path and the control unit.
   f. Control unit design, including the concepts of microprogramming and finite state machine control.
   g. Processor implementation, including discrete components, programmable logic devices, and VLSI.
   h. The effect of the instruction set/architecture on implementation, and the use of CAD tools.
   i. The memory hierarchy, including the register file, cache memory, main memory, secondary memory, virtual memory, and memory subsystem performance.
   j. Input/output subsystems, including devices, interfaces, standards, and performance.
   k. Military computer systems, reliability, and radiation tolerance.
1. EC3970 Special Topics in Electrical & Computer Engineering: Constructs in Malware

2. Credits: 3
   Contact hours (lecture-lab): 2-2

3. Course Coordinator: J. McEachen

4. Text books:
   d. Lecture notes

5. Specific course information:
   a. Description: An examination of common system programming constructs used by malicious software. The course examines mechanisms used by malicious software in the enumerating computer configurations, exfiltrating data, damaging computer systems. Advanced techniques will be explored to include obfuscation, process attachment, hooking, injection, polymorphism and fuzzing.
   b. Prerequisites: EC1010
   c. Elective or selected elective

6. Specific goals for the course:
   a. Identify critical sources of computer configuration that are targets of enumeration mechanism
   b. Demonstrate methods for exfiltration of information over computer networks
   c. Identify methods that will cause damage to computer systems
   d. Demonstrate methods for obfuscation and anti-debugging of computer code
   e. Describe mechanics of techniques for hooking, injection, polymorphism, and fuzzing

7. Brief list of topics to be covered:
   a. Introduction and legal issues.
   b. Malware definition and taxonomy.
   c. Command line interface.
   d. System calls. Registry internals. Windows API.
   g. Debugging options. Obfuscation techniques.
   h. Debugging motivations and design.
   i. Process capture, freezing and attachment.
   j. Service tables.
   k. Persistence.
l. Device (keyboard, mouse) hooking.
m. Application Initiation loading.
n. Remote Threads.
o. Self-modifying and metamorphic code.
1. EC4000 Introduction to Doctoral Research

2. Credits: 2.0
   Contact hours (lecture-lab): 2-0

3. Course Coordinator: M. Tummala

4. Textbook: No textbook
   a. Selected readings from the literature.

5. Specific course information:
   a. Description: The course provides a forum for ECE doctoral students at all levels of progress to meet once a week to discuss their research, share ideas, rehearse conference presentations and dissertation defenses, and to gain exposure to a diversity of research topics and ideas. The course prepares the doctoral students to initiate the screening and qualifying steps of the program, to undertake dissertation research, and to publish and present research results. A large component of the class is presentations and seminars by doctoral students in the research phase of their program, NPS faculty and outside researchers to expose the students in the early stages of their program to ongoing research and advances in the field. Graded on Pass/Fail basis only.
   b. Prerequisites: Approved ECE Ph.D. student or Consent of the ECE Ph.D. Program Committee
   c. Required for the ECE Ph.D. students

6. Specific goals for the course:
   a. To foster interaction among doctoral students and the department faculty and to promote excellence in research.
   b. To provide orientation for students in early stages of the program to initiate the screening and qualifying steps of the program.
   c. To help students who have completed the screening phase of the program to undertake dissertation research and to publish and present research results.
   d. To provide a forum for making presentations of student research results.
   e. To bring NPS faculty and external speakers for presentations and seminars on contemporary research topics of interest to ECE doctoral students.

7. Brief list of topics to be covered:
   a. An overview of the ECE Ph.D. program, guidance on the program preliminaries, such as the screening and qualification exams and minor requirements, and the dissertation research process.
   b. A broad overview of the current research problems in the field of electrical and computer engineering relating to the needs of national defense and in the ECE department in particular is presented.
   c. Periodically review tools of interest to the class, such as bibliographical organizational packages and computational tools.
   d. Presentations and seminars by doctoral students in advanced stages of dissertation research, ECE faculty, and external speakers.
1. EC4130 Advanced Electrical Machinery Theory

2. Credits: 5
   Contact hours (lecture-lab): 4-2

3. Course Coordinator: Roberto Cristi

   a. Lecture Notes
   b. Articles from current literature

5. Specific course information:
   a. Description: The emphasis of this course is to extend three phase analysis techniques to a number of applications in the areas of machinery control, power generation and power distribution. In particular the control of brushless DC motors and induction motors will be addressed in the presence of realistic constraints in terms of voltage and current. Current topics also include wind power generation and more general power distribution networks such as microgrids, where frequency and power have to be stabilized in the presence of fluctuation introduced by various diverse sources, such as renewables.
   b. Prerequisites: EC3130
   c. Elective or selected elective

6. Specific goals for the course:
   a. Permanent Magnets and Brushless DC (BLDC) motors
   b. Open loop velocity and Torque control of BLDC motors
   c. Dual loop (Inner and Outer) Control for maximum Torque
   d. Control of BLDC motors with Voltage and Current constraints
   e. Digital Implementation of BLDC motor Control
   f. Velocity and Torque Control of Induction Motors.
   g. Introduction to Wind Power: Ideal Wind Power Dynamics
   h. Doubly Fed Induction Generators (DFIG) for Wind Power generation
   i. Power Distribution and Transmission: Two Port Systems and Power Flow
   j. Introduction to Microgrids (MG): definitions and main components
   k. Control Structure: Primary, Secondary, Tertiary of MGs

7. Brief list of topics to be covered:
   a. Velocity and Torque Control of Three Phase motors
   b. Doubly Fed Induction Machines for Wind Power Generators
   c. Power Distribution in Inductive Transmission Lines
   d. Introduction to MicroGrids and their Control Structures.
1. EC4150 Advanced Power Electronics

2. Credits: 5
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: Giovanna Oriti


5. Specific course information:
   a. Description: The course presents steady state and dynamic analysis of modern power electronic converters for advanced shipboard electric power distribution with emphasis on comparison to military standards. Physics-based modeling is used to simulate power converters and their control systems in microgrids for Navy shipboard and shore applications. The course includes some more advanced topics like resonant converters, renewable energy power conditioning converters and grid-interface inverters.
   b. Prerequisites: EC3150

6. Specific goals for the course:
   a. This course continues the study on DC/AC converters, or inverters, initiated in EC3150. The students learn about three phase inverters and space vector modulation, and how they compare to single phase inverters and sine-triangle modulation respectively. Emphasis is placed on digital implementation of the inverter’s control systems.
   b. To design control systems for shipboard inverters, including synchronous reference frame controllers, voltage and current control methods. The students learn how to use physics-based models to design and simulate power converters and their control systems.
   c. Students learn about practical design of power converters and control related to Navy applications. They also learn to understand and apply military standards that regulate power distribution in military microgrids.
   d. Laboratory exercises provide experience with microgrid components including active and reactive power control, photovoltaic power conditioning and energy management systems

7. Brief list of topics to be covered:
   a. Three phase voltage source inverter topology and applications
   b. Three phase inverters with sine-triangle pulse width modulation (PWM)
   c. Space Vector Modulation
   d. Three phase voltage source inverters (VSI) used as variable speed drives for electric machines
   e. Closed loop control techniques, current control in the synchronous reference frame.
   f. Voltage source inverters used to generate fixed frequency/fixed voltage three
phase AC shipboard electric power

g. Modeling and simulations

h. Resonant Converters: Zero current and zero voltage switching; Series loaded resonant dc-dc converters

i. Dynamics of power electronic circuits – software projects including: Single phase microgrids with energy storage, Photovoltaic source power conditioning, Grid-connected microgrids, and Active and reactive power control
1. EC4210 Electro-Optic Systems Engineering

2. Credits: 3  
   Contact hours (lecture-lab): 3-0

3. Course Coordinator: P. E. Pace

4. Text book: Textbook to be determined at time of offering depending on students interest;  
   a. Lecture notes  
   b. Journal papers  
   c. Included software

5. Specific course information:  
   a. Description: Advanced topics and application of electro-optics. Military applications of electro-optic and infrared technology such as laser communications, laser radar, and Bragg cell signal processors. Signal-to-noise analysis of laser detector performance. Student reports on EO/IR topics of current military interest.  
   b. Prerequisites: EC3210

6. Specific goals for the course:  
   a. Determined when content of course if finalized

7. Brief list of topics to be covered:  
   a. Various topics in electro-optic devices and systems
1. EC4220 Introduction to Analog VLSI

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: S. Michael

4. Textbook:
   d. Lecture notes

5. Specific course information:
   a. Description: Modern active circuit design topologies; analog and sampled data networks. Analysis of transfer function properties, stability and causality. Higher order filter design and synthesis. Use of computer simulation tools, SPICE, and different device models for network analysis. Transformation methods and switched-capacitor filtering and non-filtering applications. Introduction to analog VLSI techniques using stray-insensitive switched-capacitor networks. Examples of such analog VLSI designs in military applications.
   b. Prerequisites: EC3200
   c. Required or elective

6. Specific goals for the course:
   a. To acquire a qualitative understanding of Modern active circuit design topologies; analog and sampled data networks.
   b. Analysis of transfer function properties, stability and causality. Higher order filter design and synthesis.
   c. Use of computer simulation tools, SPICE, and different device models for network analysis.
   d. Transformation methods and switched-capacitor filtering and non-filtering applications. Introduction to analog VLSI techniques using stray-insensitive switched-capacitor networks.
   e. Examples of such analog VLSI designs in military applications.

7. Brief list of topics to be covered:
   a. Introduction to Network Functions and Filters Classifications
   b. Frequency Response and Transfer Function review.
   c. Transformation Methods
   d. Sensitivity Analysis
   e. Continuous-time Active Filters
   f. High-order Filter Realization (Filter Synthesis)
   g. Switched Capacitor (SC) Networks
   h. SC Filtering and Non-filtering Applications
i. Applications of SC Networks in Analog VLSI
j. Military applications of analog VLSI.
1. EC4230 Reliability Issues for Military Electronics

2. Credits: 3.5
   Contact hours (lecture-lab): 3-1

3. Course coordinator: T.R. Weatherford

4. Text book:

5. Specific course information
   a. Description: This course investigates where and why semiconductor devices fail in military environments. Topics include limitations of commercial-off-the-shelf (COTS) integrated circuits, thermal failure, electrostatic breakdown, noise in solid state devices, packaging reliability issues, radiation effects due to space and nuclear environments, and the limited availability of military integrated circuit suppliers.
   b. Prerequisites: EC3220
   c. Elective, or selected elective course

6. Specific goals for the course
   a. Understanding of semiconductor device physics of failure mechanisms.
   b. Recognize statistical distributions of failures in time.
   c. Develop knowledge of how radiation can degrade electronics.
   d. To know relevant military specifications for DoD electronic requirements.

7. Brief list of topics to be covered:
   a. Physics of Failure of semiconductor devices
   b. Packaging of semiconductor components
   c. Statistical distributions
   d. Yield vs Reliability
   e. Noise in semiconductor devices
   f. Counterfeit devices
   g. Military specifications
1. EC4280 Micro Electro Mechanical Systems (MEMS) Design II

2. Credits: 3  
   Contact hours (lecture-lab): 2-4

3. Course coordinator: T.R. Weatherford


5. Specific course information  
   a. Description: This course exposes students to advanced topics on material considerations for MEMS, microfabrication techniques, forces in the micro- and nano-domains, and circuits and systems issues. Case studies of MEMS based microsensors, microactuators and microfluidic devices are discussed. Laboratory work includes computer aided design (CAD) and characterization of existing MEMS devices. 
   b. Prerequisites: EC3280 or content of instructor  
   c. Elective, or selected elective course

6. Specific goals for the course  
   a. The student should develop an understanding of design, modeling, fabrication, and fundamental characterization techniques for MEMS devices.  
   b. Application of this technology to military systems.

7. Brief list of topics to be covered:  
   a. Microfabrication Techniques  
   b. Circuits and Systems Issues  
   c. MEMS Design and Case Studies
1. EC4300 Advanced Topics in Modern Control Systems

2. Credits: 3, Contact hours (lecture-lab): 3-0

3. Course coordinator: X. Yun

4. Text book:
   a. Selected journal and conference papers on topics to be covered
   b. class notes

5. Specific course information
   a. Catalog description: Advanced topics and current developments in control systems are presented in this course. The list of special topics includes (but it is not limited to) robotics systems, autonomous vehicles, design by robust techniques.
   b. Prerequisites: Consent of instructor.
   c. Elective

6. Specific goals for the course
   a. To gain in-depth knowledge of one or more selected topics in control systems
   b. To learn newly developed theories and algorithms in the selected topics
   c. To explore the latest trend in control systems theory development and applications
   d. To build skills in conducting research in control systems

7. Brief list of topics to be covered
   a. Specific topics to be selected by the instructor, examples include
   b. Modeling and control of advanced robotic systems
   c. Navigation and control of autonomous vehicles
   d. Control system design using robustness techniques
   e. Theory and implementation of adaptive control systems
   f. Advanced topics in optimal control systems
   g. Advanced topics in nonlinear control systems
   h. Advanced topics in guidance and control
   i. Neural networks and applications
1. EC4310 Fundamentals of Robotics

2. Credits: 4, Contact hours (lecture-lab): 3-2

3. Course coordinator: X. Yun

4. Text book:

5. Specific course information
   a. Catalog description: This course presents the fundamentals of land-based robotic systems covering the areas of locomotion, manipulation, grasping, sensory perception, and teleoperation. Main topics include kinematics, dynamics, manipulability, motion/force control, real-time programming, controller architecture, motion planning, navigation, and sensor integration. Several Nomad mobile robots will be used for class projects. Military applications of robotic systems will be discussed.
   b. Prerequisites: MA3042 and either EC2300 or EC2320 or consent of instructor.
   c. Elective

6. Specific goals for the course
   a. To understand advantages and disadvantages of different types of robotic systems and platforms including wheeled robots, legged robots, and other types of robots
   b. To learn methods for representing position and orientation, coordinate systems, rotation matrix, homogeneous transformation, and quaternion
   c. To learn robotic kinematics and inverse kinematics
   d. To understand motion planning strategies and algorithms
   e. To understand localization and mapping techniques and algorithms
   f. To learn coordinated control algorithms for distributed autonomous robots
   g. To gain insight into the latest trends in research and development in robotics

7. Brief list of topics to be covered
   a. Definition and classification of robots and robotic systems, applications of robots in civilian and military domains
   b. Mathematical description of position and orientation, coordinate systems, rotation matrix, homogeneous transformation, Euler angles, quaternion, roll-pitch-yaw angles
   c. Direct and inverse kinematics, manipulator configurations, robotic hands and end-effectors
   d. Sensors and actuators used in robotics systems
   e. Legged robots, static vs dynamic stability
   f. Wheeled mobile robots, kinematic model, simulation and programming environment, nonholonomic constraints
g. Motion planning, configuration space, bug algorithms, potential field algorithm, visibility graph, Voronoi diagram, cell decomposition

h. Localization, mapping, dead reckoning, landmark-based localization, feature-based localization, Hough transform

i. Distributed autonomous robots, distributed control, distributed programming, formation problem, moving in formation.
1. **EC4320 Design of Robust Control Systems**

2. **Credits:** 4  
   Contact hours (lecture-lab): 3-2

3. **Course Coordinator:** R. G. Hutchins

   a. Lecture Notes

5. **Specific course information:**
   a. **Description:** This course presents advanced topics on control system design. Major emphasis is on robust techniques in order to account for uncertainties on the systems to be controlled. Several applications show the trade-offs in several applications, such as missile and/or underwater vehicles control design. Advanced concepts on H2 and H-infinity will be introduced as part of the course.
   b. **Prerequisites:** EC3310, EC3320  
   c. Elective or Selected Elective

6. **Specific goals for the course:**
   a. Convey the mathematical theory of LQG control  
   b. Convey the mathematical theory of H-infinity control  
   c. Transmit an understanding of practical applications via computer simulations

7. **Brief list of topics to be covered**
   a. Introduction to multivariate linear systems  
   b. Review of vector random processes  
   c. Control system performance measures  
   d. Robustness  
   e. LQG (H2) control  
   f. H-infinity control with full information  
   g. H-infinity output feedback control
1. EC4330 Navigation, Missile and Avionics Systems

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: R. G. Hutchins

4. Text book:  
   b. Lecture Notes

5. Specific course information:  
   a. Description: Principles of missile guidance, including guidance control laws, basic aerodynamics and six degree-of-freedom motion simulation. Additional topics are selected from the following areas to address the general interests of the class: advanced guidance laws, passive sensors, INS guidance, fire control and tracking systems, and ballistic missile targeting.  
   b. Prerequisites: EC3310  
   c. Elective or Selected Elective

6. Specific goals for the course:  
   a. Basic theory of tactical missile guidance  
   b. Basic aerodynamics for implementing guidance commands  
   c. Navigation, force and torque equations for motion near the Earth

7. Brief list of topics to be covered  
   a. Review of basic control concepts  
   b. Nonlinear state space representations for missile dynamics  
   c. Proportional Navigation Guidance  
   d. Equations for implementing guidance commands using aerodynamic control surfaces  
   e. Navigation equation for motion around an ellipsoidal earth  
   f. Force and torque equations for motion around an ellipsoidal earth  
   g. Ballistic missile dynamics and trajectory simulation  
   h. Advanced guidance laws
1. EC4350 Nonlinear Control Systems

2. Credits: 4, Contact hours (lecture-lab): 3-2

3. Course coordinator: X. Yun


5. Specific course information
   a. Description: This course presents techniques for automatic control of nonlinear systems with application to current military and robotic systems. Main topics include the analysis and design of nonlinear systems with phase plane and describing function methods, Lyapunov and sliding mode control techniques. Accuracy limit cycles, jump resonances, relay servos, and discontinuous systems will also be considered.
   b. Prerequisites: EC2300, EC2320.
   c. Required

6. Specific goals for the course
   a. To represent nonlinear systems in the state space
   b. To learn methods and techniques for simulating nonlinear systems
   c. To understand the concept of system stability
   d. To learn methods for analyzing nonlinear systems
   e. To learn design methods for nonlinear systems.

7. Brief list of topics to be covered
   a. Mathematical models of nonlinear systems in the state space
   b. Simulation of nonlinear system response using MATLAB and Simulink
   c. Phase plane analysis, singular points, phase plane analysis for nonlinear systems, limit cycles, equilibrium points
   d. Concept of stability, asymptotical stability, exponential stability, local and global stability, convergence
   e. Linearization principle
   f. Lyapunov theory, Lyapunov direct method, Lyapunov function, invariant set theory, Barbalat’s lemma
   g. Feedback linearization, Lie derivatives, Frobenius theory, input-state linearization, input-output linearization, feedback linearization of multi-input multi-output systems, dynamic state feedback
   h. Zero dynamics, internal dynamics
   i. Sliding mode control.
1. EC4400 Advanced Topics in Signal Processing

2. Credits: 3  
   Contact hours (lecture-lab): 3-0

3. Course coordinator: Roberto Cristi

4. Text book: Selected journal and conference papers on topics to be covered and class notes

5. Specific course information
   a. Catalog description: Special advanced topics in signal processing not currently covered in a regularly scheduled course and relevant to advanced naval and other military applications. Topics may include digital filter structures and implementations, advanced computational topics and architectures for signal processing, imaging, recent work in signal modeling, array processing, or other topics of interest.
   b. Prerequisites: Consent of instructor.
   c. Elective

6. Specific goals for the course
   a. To gain in-depth knowledge of one or more selected topics in signal processing
   b. To learn newly developed theories and algorithms in the selected topics
   c. To explore the latest trends in signal processing
   d. To build skills in conducting research in signal processing

7. Brief list of topics to be covered
   a. Specific topics to be selected by the instructor
1. EC4430 Multimedia Information and Communications

2. Credits: 4.0
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: M. Tummala

   a. Lecture notes
   b. JPEG, MPEG, and other media standards documents

5. Specific course information:
   a. Description: The course presents essentials of signal and text compression, distribution of compressed information over communication networks, and information hiding (covert communication). Principles and algorithms for signal (speech, audio, image, video) and text compression are presented, and related standards (G.729, JPEG, MPEG, MP3) are discussed. Distribution (and storage) of compressed information over wired/wireless networks and end-to-end delivery issues (streaming, VoIP, IPTV) to ensure quality of service are reviewed. Information hiding (steganography), information privacy and security, and forensic steganalysis for detecting and aborting covert communication are discussed.
   b. Prerequisites: EC3410 or EC3500 or consent of instructor
   c. Elective or selected elective

6. Specific goals for the course:
   a. Given a message, the student will be able to determine the Huffman and arithmetic codes if symbol statistical characteristics are available, or construct a Lempel-Ziv dictionary and calculate the compression gain.
   b. Given the image format and luminance/chrominance values, the student will be able to apply the DCT or wavelet decomposition algorithm, analyze signal loss, determine the JPEG codes, and compute the compression gain.
   c. Given the frame rate, frame size, and color format, the student will be able to propose a schematic for video compression using MPEG/H.264 standard that addresses motion compensation, bit rate, delay, frame prediction and signal quality.
   d. Given the sampling rate and bit resolution, the student will be able to develop speech and audio compression schemes utilizing current standards (G.729.1, G.719, MP3) while addressing the bit rate, delay and quality of service issues.
   e. Given the general channel characteristics including capacity and error rates, the student will be able to propose schemes to insure error robustness and resilience of multimedia signals.
   f. Given the quality of service requirements of multimedia information, the student will be able to select appropriate networking protocols and distribution mechanisms for timely, accurate delivery.
g. Given a secret message and a cover object (image, video, speech, text), the student will be able to propose a steganographic covert communication scheme (as an alternative or in addition to a cryptographic scheme) consisting of effective embedding and extraction algorithms to ensure message security and robustness.

h. Given the need for defending against covert communications, the student will be able to propose attack schemes for forensic steganalysis consisting of detecting the presence of stego objects, breaking the covert channel, and extracting the secret message.

7. Brief list of topics to be covered:
   a. Digital Information
   e. Motion estimation and motion compensation in video compression. MPEG and H.26x.
   f. Effects of channel and network errors on video quality.
   g. Audio and Speech Compression: MP3 standard. CELP algorithm. Distortion measures and perceptual issues.
   h. Transmission of Digital Information
   j. Wire pairs, coaxial cable, fiber, and wireless.
   k. Channel quality issues, such as equalization and echo cancellation.
   m. Channel coding for protecting compressed information. Security and encryption of compressed information.
   n. Distribution of Digital Information
   o. Advanced Internet. Real-time communication over packet-switched networks.
   q. UDP/IP, RTP, and RSVP. Differentiated services. Asynchronous transfer mode (ATM).
   s. Applications
   t. Voice over IP, video on demand, broadcast, multicast and teleconferencing.
1. EC4440 Statistical Digital Signal Processing

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: M. Fargues

4. Text book:
   b. Lecture notes

5. Specific course information:
   a. Description: Modern methods of digital signal processing are developed in this
course from a statistical point of view. Methods are developed for processing
random signals through statistical data analysis and modeling. Topics include
adaptive filtering, MA and AR modeling, an introduction to spectrum estimation
and basic machine learning concepts. Techniques presented are applied to various
engineering problems such as system identification, forecasting, and equalization.
The algorithms introduced have direct applications in communication, sonar,
radar systems signal processing, and modern Navy weapon systems.
   b. Prerequisites: EC3410 or EC3500 and MA3042 or consent of instructor
   c. Elective or selected elective

6. Specific goals for the course:
   a. Develop the ability to characterize, analyze and extract information from random
signals.
   b. Learn to design FIR Wiener filters to extract information in the presence of
additive noise.
   c. Learn to apply basic adaptive filter structures such as the LMS and the RLS
algorithm to extract signals from noisy environments. Understand the relative
advantage and disadvantage of each adaptive method. Learn classic problems to
which methods of adaptive filtering can be applied.
   d. Learn how to apply the concept of mean squared filtering to spatial filtering.
   e. Learn to apply adaptive filtering to extract the number and the direction of arrival
of signals impinging on a linear array.
   f. Learn classical methods of spectral estimation and their advantages and
limitations to extract signal frequency information.
   g. Learn basic principles of machine learning and their applications to engineering
scenarios.
   h. Understand the difference between supervised and unsupervised machine learning
schemes.
   i. Learn basic principles of neural networks, support vector machines, and k-means
and clustering algorithms.

7. Brief list of topics to be covered:
a. Review of FIR Wiener filtering and practical applications
b. Spectrograms
c. Non parametric spectrum estimation
d. Adaptive FIR Wiener filters (LMS & RLS types)
e. Adaptive filter applications (adaptive noise canceling, channel equalization, spatial filtering)
f. Spatial filtering: Direction of Arrival (DOA), beamforming
g. Adaptive beamforming: introduction to smart antennas
h. Introduction to Machine Learning concepts
i. Supervised learning (Neural Networks & Support vector machines)
j. Unsupervised learning (Clustering)
1. EC4450 Sonar Systems Engineering

2. Credits: 4.5
   Contact Hours (lecture-lab): 4-1

3. Course Coordinator: L. J. Ziomek


5. Specific course information:
   a. Description: Mathematical development and discussion of fundamental principles that pertain to the design and operation of passive and active sonar systems critical to naval operations. Topics from complex aperture theory, array theory, and sonar signal processing are covered. This course supports the undersea warfare and engineering acoustics curricula and others.
   b. Prerequisites: EC3450 or OC3260 or PH3452 and either EC3410 or EC3500 or EO3402 or equivalent.
   c. Elective or selected elective

6. Specific goals for the course:
   a. Knowledge of basic theoretical principles and concepts that govern the design, analysis, and operation of passive and active sonar systems.
   b. Awareness of the consequences and design tradeoffs associated with altering important sonar system parameters such as beamwidth, array gain, probability of detection, probability of false alarm, range and Doppler resolution, etc.

7. Brief list of topics to be covered:
   a. Complex Aperture Theory: 1-D, 2-D, and 3-D spatial Fresnel and Fourier transforms; spatial frequencies and direction cosines; far-field and near-field beam patterns of linear, planar, and volume apertures; amplitude windows; beam steering and aperture focusing; 3-dB beamwidth at an arbitrary beam-steer angle; far-field beam patterns and 3-dB beamwidths of rectangular and circular pistons; time-average radiated acoustic power; directivity and directivity index; source level of a directional sound-source; side-looking sonar including swath width, blind zone, area coverage rate, cross-track (slant-range) resolution, along-track (azimuthal) resolution, slant-range ambiguity, slant-range swath width, pulse repetition interval, pulse repetition frequency, azimuthal ambiguity, a rectangular-piston model for a side-looking sonar, design and analysis of a side-looking sonar mission for deep and shallow water
   b. Array Theory: far-field beam patterns of linear, planar, and volume arrays; near-field beam patterns of linear and planar arrays; common amplitude weights; complex weights (amplitude and phase weights); phased arrays; beam steering and array focusing; Product Theorem for linear and planar arrays; 1-D and 2-D spatial DFTs; grating lobes; array gain; FFT beamforming for linear and planar arrays; target signature analysis; estimation of angles of arrival; far-field beam
patterns of cylindrical and spherical arrays; beam steering for cylindrical and spherical arrays

c. Sonar Signal Processing: real bandpass signals; complex envelopes; envelopes, amplitude-and-angle-modulated carriers, instantaneous phase and frequency, phase and frequency modulation; signal energy and time-average power; the complex envelope of an amplitude-and-angle-modulated carrier; cosine and sine components; the quadrature demodulator; target detection in the presence of reverberation and noise; binary hypothesis-testing; correlator receiver; signal-to-interference ratio; Neyman-Pearson test; probability of false alarm; decision threshold; probability of detection; receiver operating characteristic (ROC) curves; the normalized auto-ambiguity functions of rectangular-envelope CW and LFM pulses, range and Doppler profiles, signal design of rectangular-envelope CW and LFM pulses for desired range and Doppler resolutions
1. EC4480 Image Processing and Recognition

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: Roberto Cristi

4. Text book: Lecture Notes

5. Specific course information:
   a. Description: This course presents the fundamentals of image processing as extension of 1D techniques to 2D and general MD domains, as well as efficient signal representation by DKLT, DCT and Wavelet Transform. Multiscale representation of images is also introduced for objects characterization and recognition. Also, video processing includes optical flow and KLT (Kanade, Lucas, Tomasi) for detecting moving targets and statistical modeling for detecting anomalous behavior in video surveillance.
      a. Prerequisites: EC3400
      b. Elective or selected elective

6. Specific goals for the course:
   a. 2D Fourier Transforms, Discrete Fourier Transform (DFT)
   b. 2D Filter design and the McClellan transformation
   c. Efficient representation of signals and image compression
   d. Discrete Karhunen-Loeve Transform (DKLT) and Discrete Cosine Transform (DCT)
   e. Multi Resolution decomposition, in 1D and 2D domains
   f. Quadrature Mirror Filters, Conditions for Perfect Reconstruction and non-Aliasing
   g. Biorthogonal and Daubechies Filters, and application to compression and filtering
   h. Video processing: Optical Flow and Kanade Lucas Tomasi (KLT) for motion det.
   i. Statistical models for detection for abnormal behavior: Markov chains.
   j. Multiscale Representation of Images, Laplacian of Gaussian (LoG) and its properties
   k. SIFT and SURF algorithms for Object Recognition

7. Brief list of topics to be covered:
   a. Multidimensional Signal processing
   b. Efficient representation of signals and compression
   c. Multi resolution decomposition and the Wavelet Transform
   d. Video processing for object tracking and detection
   e. Multiscale image processing for object recognition
1. EC4500 Advanced Topics in Communications

2. Credits: 3
   Contact hours (lecture-lab): 3-0

3. Course coordinator: Tri Ha

4. Text book: Selected journal and conference papers on topics to be covered and class notes

5. Specific course information
   a. Catalog description: Topics and current developments in communications relevant to advanced naval and other military applications. Offered on an occasional basis with the topics determined by the instructor.
   b. Prerequisites: Consent of instructor.
   c. Elective

6. Specific goals for the course
   a. To gain in-depth knowledge of one or more selected topics in communications
   b. To learn newly developed theories and algorithms in the selected topics
   c. To explore the latest trends in communications systems
   d. To build skills in conducting research in communications

7. Brief list of topics to be covered
   a. Specific topics to be selected by the instructor
1. EC4510 Cellular Communications

2. Credits: 3, and contact hours: 3

3. Course coordinator: Tri Ha

4. Text book:
   b. Lecture Notes
   c. Standards

5. Specific course information
   a. Description: This course covers both fundamentals and advanced concepts of 4G and 5G cellular communications. The fundamentals include cellular architectures, propagation models, modulation formats such as QPSK, QAM, OFDM, and multiple access such as OFDMA. The advanced concepts include single-user MIMO, massive MIMO, and localization. 4G Standards such as LTE, LTE-Advanced, WiMAX, and 5G are examined in details.
   b. Prerequisites: EC 3510
   c. Elective, or selected elective course

6. Specific goals for the course
   a. Evaluate co-channel interference, optimize sectoring and channel allocation to users.
   b. Propagation models for all eligible cellular frequency bands.
   c. Link design for 4G and 5G.
   d. Analysis of single user MIMO for 4G and massive MIMO for 5G.
   e. Design localization techniques for 4G and 5G OFDM/OFDMA signals.

7. Brief list of topics to be covered
   a. Cell architectures of 4G and 5G.
   b. Propagation models for all cellular frequency bands.
   c. Uplink and downlink designs for 4G and 5G.
   d. Concepts and analyses of single user MIMO and massive MIMO.
1. **EC4530 Soft Radio**

2. **Credits:** 4  
   Contact hours (lecture-lab): 3-2

3. **Course Coordinator:** F. Kragh

4. **Text book:**  

5. **Specific course information:**  
   a. Description: An introduction to soft radios, devices that generate (transmitter) and/or process (receiver) digital communications signals in software and in reconfigurable hardware. The course covers basic radio frequency (RF) design principles, soft radio architectures, analysis of receiver operation, design of transceivers for sample digital modulations.  
   b. Prerequisites: EC3510 or consent of the instructor

6. **Specific goals for the course:**  
   a. Understand the technical advantages and disadvantages of soft radio vs. conventional radio in a military environment.  
   b. Obtain an understanding of soft radio design and its distinction from conventional radio design.  
   c. Obtain a qualitative and quantitative understanding of the tradeoffs in the use of general purpose digital signal processors (DSPs), field programmable gate arrays (FPGAs), and application specific integrated circuits (ASICs).  
   d. Obtain an understanding of the technical challenges of soft radio development for military use.  
   e. Design software for simple digital radio transceivers.

7. **Brief list of topics to be covered:**  
   a. RF design issues: dynamic range, RF components, noise, transmitter architectures, power consumption  
   b. Multi-rate signal processing: decimation, interpolation, filtering, timing recovery  
   c. Receiver architecture, synchronization, demodulation  
   d. Generation of signals using digital hardware: direct digital synthesis (DDS), spurious signals, jitter, bandpass signal generation, performance of DDS systems  
   e. Analog to digital and digital to analog conversion: ideal vs. practical data converters, architectures  
   f. Relevant digital hardware: DSP hardware, FPGAs, ASICs, power management  
   g. Case study: Joint Tactical Radio System (JTRS) and/or Digital Modular Radio (DMR).
1. EC4550 Digital Communications

2. Credits: 4 credits
   Contact hours (lecture-lab): 4-0

3. Course Coordinator: Clark Robertson


5. Specific course information
   a. This course presents the advantages and limitations of modern military M-ary digital communications systems. M-ary modulation formats, matched filter receivers, probability of symbol error calculations, coherent and noncoherent receivers, carrier and symbol synchronization, modems, bandwidth and signal energy, diversity combining, and fading channels are covered. Examples of current operational and proposed military and commercial space and earth links are treated.
   b. Prerequisite EC3510
   c. Required for Communications Engineering Specialty, elective otherwise

6. Specific goals for the course
   a. To obtain an understanding of the basic concepts of M-ary digital communication systems, multipath and fading channels, and diversity.
   b. To obtain a qualitative and quantitative understanding of the performance characteristics of M-ary digital communication systems, and the capability to specify system parameters to achieve specified performance objectives.
   c. To obtain the capability to determine the sensitivity of alternate system realizations to common vagaries of propagation, implementation and interference, and to analyze the trade-offs among signal-to-noise ratio, error rate, information rate, bandwidth, complexity, and robustness.

7. Brief list of topics to be covered
   a. M-ary digital communication systems and M-ary signaling
   b. Coherent MFSK
   c. Noncoherent MFSK
   d. M-ary Biorthogonal and simplex signals
   e. Walsh Functions and orthogonal signaling
   f. MPSK and M-DPSK
   g. MQAM
   h. Diversity
   i. Multipath and fading channels
   j. Frequency-nonelective, slowly fading channels
   k. Diversity techniques for frequency-nonelective, slowly fading channels
   l. RAKE receivers for frequency-selective, slowly fading channels
1. EC4560 Spread Spectrum Communications

2. Credits: 4 credits
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: Clark Robertson


5. Specific course information
   a. Methods of reducing the effects of hostile jamming on military radio communications systems are considered. Direct sequence spread spectrum systems and frequency-hopped spread spectrum systems are examined with regard to their LPI, LPD, AJ, and multiple access capabilities. Time-hopped and hybrid systems are also considered. Coarse and fine synchronization problems and techniques are presented.
   b. Prerequisite EC3510
   c. Elective

6. Specific goals for the course
   a. To obtain an understanding of the effects of hostile jamming on conventional and spread spectrum communication systems.
   b. To obtain an understanding of the role of spread spectrum communications in modern military and commercial communications systems.

7. Brief list of topics to be covered
   b. Effect of interference on BPSK, BFSK: barrage jamming, pulse jamming, partial-band jamming, tone jamming.
   c. Pseudo-Noise (PN) codes: m-sequences, Gold codes, nonlinear codes.
   d. Slow frequency-hopped BFSK: dehopping, transmission band-width, barrage jamming, multi-tone jamming, partial-message and partial-band jamming, FHMA.
   e. Fast frequency-hopped BFSK: barrage and partial-band jamming, perfect side information, noise-normalized BFSK receiver.
   f. Direct-Sequence (DS) spread spectrum: signal spreading and de-spreading, transmission band-width, barrage jamming, single- tone jamming, pulse jamming, near-far problem, CDMA, CCK.
   g. Code tracking: baseband Delay-Locked Loop (DLL), passband DLL, tau-dither loop.
   h. Code acquisition: serial search techniques and acquisition using matched filters.
   i. Time-hopped and hybrid systems.
   j. Interception and countermeasures: radiometer, cross correlator, channelized receiver, scanning superheterodyne receiver and other detection systems.
1. EC4570 Signal Detection and Estimation

2. Credits: 4  
   Contact hours (lecture-lab): 4-0

3. Course Coordinator: M. Fargues

4. References:
   e. Class notes.

5. Specific course information:
   a. Description: Principles of optimal signal processing techniques for detecting signals in noise are considered. Topics include maximum likelihood, Bayes risk, Neyman-Pearson and min-max criteria and calculations of their associated error probabilities (ROC curves). Principles of maximum likelihood, Bayes cost, minimum mean-square error (MMSE), and maximum a posteriori estimators are introduced. Integral equations and the Karhunen-Loeve expansion are introduced. The estimator-correlator structure is derived. Emphasis is on dual development of continuous time and discrete time approaches, the latter being most suitable for digital signal processing implementations. This course provides students the necessary foundation to undertake research in military radar and sonar systems.
   b. Prerequisites: EC3410 or EC3500
   c. Elective or selected elective

6. Specific goals for the course:
   a. Given the problem parameters, the student will be able to define the strategy to be used and designs the appropriate detector and determine the correct threshold to be used with the detector.
   b. Given the detector and threshold, the student will be able to obtain the statistics of the detection process, probability of detection, probability of false alarm, probability of miss, and probability of correct dismissal.
   c. The student will be able to implement a non-parametric decision test.
   d. The student will be able to implement a sequential hypothesis decision test, given data in the MATLAB environment.
   e. The student will be able to derive a decision test to detect a discrete dynamic signal in noise.
   f. The student will be able to assess the performance of simple estimation schemes using the ROC.
7. Brief list of topics to be covered:
   a. Review of basic probability concepts - RV, CDF, PDF, moments, conditional probability, Bayes’ theorem, statistical independence between RVs, functions and transformations of RVs, useful pdf types.
   d. Detection: Sequential detection, Multiple hypotheses detection, Receiver Operator Characteristic (ROC) curves, Model consistency testing.
   e. Detection: Composite hypothesis testing, Definitions, Applications to communication signals: unknown phase, unknown amplitude, unknown frequency cases.
   f. Non parametric detection.
   g. Estimation: Basic estimation schemes: MAP, ML, Bayes estimation, Wiener filter.
   h. Applications: as time allows, topics selected among: Direct sequence spread-spectrum signals, Multiuser detection, Spectrum estimation, Adaptive Wiener filter.
1. EC4580 Error Correction Coding

2. Credits: 4 credits
   Contact hours (lecture-lab): 4-0

3. Course Coordinator: Clark Robertson


5. Specific course information
   a. Digital military communication systems often employ error control coding to improve effectiveness against noise, fading, and jamming. This course, together with EC4560, provides students the necessary foundations for understanding the principles of such systems. Topics include Shannon's channel capacity theorem and coding methods for error control in digital communications systems, including convolutional, block, concatenated, and turbo codes as well as trellis-coded modulation. Applications of error control coding to modern digital communications systems are discussed.
   b. Prerequisite EC3510
   c. Required for Communications Engineering Specialty, elective otherwise

6. Specific goals for the course
   To obtain an understanding of the basic concepts of error control coding and its usage in modern digital communication systems.

7. Brief list of topics to be covered
   a. Introduction to Information Theory and Error Control Coding
   b. Convolutional Codes
   c. Viterbi Decoding of Convolutional Codes
   d. Concatenated Codes
   e. Interleavers and Deinterleavers
   f. Trellis-Coded Modulation (TCM)
   g. Fundamentals of Linear Block Codes
   h. Cyclic Codes
   i. BCH Codes
   j. Reed-Solomon Codes
   k. Turbo Codes and Serially Concatenated Codes
1. EC4590 Communications Satellite Systems Engineering

2. Credits: 3
   Contact hours (lecture-lab): 3-0

3. Course Coordinator: T. Ha


5. Specific course information:
   a. Description: A detailed study of communication satellite systems including the satellites and user terminals. Subjects include orbital mechanics, satellite description, earth terminals, link analysis, frequency division multiple access (FDMA), time division multiple access (TDMA), demand assignment multiple access (DAMA).
   b. Prerequisites: EC3510 or EO4516
   c. Elective or selected elective

6. Specific goals for the course:
   a. Perform a complete link design for a repeater satellite including frequency reuse, adjacent satellite interference, rain-induced attenuation, rain depolarization.
   d. Perform an analysis of low earth orbit satellite constellation.
   e. Perform a beam pattern design for a high-throughput satellite system.
   f. Design a DAMA-TDMA system for repeater satellites.

7. Brief list of topics to be covered:
   a. Elements of Satellite Communication: satellite frequency band, multiple access, frequency reuse, overview of satellite systems.
   b. Space Segment: orbital mechanics, azimuth and elevation angles, coverage angle, slant range, repeater satellite, on-board processing satellite, high-throughput satellite, low-earth orbit satellite constellations.
   c. Ground Segment: Antenna, antenna gain-to-noise ratio, EIRP, high power amplifier, carrier combining, power combining, low noise amplifier, upconverter, downconverter, transponder hopping, polarization hopping, redundancy.
   d. Link Analysis: basic link, interference, rain-induced attenuation, rain depolarization, system availability, complete satellite link design.
   e. FDMA: single channel per carrier, intermodulation from AM and PM nonlinearity.
   f. TDMA: frame structure, burst structure, superframe structure, efficiency, acquisition and synchronization, real time satellite position determination, burst time plan, control and coordination, TDMA timing, TDMA interfaces.
   g. DAMA: types and characteristics of DAMA, real time frame reconfiguration, interfaces, SCPC-DAMA, DAMA-TDMA.
1. EC4600 Advanced Topics in Electromagnetics

2. Credits: 3
   Contact hours (lecture-lab): 3-0

3. Course Coordinator: D. Jenn

4. Text book: Selected journal and conference papers on topics to be covered and class notes

5. Specific course information:
   a. Description: Selected advanced topics in electromagnetics that are not currently covered in regular courses offerings, and relevant to naval and other military applications. Topics may include, but are not limited to, computational electromagnetics, scattering and radiation, propagation, and new device and antenna concepts.
   b. Prerequisites: EC3600 or consent
   c. Elective

6. Specific goals for the course:
   a. To gain in-depth knowledge of one or more selected topics in electromagnetics
   b. To learn newly developed theories and algorithms in the selected topics
   c. To explore the latest trend in antennas, propagation, scattering, microwave devices, and their theory and applications
   d. To build skills in conducting research in control systems

7. Brief list of topics to be covered
   a. Topics vary and are selected by the instructor. Sample topics:
      i. Electronically scanned phased arrays
      ii. Microwave solid state devices
      iii. Ionospheric propagation
      iv. Metamaterials and cloaking
      v. New antenna technology
      vi. Recent developments in assessing radiation hazards
      vii. Computational electromagnetics
1. EC4610 Radar Systems

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: R. Romero

   a. Lecture notes
   b. Instructional CDs distributed with the book

5. Specific course information:
   a. Description: The radar range equation is developed in a form including signal integration, the effects of target cross section, fluctuations, and propagation losses. Modern techniques discussed include pulse compression frequency modulated radar, moving target indicator (MTI) and pulse Doppler systems, monopulse tracking systems, multiple unit steerable array radars, and synthetic aperture systems. Laboratory sessions deal with basic pulse radar systems from which the advanced techniques have developed, with pulse compression, and with the measurement of radar cross section of targets.
   b. Prerequisites: EC3600
   c. Elective or selected elective

6. Specific goals for the course:
   a. Given the parameters of a pulsed radar system, the parameters of a target and the radar-target geometry, the student will be able to calculate the maximum range at which the target can be detected with a specified false alarm time and detection probability.
   b. Given the parameters of a CW Doppler radar system, the parameters of a target and the radar-target geometry, the student will be able to calculate echo signal Doppler shift and the maximum range at which the target can be detected with a specified false alarm probability and detection probability.
   c. Given the parameters of a pulse Doppler radar system, the parameters of a target, the radar-target geometry and clutter source, the student will be able to calculate the target signal-to-clutter power ratio.
   d. Given the configuration of a receiver and the noise performance characteristics of mixers and amplifiers, the student will be able to calculate the receiver noise temperature.
   e. Given the antenna characteristics and operating frequency of a radar system, the student will be able to estimate the antenna noise temperature.
   f. Given the characteristics of a coded pulse, the student will be able to calculate the gain when the pulse is processed in a matched filter receiver with weighting for sidelobe suppression. The student will also be able to calculate the duration of the compressed pulse.
g. Given cross-section density data and radar system parameters, the student will be able to calculate clutter power for surface and volume clutter sources.

h. Given the characteristics of a propagation channel and radar system parameters, the student will be able to determine propagation loss.

i. Given the characteristics of a synthetic aperture radar, the student will be able to calculate the down-range and cross-range resolution.

j. The student will be able to use counters, oscilloscopes, spectrum analyzers and power meters to measure radar pulsewidth, PRF, power and spectrum.

k. Given a set of operational requirements, the student will be able to do a system level radar system design.

7. Brief list of topics to be covered:
   a. History, pulse delay ranging, unambiguous range, basic range equation, types of radars, radar bands, applications, basic system block diagram.
   b. Probabilities of detection and false alarm and how they affect required system signal-to-noise ratio.
   c. Doppler effect; CW and FMCW radars.
   d. Coherent and non-coherent MTI and pulse-Doppler radars; clutter spectra; waveform design to obtain clutter free frequency bands; measurement uncertainty and ambiguity diagrams.
   e. Basic principles of radar cross section prediction and reduction; Swerling target types.
   f. Survey of radar antennas with emphasis on phased arrays and modern antenna technologies such as active antennas, multiple beam antennas, and digital beamforming.
   g. Performance of microwave devices used in radar systems (transmitter tubes, mixers, filters, rotary joints, transmit/receive modules, etc.)
   h. Design and performance analyses for specific radar applications: synthetic aperture radar (SAR) and imaging, bistatic radar, ultra-wideband radar, laser radar, weather radar, stepped frequency radar and over-the-horizon (HF) radar.
1. EC4630 Radar Cross Section Prediction and Reduction

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Jenn

   a. Lecture notes
   b. Commercial software ANSYS Savant, Altair FEKO and CST Microwave Studio

5. Specific course information:
   a. Description: This course covers the design and engineering aspects of stealth and its impact on platform and sensor design. Signature prediction methods in the radar, infrared (IR), and laser frequency bands are discussed. Radar cross section (RCS) analysis methods include geometrical optics and diffraction theory, physical optics and the physical theory of diffraction, and numerical solutions to integral and differential equations. Prediction methods for IR and laser cross sections (LCS) are also introduced. Signature reduction by shaping, materials selection, and active and passive cancellation are applied to each frequency regime. The measurement of these cross sections is also covered.
   b. Prerequisites: EC3600
   c. Elective or selected elective

6. Specific goals for the course:
   a. The student shall be familiar with the phenomenology of electromagnetic scattering in the frequency domain: plane wave reflection and refraction from interfaces, surface waves, creeping waves, edge diffraction and cavity scattering.
   b. The student will be able to describe the characteristics of scattering for the three frequency regimes: 1) Rayleigh region, 2) Mie region, and 3) optical region.
   c. The student will be familiar with the basic theorems and concepts of electromagnetics including the Uniqueness Theorem, Reciprocity Theorem, Theorem of Similitude and Equivalence Principles.
   d. Given the geometry of a scattering body, the student will calculate the surface current density using the Physical optics (PO) approximation, and determine the body’s RCS from the scattered field obtained by using the current in the radiation integral.
   e. Given simple doubly curved objects, the student will be able to compute their RCS using geometrical optics (GO) and the geometrical theory of diffraction (GTD).
   f. The student will be familiar with the integral equations commonly used in the formulation of electromagnetic problems, and their solution using the method of moments technique.
   g. The student will be familiar with the techniques available to reduce a target’s radar signature: shaping, materials selection, and active and passive cancellation.
h. The student will be aware of how low observable platform sensors such as antennas can influence RCS. The calculation of sensor RCS and the effectiveness of reduction will be investigated by the student.

i. The student will be able to compute the diffuse scattering component of a rough surface and determine the laser cross section of simple targets.

j. The student will be aware of the current state of the art in computational electromagnetics and the capabilities of several widely used RCS software packages. Included in the codes are finite element methods and finite difference techniques in the time domain.

k. A project requiring the calculation of RCS shall be completed. The student will select a particular target and the method of predicting RCS. Using available codes or analysis, the student will generate RCS data. The student’s data must be compared to published data or a secondary calculation method and any differences explained. Methods of RCS reduction will be suggested and demonstrated by the student.

7. Brief list of topics to be covered:

a. A project requiring the calculation of RCS shall be completed. The student will select a particular target and the method of predicting RCS. Using available codes or analysis, the student will generate RCS data. The student’s data must be compared to published data or a secondary calculation method and any differences explained. Methods of RCS reduction will be suggested and demonstrated by the student.

b. History, basic range equation, types of radars, radar bands, applications, definition of RCS and typical values of RCS

c. Frequency regimes and scattering mechanisms (reflection, refraction, diffraction, surface waves and cavities and resonances)

d. Surface and volume currents, equivalence, uniqueness, reciprocity, similitude; the radiation integrals.

e. The physical optics approximation in the frequency domain; characteristics of RCS patterns.

f. Integral equations and the method of moments for conducting and dielectric wires and surfaces.

g. Geometrical optics and the geometrical theory of diffraction; physical theory of diffraction; hybrid methods. RCS reduction by shaping methods.

h. Electronic properties of materials, their constitutive parameters, and the surface impedance approximation. RCS reduction by material selection.

i. RCS of antennas; reduction of antenna RCS using frequency selective surfaces and radomes.

j. Rough surfaces and diffuse scattering.

k. Definition and calculation of laser cross section for simple targets; reduction methods.
1. EC4640 Airborne Radar Systems

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: P. E. Pace

   a. Lecture notes;
   b. Included software;

5. Specific course information:
   a. Description: This class will concentrate on examining the operational and functional requirements necessary to design and maintain fighter aircraft radar data processors used in e.g., the EA-18G. A brief introduction to the fighter sensors and weapon systems is given. Mode processing discussed includes the velocity search mode, range-while-search, track-while-scan, sea surface search and air-to-air acquisition. Also, single target track, raid assessment mode, air-to-ground ranging, and precision velocity update are presented. Imaging modes such as the real-beam ground map and radar navigation ground-map are also emphasized. Fixed target acquisition and track, and ground moving target indication, acquisition and track are presented. AMRAAM support and non-cooperative target recognition (NCTR) are also discussed as well as the Reconnaissance data collection (RECCE) mode. The development of new LPI (low probability of intercept) modes will be discussed.
   b. Prerequisites: EC4610 or knowledge of radar systems;
   c. Elective or selected elective

6. Specific goals for the course:
   a. Understand the concepts and digital signal processing techniques involved in modern airborne radars
   b. Understand how they detect targets in presence of large ground clutter and other interferences
   c. Calculate the radar waveforms (or modes) as continuous wave (CW), high pulse repetition frequency (HPRF), medium pulse repetition frequency (MPRF), and low pulse repetition frequency (LPRF)
   d. Give practical implementation and the signal processing associated with each mode
   e. Detail the advantages and limitations of each mode
   f. Identify the military applications of these modes
   g. Understand the concepts and algorithms for digital pulse compression, MTI clutter cancellation, Doppler processing, constant false alarm rate (CFAR) detection, ambiguity resolution, synthetic array radar (SAR) processing

7. Brief list of topics to be covered:
a. Velocity search  
b. Range-while search  
c. Range gated HPRF  
d. Track-while-scan  
e. Single target track  
f. Air to ground ranging  
g. Doppler error correction  
h. Radar navigation ground map  
i. Real beam ground map  
j. Medium range SAR  
k. Doppler beam sharpening  
l. Ground moving target indication  
m. Ground moving target track
1. EC4680 Joint Services Electronic Warfare Systems II (US Students)  
   EC4690 Joint Services Electronic Warfare Systems II (International Students)

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: P. E. Pace

   a. Lecture notes;  
   b. Included software;

5. Specific course information:  
   a. Description: Emphasis is given to the design of electronic warfare intercept receivers. Special attention is given to the newest technologies being used. The newest signal processing techniques for interception of stealth waveforms is investigated. Interception, detection of radar systems that use waveform diversity are shown. Both time-frequency and bi-frequency techniques are emphasized. Feature vectors are developed for each detection plane. Use of a non-linear network for modulation classification is examined. Deep learning techniques and convolutional neural networks are introduced. Special Note: EC4680 and EC4690 share the same lecture material; Laboratory exercises for EC4680 (U.S. Only) can be classified up to the General/Secret level.  
   b. Prerequisites: Some knowledge of radar systems;  
   c. Elective or selected elective

6. Specific goals for the course:  
   a. Review of special modulations used by stealth emitters  
   b. Learn how electronic warfare receivers are designed  
   c. Understand the tradeoffs in the various architectures  
   d. Examine the different technologies that can be used in the receiver  
   e. Understand the kernel function correlation between the Cohen class of distributions  
   f. Investigate the Choi-Williams time frequency distribution for interception of stealth waveforms  
   g. Use the pseudo Wigner-Ville time frequency distribution of the detection of stealth modulations  
   h. Use quadrature mirror filters to perform a wavelet decomposition of the input signal  
   i. Investigate the cyclic spectral density function for the identification of modulation parameters  
   j. Learn how to develop feature vectors using the time-frequency, bi-frequency detection planes  
   k. Use a non-linear network coupled with a principal component analysis to correctly classify the detected modulation
7. Brief list of topics to be covered:
   a. Electronic warfare receiver design
   b. Intercept strategies
   c. Short-time Fourier transform
   d. Choi-Williams time frequency distribution
   e. Wigner-Ville time frequency distribution
   f. Quadrature mirror filter bank design using a modified sinc filter
   g. Cyclostationary signal processing
   h. Feature vector formation
   i. Hopfield neural networks
   j. Multi-layer perceptrons
   k. Classification generalization and probability of correct classification
   l. Convolutional neural networks
1. EC4710 High Speed Networking

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: W. Su

   (9780470021637)
   a. Lecture notes

5. Specific course information:
   a. Description: The course systematically develops the traffic characteristics of broadband services and determines the need for high-speed networks with emphasis on Quality of Service (QoS). Queuing theory is used in modeling, design and analysis of the various modules of a high-speed network: traffic modeling, switches, admission control, scheduling, traffic monitoring, and congestion control. Emerging trends, architectures, and technologies that enable deployment of high-speed global networks for military and commercial use are discussed. Specific topics covered include broadband technologies including SONET, DWDM, Gigabit Ethernet, queuing theory, traffic models, traffic management, and QoS guarantee via DiffServ and MPLS. Hands-on labs explore traffic management and QoS setup of network supporting IPTV.
   b. Prerequisites: EC3710
   c. Elective or selected elective

6. Specific goals for the course:
   a. The student will be able to list the data rates of various multimedia information (speech, audio, image, video, and text) and determine the required transport channel capacities.
   b. Given a description of the multimedia information, the student will be able to determine the appropriate adaptation layer protocol.
   c. Given the number of users and their average source data rates, the student will be able to determine the protocol efficiency and estimate the required channel capacity.
   d. Given the application scenario, the student will be able to propose an access technology.
   e. Given the state transition rates and traffic arrival statistics, the student will be able to analyze the queuing scheme (M/M/1, M/D/1, D/D/1) and determine the overload and underload states.
   f. Given the voice activity factor and transition rates, the student will be able to develop a Markov model multiple voice sources and determine the buffer capacity requirements for the switch.
g. Given the traffic characteristics of variable bit rate real-time information, the student will be able to determine the admission control laws based on peak, average or Gaussian rules.

h. Given the traffic generation characteristics of a source, the student will be able to determine the rate control parameters and buffer occupancy profile under network congestion.

7. Brief list of topics to be covered:
   a. Broadband Technologies:
      i. Model of a modern broadband communications network: high-speed backbone, high-speed local area network, and broadband access. Need for broadband services. Quality of service.
      ii. Broadband Access: Gigabit Ethernet physical layer specification. SONET. DWDM. MAC layer extensions. Signal encoding. DSL, Cable, Wireless (terrestrial and satellite), and power lines.
   b. Traffic Characteristics
      i. Queuing Theory: Nature of traffic and fundamentals of traffic modeling in integrated-services, broadband networks. Little’s formula. M/M/1 queue. M/M/1/k queue. Blocking probability. Networks of queues; Burke’s and Jackson's theorems. M/G/1 queue. P-K formula. M/D/1 queue.
   c. Traffic Management
   d. Applications: IPTV
1. EC4715 Cyber System Vulnerabilities and Risk Assessment

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: J. McEachen

4. Text books:
   d. Lecture notes
   e. Commercial software: HexRays IDAPro
   f. Open source software: Wireshark

5. Specific course information:
   a. Description: The course utilizes reverse engineering principles to identify and assess vulnerabilities in electronic, communication, and control systems and analyze risk to provide tradeoffs. Vulnerabilities in cyber systems based on genetic, developmental, and those caused by system overload are presented. Widely accepted industry and military standards, underlying technologies, specification mismatches and interoperability, and resource constraints are examined to identify vulnerabilities of interest. Vulnerability assessment at component and system levels along with prioritization and elimination procedures are discussed. Risk analysis for secure operation of the system and relevant tradeoffs are presented. Laboratory exercises provide hands-on experience.
   b. Prerequisites: EC3740
   c. Elective or selected elective

6. Specific goals for the course:
   a. The student will be able to describe the vulnerability pyramid and its relationship to the system supply chain.
   b. Given an entry point in the vulnerability pyramid, the student will be able to describe the dispersion of risk and vulnerabilities.
   c. The student will take a structured approach to analyzing cyber systems for vulnerabilities
   d. The student will select appropriate models for risk analysis given the parameters of a specific cyber system.
   e. The student will illustrate the effects of resource constraints on cyber systems

7. Brief list of topics to be covered:
   a. Introduction
   b. System stimulation
c. Data collection methods

d. Vulnerability Identification

e. System malfunction

f. Risk Analysis

g. Case Studies
1. EC4725 Advanced Telecommunications System Engineering

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: P. Thulasiraman

4. Text book:
   b. Lecture notes and slides
   c. Supplemental readings from published literature

5. Specific course information
   a. Description: Studies the engineering of communication transport networks, presenting basic concepts in conventional telephony and traffic engineering such as blockage, availability, dimensioning and survivability. The public switched network (PSTN), mobile switched networks (MSN) and public land mobile networks (PLMN) are discussed. The Signaling System No.7 (SS7) architecture for the PSTN is presented along with a variety of transport technologies including the Synchronous Optical Network (SONET)/ Synchronous Digital Hierarchy (SDH). Dense Wavelength Division Multiplexing (DWDM) is also examined. Voice over IP (VoIP) and its associated signaling protocol, the Session Initiation Protocol (SIP), is examined. Skype is used as a case study. VoIP vulnerabilities are also discussed. Cellular telecommunications standards, including GSM/2G, GPRS, UMTS/3G, LTE/4G and 5G are studied. Security measures for different telecommunications standards are also discussed. Concludes with a discussion of Network Management Systems.
   b. Prerequisites: EC3710
   c. Required or elective

6. Specific goals for the course
   a. Discuss how various public communications transport architectures function
   b. Be able to dimension the network and predict future performance
   c. Provision the network for increased efficiency
   d. Understand how signaling works and in particular the SS7 system used in the public switched telephone network
   e. Understand how different cellular standards used in telecommunications function: GSM, GPRS, UMTS and 4G
   f. Understand the signaling protocols for cellular standards
   g. Understand the different telecommunications architectures for cellular systems and how they interface with the PSTN
   h. Evaluate VoIP systems, including Skype
   i. Understand how long haul optical telecommunications is used, including the SONET/SDH standards
7. Brief list of topics to be covered
   a. Concept of dimensioning and traffic intensity
   b. Mathematical modeling of traffic statistics
   c. Mathematical modeling of Grade of Service and the overflow process
   d. Traffic matrices and forecasting
   e. Operation of SIP and VoIP
   f. Attack scenarios (Denial of Service) against SIP VoIP infrastructure
   g. Analysis of Skype
   h. SS7 and related protocols for PSTN
   i. Optical telecommunications
   j. GSM architecture, signaling protocols in the core network and over the air interface, security
   k. GPRS and 3G architecture, handoff procedures, and security measures
   l. 4G/LTE architecture, signaling protocols, and security measures
1. EC4730 Covert Communications

2. Credits: 4.0
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: M. Tummala

   a. Lecture notes
   b. Sample image files, Matlab files

5. Specific course information:
   a. Description: Electronic signal and data communication mechanisms in which the presence of a message being transmitted is concealed in plain sight of other signals or data are presented. Information hiding in user data, protocol data, and radio, electronic, acoustic and other sensory signals is examined. The techniques of steganography, covert channels, low probability exploitation, and information concealment in analog signals are studied. Techniques and mechanisms for establishing robust, secure covert communication schemes are introduced. The detection, analysis, and abortion of adverse covert communication schemes are discussed. Design of systems suitable for attack and defense of covert communications using programmable logic devices is introduced. Low probability of detect, low probability of intercept, and anti-jamming techniques are reviewed. Embedding and extraction algorithms of steganography are presented. Related topics of watermarking and embedded malware are reviewed.
   b. Prerequisites: EC3730 or EC3710
   c. Elective or selected elective

6. Specific goals for the course:
   a. The student will able to list the information hiding techniques applicable to compressed digital data and other information signals and network protocol data.
   b. The student will be able to describe issues in information hiding unique to communicating in a radio frequency environment.
   c. The student will be able to describe modern information compression schemes and outline potential vulnerabilities in the standards.
   d. Given an information hiding scenario, the student will be able to propose schemes for analysis and detection of stego objects.
   e. The student will be able to describe covert channel in the present day communication networks and propose methods for detecting and mitigating covert channels.
   f. The student will be able to discuss cooperative communication techniques for secrecy in wireless communications.
   g. The student will be able to describe spatial channels and outline potential avenues for covert communications in emerging wireless communications schemes, such as orthogonal frequency division multiplexing, multiple input multiple output
schemes, and directional antennas.
h. The student will be able to describe potential use of acoustic signals (and others) for information hiding.
i. The student will be able to discuss the issues related to transporting of malware through hidden channels, both media and protocol based.
j. The student will be able to propose real-time stegoanalysis schemes using field programmable logic devices.
k. The student will be able to dissect the stego objects using well established statistical stegoanalysis techniques.
l. The student will be able to demonstrate the effectiveness of low probability of detection and interception in an RF environment.

7. Brief list of topics to be covered:
a. Information hiding in digital data and media
   i. Signal digitization: linear and nonlinear quantizers, under-sampling, and aliasing effects
   ii. Signal compression: compression of speech, audio, image, video, and text messages
   iv. Analysis of compressed information packaging and potential vulnerabilities.
   v. Steganography: cover objects, message encryption, embedding, stego key, extraction
   vi. Steganalysis: detection, forensic analysis, message extraction, abortion, origin determination
   vii. Covert Channels: storage media, network protocols, detection, extraction. Elimination versus flexibility. Emphasis on wireless networking protocols and vulnerabilities associated with the electromagnetic propagation phenomena.
   viii. Digital watermarking
   ix. Embedded malware
b. Information hiding in signals and media
   i. Low probability of intercept, low probability of detection, anti-jamming, direct sequence spread spectrum, frequency hopping spread spectrum
   ii. Cooperative jamming
   iii. Cooperative secrecy in wireless channels
   iv. Spatial channels: multiple input multiple output schemes and directional antennas; space, time slot, and frequency band issues
   v. Acoustic, electrical, optical and mechanical signals; under-sampling, and aliasing effects; signal hiding, low frequency patterns
c. Programmable logic devices
   i. Real-time steganalysis, implementation issues
   ii. Potential system architectures
   iii. Attack and defense schemes and design requirements
1. EC4735 Telecommunications Systems Security

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: J. McEachen

   a. Lecture notes
   b. Commercial software: HexRays IDAPro; Range Networks OpenNodeB; Amarisoft eNodeB
   c. Open source software: Wireshark

5. Specific course information:
   a. Description: Examines underlying technical security issues, policies, standards, implementations, and technologies associated with large-scale commercial telecommunications systems. Reviews the infrastructure and components of carrier class networks to include transport multiplexers and multi-protocol switches. Discusses the public switched telephone network (PSTN) and public land mobile network (PLMN). Begins with a review of the need for Signaling System No. 7 (SS7) and how security is implemented in SS7 networks. Presents fundamental trust assignments in second generation (2G) cellular mobile networks and specifically analyzes trust relationships between core components of the PLMN subsystems. Specifically discusses air interface (Um, Gm) protection measures and presents case studies of systemic flaws. Presents evolutionary changes in security practices in third (3G) and fourth generation (4G) protocols and standards. Examines underlying principles of lawful intercept (LI) implementation and discusses the evolution of LI capability from the PSTN through 3G and 4G networks. Studies the protection of data services in the PLMN and IP Multimedia Subsystem (IMS). Specifically focuses on the General Packet Radio Service (GPRS) Tunneling Protocol (GTP) and Roaming Exchanges (GRX). Discusses future research and proposed security standards in next generation systems.
   b. Prerequisites: EC3730
   c. Elective or selected elective

6. Specific goals for the course:
   a. Given a specific telecommunications technology, the student will describe critical trust relationships between components of the network architecture.
   b. The student will illustrate a variety of authentication mechanisms suitable for mobile network access.
   c. The student will discuss the benefits of various encryption technologies in the implementation of mobile telecommunications networks.
   d. The student will describe the evolution of various components of mobile network security.
e. The student will discuss the need for GPRS tunneling protocol and GPRS roaming exchanges
f. The student will describe lawful intercept techniques and how they are implemented in various mobile network technologies.
g. The student will discuss various techniques for protecting signaling system no. 7 exchanges.

7. Brief list of topics to be covered:
   a. Overview
   b. Transport Network Architecture
   c. Public Switched Telephone Network
   d. Public Land Mobile Network
   e. Signaling System No. 7
   f. 2G Network Security
   g. 3G Network Security
   h. 4G Network Security
   i. Lawful Intercept
   j. Data Service Protection
1. EC4745 Mobile Ad Hoc Wireless Networking
2. Credits: 4.0  
   Contact hours (lecture-lab): 3-2
3. Course Coordinator: M. Tummala
   a. Lecture notes
   b. IEEE802.11, 802.16, 802.15.4 and 3GPP Standards Documents
5. Specific course information:  
   a. Description: The course presents the fundamental principles, design issues, performance analysis, and military applications of wireless networks. Radio wave propagation, wireless channel, modulation, orthogonal frequency division multiplexing, channel coding, and other physical layer technologies are reviewed. Principles of traditional wireless local area networks, wireless metropolitan area networks, and ad hoc and sensor networks are presented. Performance issues of medium access control mechanisms—contention, reservation and scheduling—are covered. Routing in wireless networks including reactive and proactive principles is introduced, and transport layer issues are discussed. Sensor networks along with energy management are introduced. Cognitive radio and RFID are discussed. Current and evolving wireless standards (IEEE 802.11, 802.16, 802.15, 802.22, LTE) are reviewed. Laboratory assignments provide hands-on experience to complement the theory.
   b. Prerequisites: EC3710 or consent of instructor
   c. Elective or selected elective
6. Specific goals for the course:  
   a. Given the system operating parameters, the student will be able to propose alternative wireless network architectures, design wireless networks, and analyze and test their performance to ensure integration among heterogeneous wireless and wired systems.
   b. The student will be able to outline the system design issues in terms of network architecture, interoperability, security, quality of service, capacity, availability, reach, and mobility.
   c. The student will be able to list the widely used wireless networking standards and identify the associated technologies, system architectures, and protocols.
   d. Given the operating environment in which the network is to be deployed, the student will be able to use standard models, such as TIA’s JTC, to determine the network reach and desired node density.
   e. Given the channel bandwidth, the number of subcarriers, the range of values for signal-to-noise ratio, and the multipath delay spread, the student will be able to (a) calculate length of the OFDM frame, the cyclic prefix and the guard period, (b) select the appropriate modulation and channel coding schemes, and (c) determine
the bit error performance.
f. Given the channel and system parameters, the student will be able to determine the effective system throughput (capacity), delay, and other performance metrics.
g. The student will be able to discuss the ad hoc networks and sensor networks and detail the advantages of clustered architecture over a layered architecture.
h. Given the battery power constraints, transmission power requirements and the type of technology being used, the student will be able to propose energy management solutions for the system and discuss network availability and lifetime issues.
i. The student will be able to demonstrate link connectivity, implement a multihop ad hoc network and capture packets.
j. Given two standards-based wireless systems, the class will be able to integrate them, demonstrate interoperability, assess node mobility and network reach, and connect to wired infrastructure.

7. Brief list of topics to be covered:
   g. Selected topics and applications: Cognitive radio. RFID, UWB. Mobile services: mobile enterprise networking, mobile health monitoring, mobile communications. Location based services. Sensor network applications.
1. EC4747 Data Mining in Cyber Applications

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: J. Scrofani

   a. Lecture notes  
   b. Jupyter notebooks  

5. Specific course information  
   a. Brief description of the content of the course: Data mining concepts, theories and methods are examined and applied to the cyber domain. Specific applications considered include network and computer intrusion detection, malware detection, fraud detection and identity theft. Classification approaches, including decision tree and ensemble methods are examined. Association analysis using both attribute- and graphical-based approaches are studied. Cluster analyses, both hierarchical and partitional approaches, are examined. The course concludes with a study of anomaly detection techniques, methodologies and associated system designs and implementations relevant to the cyber mission. Each topic will be presented in lectures and followed with hands-on exercises that will allow the students to understand how each concept is implemented in practice.  
   b. Prerequisites: EC2010 and EC3730 or equivalents.  
   c. Elective.

6. Specific goals for the course  
   a. Explain the appropriate data mining approaches applicable to various cyber applications, including network and intrusion detection.  
   b. Describe current cyber domain problems that require data mining implementations, including network and computer intrusion detection, malware detection, fraud detection and identity theft.  
   c. Realize system-level implementations of data mining systems, incorporating various data ingest, data preprocessing, data mining, data post processing and visualization approaches.  
   d. Explain prevalent data mining concepts, theories and methods.  
   e. Explain the general classification problem and demonstrate the ability to implement various classification approaches.  
   f. Explain the general association problem and demonstrate the ability to implement various association approaches.  
   g. Explain the general clustering problem and demonstrate the ability to implement various clustering approaches.
h. Given an intrusion detection scenario, the student will be able to discuss strategy and propose schemes for analysis and detection of anomalous behavior.

7. Brief list of topics to be covered:
   a. Data mining framework, concepts and processes
   b. Cyber domain applications of data mining
   c. Preliminaries in linear algebra, probability and statistics, and Python programming
   d. Data types, quality, preprocessing, measures of similarity
   e. Data analysis and visualization
   f. Classification approaches, general approaches to solving classification problems, rule-based classifiers, nearest-neighbor classifiers, Bayesian classifiers
   g. Association analysis, general approaches to solving association problems, a priori algorithm, measures of association
   h. Cluster analysis, general approaches to solving clustering problems, hierarchical and partitional methods
   i. Anomaly detection, characteristics of anomaly detection problems, statistical, proximity-based, and clustering-based approaches
1. EC4755 Network Traffic, Activity Detection, and Tracking

2. Credits: 4.0
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: M. Tummala

   a. Lecture notes
   b. Selected readings from the literature
   c. Wireshark and other open source traffic analysis software packages

5. Specific course information:
   a. Description: Network traffic characterization, traffic engineering/management and detection and tracking of traffic anomalies are covered with a focus on statistical and information theoretic concepts, signal processing, and control theory. Network (cyber) traffic is characterized based on statistical and information theoretic approaches such as self similarity and information entropy. Traffic flows and traffic flow analysis are presented; multimedia nature of network traffic discussed. Traffic engineering techniques of congestion control, traffic redirection, and admission control are examined utilizing network flows and queue management and analysis. Detection theory is introduced. Detection of threat activity based on traffic anomalies is examined. Neyman-Pearson criterion and the receiver operating characteristic are presented. Traffic flow analysis for activity tracking is discussed. Case studies of local area networks, the Internet, sensor networks, and wireless networks including the 4G systems are conducted. Laboratories will provide hands-on experience and introduce tools of traffic characterization, detection, monitoring, and tracing.
   b. Prerequisites: EC3730, EC3500
   c. Elective or selected elective

6. Specific goals for the course:
   a. The student will able to outline network traffic elements: media, packet types, and structure.
   b. The student will be able to determine traffic characterization using second moment analysis and information theoretic techniques.
   c. The student will be able to define self-similarity of traffic using long tailed distributions and Hurst parameter.
   d. Given an operational scenario, the student will be able to propose congestion control schemes to improve network performance.
   e. The student will be able to list network data flows and traffic management requirements.
   f. The student will be able to apply the Neyman-Pearson criterion to traffic anomaly detection problems.
   g. The student will be able to describe traffic classification by way of traffic patterns and flow identification.
h. The student will be able to propose anomaly detection schemes using object tracking and flow monitoring and apply statistical and visualization tools.

i. The student will be able to develop schemes for network traffic analysis and anomaly detection for both wired and wireless platforms.

j. The student will be able to undertake case studies of LAN, WAN, 4G networks, and the Internet based traffic and anomaly detection.

7. Brief list of topics to be covered:
   a. Traffic Elements: media, packet types and structure
   b. Models: traffic, protocol, service oriented architecture
   c. Network Traffic Characterization: Statistical characterization; Correlation and covariance functions, Information theoretic characterization
   d. Poisson and non-Poisson arrivals, M/G/1 and G/G/1 queues
   e. Measured traffic: LANs, Internet, wireless networks, sensor networks
   f. Self-similarity: long tail distribution, Hurst parameter
   g. Entropy and entropy rate, Joint entropy and multiple flows
   i. Protocol specific parameters, Packet type, size, Connection life times
   j. Traffic Engineering, Traffic Congestion, Bottlenecks
   k. DDoS, flash crowd, Equipment malfunction, System outage: local, wide area
   l. Congestion control, Congestion indication
   m. Queue monitoring, Congestion management, Traffic redirection, Admission control
   n. Traffic Anomaly Detection, Detection theory, Neyman Pearson criterion, Receiver operating characteristic
   o. Traffic classification, Traffic patterns, Traffic flow identification
   p. Anomaly detection schemes, Single location temporal methods, Network-wide spatial-temporal methods, Metrics for threshold estimation, Threat determination
   q. Tools: statistical, visualization
   r. Tracking of Anomalous Activity, Basics of object tracking, Traffic flow monitoring, Traffic anomaly tracking, Tools: statistical, visualization
   s. Case Studies: LANs, WANs, Wireless networks, industrial control systems, 4G networks, Internet
1. EC4765 Cyber Warfare

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: J. McEachen

4. Text books:
   d. Lecture notes
   e. Commercial software: HexRays IDAPro, RangeNetwork OpenBTS
   f. Open source software: Wireshark

5. Specific course information:
   a. Description: Cyber warfare explored from an electrical engineering perspective. Historical examples of military cyber warfare operations are reviewed. Components of network-centric capabilities (NCC) are discussed in depth and several scenarios are evaluated and developed. Extension of cyber warfare concepts to large scale systems is presented to include concepts in distributed denial of service attacks, distributed storage, distributed sensor coordination, and information exfiltration. Rudimentary denial-of-service techniques are initially discussed and progress to intelligent waveform-specific forms of computer network attack (CNA). The effect of communications signaling manipulation is analyzed in examples involving mobile wireless networks such as Global Systems Mobile (GSM), Long Term Evolution (LTE) and the IEEE 802.11 standards.
   b. Prerequisites: EC3760; US Citizenship and TOP SECRET clearance with SCI access.
   c. Elective or selected elective

6. Specific goals for the course:
   a. The student will able to cite historical examples of cyber warfare, describe their underlying mechanics, and discuss their effectiveness.
   b. Given a pre-defined communications system, the student will be able to determine efficient techniques for denying service to the system through analysis of the system's control mechanisms.
   c. The student will be able to describe techniques for communications signaling and discuss the effects of inserting signaling variations into the system.
   d. The student will be able to discuss large scale systems for cyber warfare and suggest methods for extending their capabilities.
   e. The student will be able to describe the mechanics of classified large scale sensors.
f. The student will be able to list operational techniques for information exfiltration.
g. The student will describe unique warfare capabilities of software-defined radios.

7. Brief list of topics to be covered:
   a. Review of network-centric capabilities (NCC)
   b. Historical review of military cyber operations
   c. Classic Denial of Service techniques
   d. Intelligent waveform synthesis
   e. Signaling and Control Fundamentals
   f. Mobile Technologies Refresher
   g. Mechanics of modern cyber warfare
   h. Software-radio implementations
   h. Large scale system implementation and deployment
1. EC4770: Wireless Communications Network Security

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: P. Thulasiraman

      (ISBN: 0-7506-7746-5)  
   b. Lecture notes and slides  
   c. Supplemental readings from published literature

5. Specific course information  
   a. Course Description: Examines the impact of the radio frequency (RF) environment on the security of wireless communications networks. Specifically, examines the impact of the RF environment on security primitives including confidentiality assurance, integrity and authentication. Block and stream ciphers, such as the Data Encryption Standard, Advanced Encryption Standard and RC4 are studied. Evaluates Public key cryptography (PKC) and its associated algorithms (RSA). Discusses approaches to integrity assurance in the form of cryptographic hash functions. Examines all of the above factors in the context of a variety of network topologies to include personal area networks (PAN-Security in Bluetooth), wireless local area networks (WLAN), and wireless metropolitan area networks (LTE and WiMax). Analyzes and compares protocol implementations such as Wired Equivalent Privacy (WEP) and Wi-Fi Protected Access (WPA/WPA2). Also analyzes security in wireless cellular standards, including 2G (GSM), 3G, and 4G(LTE). The course studies communication vulnerabilities in wireless systems with example attacks such as Denial of Service (DoS), replay, and man-in-the-middle (MITM). Security in mobile ad hoc networks, including wireless sensor networks and Internet of Things (IoT) is also studied.  
   b. Prerequisites: EC3710 or EC3730  
   c. Required for unclassified Cyber specialty, Cyber Elective

6. Specific goals for the course  
   a. Describe issues in wireless security unique to communicating in the RF environment  
   b. Understand the concept of trust and how it applies to wireless networks  
   c. Discuss cryptographic methods appropriate for use in the RF environment, including AES and PKC and stream ciphers  
   d. Discuss security mechanisms used in GSM, 3G and 4G and identify problem areas associated with these mechanisms  
   e. Understand the security implementations of WEP and WPA/WPA2 and demonstrate their failings/disadvantages in the RF environment
f. Evaluate security algorithms designed for wireless sensor networks

g. Evaluate security algorithms designed for Internet of Things

h. Understand security mechanism of Bluetooth

i. Evaluate security measures for RFID

7. Brief list of topics to be covered

a. Introduction to Security Primitives: Encryption, Authentication and Integrity

b. Block (DES, AES) and Stream Ciphers (RC4) and their associated weaknesses in the RF environment

c. Public Key Cryptography, including RSA

d. Hash functions and message authentication codes and their use in the wireless realm

e. GSM Security

f. 3G/UMTS Security

g. 4G Security

h. Security of Bluetooth

i. Integrity and trust in wireless sensor networks

j. Vulnerabilities of Internet of Things networks

k. RFID Security

l. Basic attacks over the wireless channel, including DoS and MITM
1. EC4785 Internet Engineering

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: W. Su

4. Text book:

5. Specific course information:
   a. Description: This course examines the optimal design and analysis of large-scale, interconnected heterogeneous computer networks, specifically those employed by the US Navy (e.g. - IT-21). The course will focus primarily on the design and implementation of both carrier-class and enterprise networks based on the Transmission Control Protocol/Internet Protocol (TCP/IP) suite. Planning, analysis, and overarching design will be discussed and implemented in a laboratory environment. Specifically, an end-to-end interworking system, to include telecommunications carrier and enterprise networks will be implemented. Techniques for segmentation and reassembly, routing, transfer agent placement, error control, throughput analysis, broadcasting and multicasting will be examined in detail. Performance of common distributed applications will be analyzed.
   b. Prerequisites: EC3710
   c. Required

6. Specific goals for the course:
   a. The student will have an understanding of the underlying issues associated with computer communications over heterogeneous communications systems.
   b. The student will have a solid understanding of the architecture of the Internet and how path determination is performed across the Internet.
   c. Given demographic growth estimates for numbers and types of users, the student will be able to design an network topology that will adequately handle the organization’s data communications needs.
   d. Given a specified address space, the student will demonstrate optimal management of addresses in network design.
   e. The student will be able to discuss methods for addressing congestion control and error recovery across such systems.
   f. The student will be able to identify the advantages and disadvantages of both circuit and packet switching and discuss hybrid techniques for improving throughput by drawing from both switching methodologies.
   g. The student will be able to identify all the tasks of network management.
7. Brief list of topics to be covered:
   a. Overview
      i. Heterogeneous network definition
      ii. Concept of Autonomous Systems: Interior and Exterior perspectives
      iii. Connection-oriented vs. connectionless
      iv. Traffic engineering concepts
      v. Review of High-Speed IEEE 802.3
      vi. Review of Link layer technologies
      vii. Combining Ethernet, DWDM, PoS, WiFi, 3G/4G and TCP/IP
      viii. The service provider’s business case
      ix. Discussion of coding paradigm used for exercises
      x. Internetworking
      xi. Layering
      xii. Addressing
      xiii. Summarization
      xiv. Routing
      xv. Services
      xvii. Hardware Architecture: Processor alternatives, Bus constraints, Timer resolution
   b. Design
      i. Definitions of network tiers
      ii. Case study of network design
      iii. Service and Data Planning
      iv. Separation of network and user traffic
      v. Analysis of User requirements
      vi. Cost versus Performance trade-offs
      vii. Address Space Management
      viii. Area Design
   c. Functions
      i. Address Resolution
      ii. Internetwork Control
      iii. Topology Identification
      iv. Dynamic Routing Configurations: Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Border Gateway Protocol (BGP), Routing Protocol Performance Analysis
      v. Datagram/Best-effort delivery
      vi. Congestion Avoidance, Error Recovery: Nagle Algorithm, Karn’s Algorithm, Jacobsen’s Algorithm
      vii. Traffic Engineering
      viii. Broadcasting and Multicasting
      ix. Anycast Implementation
      x. Domain Name Service
      xi. TCP Data Flow
   d. Performance of Web Services and Distributed Applications
i. Hypertext Transfer Protocol/Worldwide Web traffic
ii. Telnet/SSH traffic
iii. File Transfer Protocol traffic
iv. Electronic mail traffic (SMTP and Exchange)
v. Video Teleconferencing
vi. Network Monitoring and Management
vii. Extensible Markup Language (XML)
viii. Search Engines, Ajax, mash-ups
ix. Large-scale virtualization
x. Service-oriented architecture, service orchestration
1. EC4790 Cyber Architectures and Engineering

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: W. Su

4. Text book: Instructor’s Notes

5. Specific course information:
   a. Description: The course addresses the holistic design, analysis and integration of
      the three-tiered cyber architecture of the medium, network, and services. Interoperability
      and interconnection of heterogeneous networks are discussed. Service oriented architectures
      and service orchestration mechanisms to include such techniques as artificial intelligence,
      control theory, min-max algorithm and feedback analysis are introduced. Network centric
      services and system design for both wired and wireless platforms are emphasized. Tools such
      as WSDL and SoaML will be introduced. System availability calculations and quality of service
      issues at different levels of the system are discussed in-depth. Comprehensive
      approaches to security across all levels of the system—medium, network, and
      services—are analyzed. Development of network centric, distributed engineering
      applications will be considered for static as well as mobile services. Sensor
      networks, information fusion, and end-to-end services are studied.
   b. Prerequisites: EC3710 or EC3730
   c. Elective or selected elective

6. Specific goals for the course:
   a. The student will able to outline the medium, network, and service issues in large-
      scale heterogeneous network centric system.
   b. The student will be able to demonstrate the need for system interoperability
      functions in network centric systems.
   c. The student will be able to define service oriented architecture and discuss service
      orchestration and the various techniques used in large scale system
      implementation and design using the principles of artificial intelligence, min-max
      principle, and feedback analysis.
   d. Given an operational scenario, the student will be able to propose network centric
      design schemes.
   e. The student will be able to list system data flows and traffic management
      requirements.
   f. The student will be able to calculate system availability metrics.
   g. The student will be able to propose quality of service requirements and list the
      relevant system resource metrics to meet the users quality of service expectations.
   h. The student will be able to propose network centric system security requirements
      and determine system vulnerabilities.
   i. The student will be able to develop schemes for network centric applications for
      both wired and wireless platforms.
j. The student will be able to propose information processing schemes to enable implementation of centralized and/or distributed fusion algorithms.

7. Brief list of topics to be covered:
   a. Three tiered architecture
      i. Medium
      ii. Network
      iii. Services
   b. Heterogeneous networks
      i. Interconnection
      ii. Interoperability
      iii. Cooperative secrecy in wireless channels
   c. Service oriented architecture
      i. Service orchestration
      ii. Artificial intelligence based techniques
      iii. Min-max criterion
      iv. Feedback analysis
   d. Network-centric system design
      i. Wired backbone and wireless for extending network reach
      ii. Data flows and traffic management
      iii. Routable networks and interoperability
      iv. System availability calculations
      v. Quality of service
   e. Network centric system security
      i. Security in the medium
      ii. Security issues in the network
      iii. Service level security issues
      iv. System vulnerabilities and exploitation
      v. System security evaluation and modeling
   f. Network-centric applications
      i. Distributed applications and SOA modeling
      ii. Wired and wireless platforms
      iii. Mobile services: infrastructure and ad hoc architectures
      iv. Sensor networks
      v. Information fusion
      vi. End-to-end delivery and interaction
      vii. Case studies
      viii. Introduction to Web services description language (WSDL) and Service oriented architecture modeling language (SoaML) to support lab assignments
1. EC4795 Wireless Device Security

2. Credits: 3.5
   Contact hours (lecture-lab): 3-1

3. Course Coordinator: F. Kragh


5. Specific course information:
   a. Description: An introduction to soft radios, devices that generate (transmitter) and/or process (receiver) digital communications signals in software and in reconfigurable hardware. The course covers basic radio frequency (RF) design principles, soft radio architectures, analysis of receiver operation, design of transceivers for sample digital modulations.
   b. Prerequisites: EC3510 and EC4530

6. Specific goals for the course:
   a. The student will understand the security vulnerabilities, attacks, and safeguards associated with wireless devices. Vulnerabilities include signal detection and/or interception, sender authentication, transmitter location, and transmitter identification.
   b. The student will understand the security vulnerabilities, attacks, and safeguards associated with transmitting radio signals. Vulnerabilities include backdoor access, non-trusted foundry, reverse engineering, soft jamming, cloning and tampering of hardware, physical compromise, malware, side channel attacks, covert channels, and vulnerabilities in software defined and cognitive radios.

7. Brief list of topics to be covered:
   a. wireless device architecture
   b. radio signal vulnerabilities
   c. wireless device vulnerabilities and security
   d. backdoor access
   e. standards specific constraints
   f. passive and active wireless attacks and threats
   g. cloning and tampering of SRAM FPGAs
   h. physical compromise
   i. malware
   j. side channel attacks
   k. covert channels
   l. security in software defined and cognitive radios
1. EC4800 Advanced Topics in Computer Engineering

2. Credits: 3
   Contact hours (lecture-lab): 3-0

3. Course Coordinator: D. Fouts

4. Text book: Recent research publications from the IEEE, ACM, and other sources

5. Specific course information:
   a. Description: Advanced topics and current developments in computer engineering. Topics subject to change from one course offering to the next. Topics may include such subjects as: recent developments in logic and memory devices, such as advanced fabrication processes, advanced FPGA technology, and spin-torque transfer memory; recent developments in computer architecture, such as massively parallel computing, reconfigurable computing, heterogeneous computing, and quantum computing; new algorithms, programming languages and compiler techniques; and new computer aided design techniques and tools.
   b. Prerequisites: Consent of instructor
   c. Elective open to all students with significant previous study in Computer Engineering

6. Specific goals for the course:
   a. To gain in-depth knowledge of one or more selected topics in computer engineering
   b. To learn newly developed theories and algorithms in the selected topics
   c. To explore the latest trends in computer engineering
   d. To build skills in conducting research in computer engineering

7. Brief list of topics to be covered:
   a. Varies depending on material being taught and instructor
1. EC4810 Fault-tolerant Computing

1. Credits: 4
   Contact hours (lecture-lab): 3-2

2. Course Coordinator: D. Fouts

   a. Reference: Selected IEEE Papers
   b. Reference: Handouts & Instructor’s Notes

4. Specific course information:
   a. Description: Introduction to fault-tolerant computing. The causes and effects of computer, digital system, and software failure. The fundamental concepts and techniques for the design and implementation of fault-tolerant computer hardware and software, including testing of digital systems. Modeling, simulation, and evaluation of fault-tolerant systems. Military and space applications of fault-tolerant computers and digital systems.
   b. Prerequisites: EC3800 or EC3840
   c. Elective

5. Specific goals for the course:
   a. The student will be able to explain the difference between faults, errors, and failures
   b. The student will understand the basic failure mechanisms for CMOS and BiCMOS digital integrated circuits
   c. The student will be able to explain the basic fault models for digital logic circuits
   d. The student will be able to use software tools, such as SPICE and Verilog, to model and simulate the behavior of faulty digital circuits and digital systems
   e. The student will be able to explain fault detection and location techniques for digital systems
   f. The student will understand the fundamentals of design for testability, built-in self-test, and the IEEE JTAG standard
   g. The student will be able to explain the fundamentals of hardware, information, and time redundancy
   h. The student will be knowledgeable of redundancy techniques, and their application to computer and digital systems hardware, to achieve fault tolerance
   i. The student will be knowledgeable about software failure mechanisms
   j. The student will be knowledgeable about software design techniques used to avoid software faults
   k. The student will be knowledgeable about software testing and verification techniques
   l. The student will be aware of the limitations of software diversity

6. Brief list of topics to be covered:
a. Faults, errors, and failures
b. Failure mechanisms for CMOS and BiCMOS digital and mixed-signal integrated circuits
c. Fault models for digital logic circuits
d. Fault modeling and simulation using SPICE, Verilog, and other software tools
e. Techniques for fault detection and location in digital logic circuits
f. Design for testability (DFT) and built-in self-test (BIST) techniques, including the IEEE JTAG standard
g. Hardware, information, and time redundancy
h. Techniques for using redundancy to achieve fault tolerance
i. Software failure mechanisms
j. Software design techniques to avoid faults
k. Software testing and verification techniques
l. The limitations of software diversity
1. EC4820 Advanced Computer Architecture

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Fouts

   a. Lecture notes
   b. Commercial software ANSYS Savant and CST Microwave Studio

5. Specific course information:
   a. Description: Techniques to achieve high-performance computing, including advanced architectural features and highly parallel processors. Techniques for improving processor, memory subsystem, and I/O subsystem performance, including pipelining, memory interleaving, multi-level caching, and parallel I/O. Parallel computer models, scalability, and clustering. Parallel programming, the role of the compiler, and compiler parallelization techniques. Performance metrics, evaluation, and comparisons between parallel processors. Enabling technologies for highly parallel computers, including the use of microprocessors and field-programmable gate arrays. Distributed memory. Processor/cluster interconnection networks. Advanced implementation technologies and techniques, including reconfigurable computing. Military applications of high-performance computers and parallel processors.
   b. Prerequisites: EC3800 or EC3840
   c. Required for Computer specialization area

6. Specific goals for the course:
   a. Given the specifications for a pipelined processor, be able to design and analyze the hardware necessary to implement pipelined instruction execution using reservation stations, the Tomasulo algorithm, or register renaming
   b. Given specifications for a high-performance arithmetic unit, be able to design and analyze single-function and reconfigurable arithmetic pipelines
   c. Given the requirements for a high-performance memory subsystem, the student will be able to design and analyze a memory system using techniques such as interleaving and multi-level caching
   d. Given the requirements for a high-performance I/O subsystem, be able to design a parallel I/O system and evaluate it for performance and reliability
   e. Given the specifications for an advanced processor, be able to classify the architecture and develop a model of it
   f. Understand the issues of scalability and clustering as they apply to highly parallel computer architectures
   g. Understand the application of FPGAs in reconfigurable computer architectures
   h. Understand the role of compilers in parallel processing and have knowledge of compiler parallelization techniques
i. The student will understand the role of compilers in reconfigurable computing and have knowledge of reconfigurable computer programming techniques
j. Given one or more high performance computers, the student will be able to design, conduct, and analyze the results of experiments for measuring performance and will be able to compare and contrast results from different computers
k. The student will understand enabling technologies for high performance processors, including advanced microprocessors, RISC, VLIW processors, and FPGAs, and how such technologies influence the architectures of advanced processors
l. Given the memory requirements for a parallel processor, the student will be able to design and analyze a distributed memory system
m. Given the processor/cluster interconnection requirements for a parallel processor, the student will be able to select an appropriate network and to analyze the performance and reliability
n. Understand the influence of advanced implementation technologies such as wafer scale integration and III/V semiconductor logic on high-performance processor architectures
o. Understand the application of advanced implementation techniques and CAD tools for parallel processors

7. Brief list of topics to be covered:
   a. Pipelined processors and pipelined instruction execution, including reservation stations, the Tomasulo algorithm, and register renaming
   b. Pipelined arithmetic units, including single-function and reconfigurable pipelines
   c. Techniques for improving memory subsystem performance, including interleaving, access path widening, and multi-level caching
   d. Parallel input/output techniques for improving I/O subsystem performance and reliability
   e. Introduction to parallel processing and parallel computer models
   f. Scalability and clustering
   g. Introduction to reconfigurable computing and reconfigurable computer models
   h. Introduction to parallel programming, the role of the compiler, and compiler parallelization techniques
   i. Programming techniques for reconfigurable computers
   j. Performance metrics and benchmarks for high performance processors, including experiment design, result analysis, and comparisons between different processors
   k. Enabling technologies for highly parallel processors, including advanced microprocessors, FPGAs, RISC, and VLIW processors
   l. Distributed memory, including models, addressing mechanisms, bandwidth, latency, coherence, and consistency
   m. Processor/cluster interconnection networks, including performance and reliability
   n. Advanced implementation technologies, including wafer scale integration and III/V semiconductor logic such as gallium arsenide, indium phosphide, and silicon germanium
   o. Advanced implementation techniques and CAD tools
1. EC4830 Digital Computer Design

2. Credits: 4  
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Fouts


5. Specific course information:  
   a. Description: This course teaches techniques for designing, modeling, simulating, analyzing, implementing, and testing complex logic devices, computers, and digital systems for a wide range of applications, including high-performance computing, embedded computing, and the internet-of-things. Students are assumed to already know the fundamentals of logic circuit design, computer architecture, and digital systems. The course focuses on the hierarchical design process for complex logic devices, computers, and digital systems, including design capture, modeling, simulation, implementation, and testing. Laboratory assignments utilize FPGAs and a suite of commercial software tools to design, model, simulate, analyze, implement, and test a complex digital system-on-a-chip.
   b. Prerequisites: EC3800 or EC3840  
   c. Required for Computer specialization area

6. Specific goals for the course:  
   a. Be able to specify the functionality of a digital device, computer, or digital system using a hardware description language  
   b. Create hierarchical data flow models, structural models, and behavior models of a logic device, computer, or digital system using a hardware description language  
   c. Develop, execute, and analyze the results of simulations for a logic device, computer, or digital system to determine the correctness of functionality and timing using a hardware description language  
   d. Configure complex programmable logic devices, such as FPGAs, to implement a digital system-on-a-chip  
   e. Design, implement, and analyze the results of tests to determine the correctness of functionality and timing of FPGA designs

7. Brief list of topics to be covered:  
   a. Advanced design and implementation techniques for computer arithmetic  
   b. Advanced design and implementation techniques for synchronous finite state machines  
   c. Advanced design and implementation techniques for pipelined computers and
d. Design capture for logic devices, computers, and digital systems using a hardware description language

e. Data flow, structural, and behavioral modeling techniques for logic devices, computers, and digital systems using a hardware description language

f. Development, execution, and analysis of simulations to determine the correctness of functionality and timing for logic devices, computers, and digital systems using a hardware description language

g. Architecture and features of simple programmable logic devices

h. Architecture and features of complex programmable logic devices such as FPGAs

i. Configuration of FPGA devices

j. Development, execution, and analysis of tests to determine the correctness of functionality and timing of FPGA devices and other complex digital systems
1. EC4870 VLSI Systems Design

2. Credits: 4
   Contact hours (lecture-lab): 3-2

3. Course Coordinator: D. Fouts


5. Specific course information:
   a. Description: Introduction to the design and implementation of Complementary Metal Oxide Semiconductor (CMOS) and Bipolar CMOS (BiCMOS) Very Large Scale Integration (VLSI) digital Integrated Circuits (ICs). Topics covered include the specification of the high-level functional design, the design, implementation, and simulation of low-level cells, floor planning and the assembly of low-level cells into the high-level design using hierarchical place-and-route techniques, circuit extraction and simulation for functional verification, timing analysis, power estimation, and the principles of bulk CMOS, BiCMOS, and SOS/SOI IC fabrication. Applications of VLSI ICs in military systems are also covered. The course is centered around laboratory projects where student groups design, implement, simulate, and submit for fabrication, a full-custom CMOS or BiCMOS, VLSI IC. IC functionality is selected by each student group. A field trip to the foundry and design center at the Defense Microelectronics Activity, including a clean room tour, is also included.
   b. Prerequisites: EC3800 or EC3840
   c. Elective

6. Specific goals for the course:
   a. Given a systems problem in the field of Electrical and Computer Engineering that is solvable with a VLSI digital or mixed-signal IC, the student will be able to specify the hierarchical design of a CMOS or BiCMOS IC capable of solving the problem, including the specifications for all cells at all levels of the design hierarchy.
   b. Given the specification for either a combinatorial or sequential digital logic circuit, the student will be able to design a CMOS or BiCMOS circuit that implements the specification, including full characterization of the circuit with respect to noise margins, speed, and power consumption.
   c. Given the design of a CMOS or BiCMOS digital, analog, or mixed-signal circuit and a set of suitable IC mask design rules, the student will be able to design and...
lay out the mask for the circuit.

d. Given the mask design of a CMOS or BiCMOS circuit and appropriate process parameters, the student will be able to estimate the parasitic resistance and capacitance in the layout and estimate RC delays, circuit speed, and power consumption.

e. Given a specification for a CMOS or BiCMOS VLSI digital or mixed-signal IC and a library of low-level cells, the student will be able to implement the specification using a well-structured, hierarchical design, including estimating speed and power consumption.

7. Brief list of topics to be covered:
   a. Hierarchical design techniques for VLSI ICs.
   b. Review of silicon MOSFETs and BJTs, including structure, theory of operation, and terminal I-V characteristics.
   c. MOSFET and BJT models and computer methods for simulating circuits containing MOSFETs and BJTs.
   d. Transistor-level design of combinational logic circuits using MOFETs and BJTs, including inverters, NOR gates, NAND gates, compound logic gates, pass gates, multiplexors, demultiplexors, decoders, BiCMOS logic gates, and interface circuits to TTL gates.
   e. Analysis of MOSFET and BJT digital, analog, and mixed-signal circuits, including both manual techniques and the use of computer simulation to determine noise margins, logic propagation delays, power consumption, DC performance, and transient performance.
   f. Transistor-level and logic gate-level design of sequential VLSI circuits including flip-flops, registers, shift registers, counters, and both Mealy and Moore finite state machines and transistor-level design of large, regular structures such as sea-of-gates, PLAs, and ROMs.
   g. Integrated circuit fabrication processes, including bulk CMOS, BiCMOS, and SOS/SOI processes.
   h. Mask design and layout, including floor planning, hierarchical cell structure, and a complete set of design rules for a bulk CMOS or BiCMOS process.
   i. Latchup and latchup prevention.
   j. The design and layout of on-chip capacitors and bipolar junction transistors.
   k. Estimation of parasitic resistance and capacitance, including both manual techniques and the use of computer simulation.
   l. Lumped and distributed RC effects, data signal, control signal, and clock routing, and skew and delay estimations including both manual techniques and the use of computer simulation.
   m. Power estimation, including manual techniques and the use of computer simulation, power and ground conductor sizing and routing, IR drops, and electromigration.
   n. Input receiver and output driver circuits, including ESD protection.
   o. Packaging.
   p. Field trip to the Defense Microelectronics Activity foundry and design center and clean room tour.
Appendix A-2 – Theses and Directed Research Projects

Please describe any requisite or optional requirements for a master’s level theses and/or directed research project.

One of our student outcomes is Independent Investigation: Students will possess the ability to conduct and report the results of a technically-challenging, defense-relevant independent investigation.

In order to satisfy student outcome Independent Investigation, each student in the MSEE Degree Program at NPS is required to write an acceptable Master’s thesis at an advanced level (beyond baccalaureate) in order to graduate. An acceptable thesis for a minimum of 16 credits must be presented to, and approved by, the ECE Department.
Appendix B – Faculty Vitae (*)

CDR Chad A Bollmann, USN
Education
S.M. Nuclear Engineering – Massachusetts Institute of Technology – USA – 1998
Ph.D. Electrical and Computer Engineering – Naval Postgraduate School – USA – 2018

Academic Experience
Naval Postgraduate School
Assistant Professor, 2018- Present (full time)

Non-academic Experience
U.S. Naval Nuclear Propulsion Program
Executive Officer, 2010 – 2012 (full time)
Ship’s Engineer, 2005 – 2008 (full time)
Reactor Control Assistant, 1999 – 2002 (part time)

Certifications or Professional Registrations
Qualified U.S. Navy Nuclear Engineer

Current Membership in Professional Organizations
IEEE Student Member

Honors and Awards - none -

Service Activities
Internal Activities
2018 to present: Member of the NPS Cyber Academic Group.

External Activities
Mini-track Co-Chair, Hawaii International Conference on System Sciences (HICSS) 2019.

Significant Publications and Presentations (last 5 years) (students underlined)


Professional Development Activities (last 5 years)

Attended the following IEEE conferences: 51st Asilomar Conference on Signals, Systems, and Computers, October 2017.
Attended the following other conferences: 51st HICSS, January 2018.
James Calusdian

Education
Ph.D. EE – Naval Postgraduate School, 2010
MSEE – Naval Postgraduate School, 1998
BSEE – California State University-Fresno, 1988

Academic Experience
Naval Postgraduate School
Lab Director, 2001- Present, Control Systems/Robotics Laboratory and Optical Electronics Laboratory, Dept. ECE, full time

Non-academic Experience
Air Force Flight Test Center, Edwards AFB
Flight Test Engineer/Instrumentation Engineer, 1989 – 2001, full time

Certifications or Professional Registrations
N/A

Current Membership in Professional Organizations
N/A

Honors and Awards
N/A

Service Activities
N/A

Significant Publications and Presentations (last 5 years)
N/A

Professional Development Activities (last 5 years)
N/A
Roberto Cristi
Education
“Laurea” degree (BS and MS equivalent), University of Padua, Italy (1977);
MSEE, Brunel University and the University of Manchester Institute of Technology (UMIST), UK (1979);
PhD, the U. of Massachusetts at Amherst, Electrical and Computer Engineering, 1983.

Academic Experience
Naval Postgraduate School, Dept of Electrical and Computer Engineering
Professor (Tenured), 2006- Present
Associate Professor (Tenured) , 1990—2005
Assistant Professor (Tenure Track), 1985-1990.

U. of Michigan, Dearborn, Dept of Electrical Engineering
Assistant Professor (Tenure Track), 1983-1985

U. of Padua, Italy, “Dipartimento di Elettronica e Elettrotecnica”
“Assistente Incaricato”, 1977

Non-academic Experience
Consultant, Toyota Research Center, Palo Alto, CA, (2004), Part Time
Ford Motor Company, Dearborn, Mi (1985), Part Time

Certifications or Professional Registrations
none

Current Membership in Professional Organizations
IEEE Senior member

Honors and Awards
“Paolo Sarpi medal”, University of Padua, best graduate in EE for the AY 1977;
Research Assistantship from the U. of Massachusetts at Amherst, 1980-1983;

Service Activities
Internal Activities
DL Manager, 2006-present
Academic Council representative, 2003-present
Academic Associate for International Students, 2004-2014
Departmental PhD Committee member
Engineering Acoustics Academic Group
External Activities
Monterey County Science Fair, 2002-2018, technical chair

Significant Publications and Presentations (last 5 years) (students underlined)


Professional Development Activities (last 5 years)
Attended OCEANS 17 MTS/IEEE Conference in Aberdeen, Scotland, June 2017.
George W. Dinolt

Education
BA, Mathematics – Lawrence College, Appleton WI, 1964
MA, Mathematics – Wake Forest University, Winston Salem NC, 1966
Ph.D., Mathematics – University of Wisconsin, Madison WI, 1971

Academic Experience
University of Michigan, Dearborn MI, 1971-1977 (Associate Prof. with Tenure Dept. of Mathematics)
University of Michigan, Dearborn MI, 1977-1882 (Adjunct Prof., CS and Mathematics Departments)
Naval Postgraduate School, Monterey, CA Prof. of Practice in Cyber Operations (2002 – Present)

Non-academic Experience
Ford Aerospace and Communications Corp Western Development Labs, Palo Alto CA and San Jose CA, 1982-1990 (Senior Engineer and Researcher in CS and Communications)
Loral Corp Western Development Labs, San Jose CA, 1990-1995, (Senior Engineer and Researcher in CS and Communications)
Lockheed Martin Corp. Western Development Labs, San Jose CA, 1995-2000, (Senior Engineer and Researcher in CS and Communications)
Trusted Systems Laboratory, San Jose CA, 2000-2002 (Vice President and Chief Technical Officer)

Service Activities
Internal Activities
Chair Hiring Committee, CS Department, 2004-2008
WASC Accreditation Support for CS Department, 2010 (approximately)
Cebrowski Institute Representative to the NPS Research Board (2005-Present)
Director, Center for Cyber Warfare for Electrical and Computer Engineering Department, 2018 Academic Year

External Activities
Program Chair IEEE Symposium on Security and Privacy (1996)
Program Chair, National Computer Security Conference (about 1993)

Professional Development Activities (last 5 years)
Attended the 2017 IEEE Aerospace Conference, Big Sky Montana and presented short abstract.
Monique P. Fargues

Education
Ph.D. EE – Virginia Polytechnic Institute and State University (Virginia Tech), 1988
MSEE - Virginia Polytechnic Institute and State University (Virginia Tech), 1984
Engineering Diploma, Electrical Engineering, ESIEE, France, 1982

Academic Experience
Naval Postgraduate School
Associate Chair for Student Programs (1999 – present)
Professor, 2008 – present
Associate Professor, 1995 – 2008
Assistant Professor, 1989 – 1995

Non-academic Experience
none

Certifications or Professional Registrations
none

Current Membership in Professional Organizations
IEEE Senior member
IEEE Signal Processing Society
AAUW

Honors and Awards
IEEE (Senior, 1995), Sigma Xi, Eta Kappa Nu.
2008 GSEAS Merit Award for Academic Service, Naval Postgraduate School.
Certificate of recognition by the ECE Department at the Naval Postgraduate School for outstanding research achievement in 1995, and outstanding teaching in 1998.

Service Activities
Internal Activities (last 10 years)

- *NPS Faculty Chair*; October 2015 – December 2016.

External Activities
Past Associate Editor for the IEEE Transactions on Signal Processing, term served 1993-1995.

Category Judge, Monterey County Science Fair, Monterey, CA, 2011-2012. Judge for Special Awards, Monterey County Science Fair, Monterey, CA, XX-XX

**Significant Publications and Presentations (last 5 years) (students underlined)**


**Professional Development Activities (last 5 years)**

Attended the Asilomar Conference on Signals, Systems and Computers, yearly, Fall.
Douglas J. Fouts

Education

PhD, Electrical and Computer Engineering, University of California at Santa Barbara, 1990
MS, Electrical and Computer Engineering, University of California at Santa Barbara, 1984
BA, Computer Science, University of California at Berkeley, 1980

Academic Experience

Naval Postgraduate School, Interim Vice President and Dean of Research, January 2012 – July 2012
Naval Postgraduate School, Associate Dean of Research, July 2006 – January 2012
Naval Postgraduate School, Professor of Electrical and Computer Engineering (with secondary appointment in Space Systems Engineering), July 2003 – present
Naval Postgraduate School, Associate Professor of Electrical and Computer Engineering (with secondary appointment in Space Systems Engineering), July 1996 – June 2003
Naval Postgraduate School, Assistant Professor of Electrical and Computer Engineering (with secondary appointment in Space Systems Engineering), September 1990 – June 1996
University of California at Santa Barbara, Visiting Lecturer, Department of Electrical and Computer Engineering, September 1986 – December 1986
University of California at Santa Barbara, Instructor, UC Extension Service, August 1985

Non-academic experience

Consulting Engineer, various companies including Lockheed Martin Space and Missile Systems, CRL Technologies, DRC Computer Corporation, Znrgy International Group, Motorola Semiconductor, Advanced Micro Devices, Digital Equipment Corp., Sverdrup Technologies, Granite Mountain Technologies, Vessna Inc., and others, October 1990 to present. Consulted on various different projects involving high-performance computer architecture, fault tolerant computing for space applications, reconfigurable computing, CMOS IC design, gallium arsenide IC design, asynchronous circuit design, etc.
Burroughs Corporation (now UNISYS), Computer Systems Group, Mission Viejo, CA, Computer Engineer, September 1980 to January 1983. Participated in the design and debugging of a new, large systems, main frame computer utilizing advanced implementation technologies and design methodologies.
The Aerospace Corp., Space Computers Laboratory, El Segundo, CA, Engineering Associate, June 1979 to September 1979. Designed, constructed, and debugged hardware to interface an I/O subsystem to a satellite-based microcomputer system.

Professional Registration

Registered Professional Engineer, State of California, Field of Electrical Engineering, License Number E16158

Professional Organizations

Senior Member, Institute of Electrical and Electronics Engineers
Senior Member, IEEE Computer Society
Senior Member, IEEE Solid State Circuits Society
Honors and Awards

Menneken Faculty Award for Excellence in Scientific Research, 2002
Outstanding Research Achievement Award for the Department of Electrical and Computer Engineering, 1997
Outstanding Instructional Performance Award for the Space Systems Academic Group, 1996
Awarded Academic Tenure, Naval Postgraduate School, Department of Electrical and Computer Engineering, 1996
Outstanding Research Achievement Award for the Space Systems Academic Group, 1993

Service Activities

Associate Chair for Research, Department of Electrical and Computer Engineering, Naval Postgraduate School, July 2017 to present
Associate Chair for Instruction, Department of Electrical and Computer Engineering, Naval Postgraduate School, July 2015 to July 2017
Session Chair, various different paper presentation sessions at various different conferences attended, September 1990 to present
Scoutmaster, Boy Scout Troop 93, Salinas, CA, January 2016 to present

Publications and Presentations (past five years)

All research accomplished during the past 5 years has been classified Top Secret and the resulting publications have not been declassified for public disclosure because of the sensitive nature of the work.

Recent Professional Development Activities

Attendance and participation at various different conferences and workshops, including but not limited to:
Classified Hardware, Electronics, and Advanced Technologies Conference (HEAT)
IEEE International Symposium on Circuits & Systems (ISCAS)
IEEE System-on-a-Chip Conference (SOCC)
Asilomar Conference on Signals, Systems, and Computers (ACSSC)
Government Microcircuit Applications & Critical Technology Conference (GOMACTech)
Hardened Electronics and Radiation Technology (HEART) Conference
IEEE Nuclear and Space Radiation Effects Conference (NSREC)
IEEE Compound Semiconductor Integrated Circuit Symposium (CSICS)
International Symposium on Computer Architecture (ISCA)
David A Garren

Education
B.S., Mathematics, Physics – Roanoke College – Salem, Virginia – 1986

Academic Experience
Naval Postgraduate School
Associate Professor, 2012 – Present (full time)

Non-academic Experience
Science Applications International Corporation, Assistant Vice President and Technology Fellow, 1997 – 2012 (full-time)
Naval Research Laboratory, ONR Postdoctoral Fellow, 1991 – 1993 (full time)

Certifications or Professional Registrations
Masters Equivalent in Systems and Software Engineering, University of Texas at Austin, 1996

Current Membership in Professional Organizations
IEEE Senior member

Honors and Awards
Selected to be a Science Applications International Corporation Technical Fellow and a member of the Science and Technology Fellow Council in 2006, an honor bestowed upon less than 0.2% of all company employees
Elevated to Assistant Vice President of Technology position at Science Applications International Corporation, 2006
Served on the Technology Development Team for the National Security Space Architecture Space-Based Radar Congressionally Directed Action Team, 2001
Recipient of a Reserve Officers Association Scholarship while at Roanoke College
Salutatorian of 1986 graduating class at Roanoke College

Service Activities
Internal Activities
Service on the Richard W. Hamming Interdisciplinary Achievement Award Selection Committee in AY2017 and AY2018
Course Coordinator for EC3750 Introduction to SIGINT Engineering, beginning in June 2017
Course development for EC4610 Radar Systems: Developed Software Laboratory 2 pertaining to spotlight synthetic aperture radar imaging of both stationary and moving surface targets
Course development for EC4680 Joint Network-Enabled Electronic Warfare II: Co-developed a Laboratory Project which required each student to analyze the application of a specific low probability of intercept transmission waveform for generating synthetic aperture radar imagery
External Activities
Served as a Chair for 2 different sessions at the 2017 IEEE International Geoscience and Remote Sensing Symposium on 26 July 2017 in Fort Worth, Texas: a) Oral Session “SAR Moving Target Imaging” and b) Poster Session “SAR Image Processing”
Served as a paper reviewer for the 2017 IEEE Radar Conference held in Seattle, Washington
Served on Conference Committee for Algorithms for Synthetic Aperture Radar Imagery Conference of SPIE Defense and Security Conference in Anaheim, California, 9-13 April 2017
Served as a paper reviewer for the 2014 IEEE Radar Conference held in Cincinnati, Ohio

Significant Publications and Presentations (last 5 years) (students underlined)

Professional Development Activities (last 5 years)
Tri Ha
Education
BS EE – Ohio University – Athens, OH – 1972
MS EE – Ohio University – Athens, OH – 1973
Ph.D. ECE – University of Maryland – College Park, MD - 1977

Academic Experience
Virginia Tech
Associate Professor, 1983-1987
Naval Postgraduate School
Associate Professor, 1987- 1989
Professor, 1989—Present

Non-academic Experience
Fairchild Industries, Senior Engineer, 1977-1979
GTE, Senior Engineer, 1979-1982

Current Membership in Professional Organizations
IEEE, Life Fellow

Honors and Awards
2017 Best Paper Award: Control Systems and Applications Track, IEEE CCWC
2017 Best Paper Award: Wireless & Satellite Communication Track, IEEE CCWC

Books

Publications and Presentations (last 6 years) (students underlined)


Robert G. Hutchins

Associate Professor (1993 to present)
BS Chemistry (Honors), University of Florida (1975)
MS Statistics, University of Florida (1977)
MS Systems Science, University of California at San Diego (1985)
Ph.D. Systems Science, University of California at San Diego (1988)

Related Experience (Teaching, Industrial, etc.)

ORINCON Corporation, San Diego, CA (4/89 – 8/93) Principal Analyst on low frequency active (LFA) sonar system contract with US Navy for anti-submarine warfare. Project featured signal and information processing and target tracking research, with sea trials for algorithm test and evaluation.

TRW Electronic Systems Group, San Diego, CA (3/82 – 4/89) Systems engineer in a variety of areas involving avionics systems, principally the Integrated Electronic Warfare System (INEWS) and the Integrated Communication and Navigation System (ICNIA), then being developed for use in a variety of US aircraft.

Navy Personnel Research and Development Center, San Diego, CA (7/80–3/82) Employed as an Operations Research Analyst involved in econometric studies associated with military hardware and personnel. Also responsible for monitoring contracts associated with this activity.

Naval Aviation Logistics Center, NAS Patuxent River, MD (2/78 – 7/80) Employed as an Operations Research Analyst studying aircraft reliability and logistics management.

Consulting, Patents, etc.

N/A

Scientific and Professional Society Membership

Senior Member IEEE.

Honors and Awards

Honors Graduate, University of Florida, 1975.
Awarded Postdoctoral Fellowship in the Department of Engineering Sciences, University of California, San Diego, 1989.
David C. Jenn  
**Education**  
Ph.D. in EE, University of Southern California, 1987  
MSEE, Ohio State University, 1976  
BSEE, University of Wisconsin-Milwaukee, 1975  

**Academic Experience**  
Naval Postgraduate School  
Associate Professor, 1990-2003 (full time)  
Professor, 2003-present (full time)  

**Non-academic Experience**  
Hughes Aircraft Company, Senior Staff Engineer, Microwave and antenna engineering, Array Antenna Laboratory, 1978-1990, full time  
McDonnell Douglas Astronautics Co., Electronics Engineer, Antenna engineer for missiles and spacecraft, 1976-1978, full time  

**Certifications or Professional Registrations**  
Engineer in training, Ohio, 1976  

**Current Membership in Professional Organizations**  
IEEE Senior member  
AIAA Senior member  
ASEE  

**Honors and Awards**  
Outstanding Research Achievement, NPS, 1999  
Compass Award for Outstanding Teaching, 1999  

**Service Activities**  

**Internal Activities**  
NPS ECE Associate Chair for Students, 1998-2000  
NPS IW/EW Program Academic Associate, 1992-2008  
Faculty Director, NPS Electromagnetics Laboratory, 2000-present  
NPS Faculty Council Representative, 2000-2006  

**External Activities**  
IEEE Monterey Bay Subsection, elected officer positions, 1991-2008  
Manuscript reviewer for IEEE journals and conferences, *Radio Science*, *Progress in Electromagnetics Research*, ACES journal, IEE journals and conferences, numerous online/open source journals  
IEEE conference organizing committees and session chairmanships  

**Significant Publications and Presentations (last 5 years) (students underlined)**  


**Professional Development Activities (last 5 years)**

Consulting for Lockheed Martin, Quick Reaction Corp., Lutronix, Optimal Synthesis Corp., Monterey Consulting Services, AIAA
Frank Kragh
Education
BSEE - Caltech, Pasadena, California, 1986
MSEE - University of Central Florida, Orlando, 1990
Ph.D. EE - Naval Postgraduate School, 1997

Academic Experience
Naval Postgraduate School
  Associate Professor, 2010 – present, full time
  Assistant Professor, 2003-10, full time
  Research Assistant, 1994-7, part time
  Military Instructor, 1990-4, full time

Non-academic Experience
Space and Naval Warfare Systems Center, San Diego, Senior Research Engineer, radio design, 1999-2001, full time
Space and Naval Warfare Systems Command, San Diego, Chief Engineer’s Office, Lead Communications Engineer, communications architecture design, 2001-3, full time

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
None

Honors and Awards
2017 Rear Admiral John Jay Schieffelin Award for Teaching Excellence, Naval Postgraduate School.
2007 Alan Berman Research Publication Award, Naval Research Laboratory.

Service Activities
Internal Activities
ECE Dept. Associate Chair for Instruction, 2010 - 2015, 2017 - present
Chair, ECE Department Curriculum Committee, 2010 - 2015, 2017 - present
Chair, Communications Engineering Technical Area Group, 2008 - present
Communication Engineering Representative, ECE PhD Committee, 2008 - present

External Activities
Session organizer for the IEEE Military Communications Conf. (MILCOM), 2004-2013.
Member, best paper selection committee for the IEEE Military Communications Conf. (MILCOM), 2014-2016.
Chair, best paper selection committee for the *IEEE Military Communications Conf.* (MILCOM), 2016.
Reviewer for the *IEEE Military Communications Conf.* (MILCOM), 2004-2018.

**Significant Publications and Presentations (last 5 years) (students underlined)**


**Professional Development Activities (last 5 years)**
Attended the Asilomar Signals Systems and Computers Conference annually.
Herschel H. Loomis, Jr.

Education
BEE Cornell University (1957)
MSEE University of Maryland (1959)
Ph.D. Massachusetts Institute of Technology (1963)

Academic Experience
Naval Postgraduate School, 1999 – present
Distinguished Professor Emeritus, 2017 - present
Distinguished Professor, 2010 – 2017
Adjunct Research Professor 1982-6
NAVELEX Chair Professor 1981-2
University of California, Davis
Professor and Acting Associate Dean for Graduate Studies, College of Engineering 1978
Professor, Department of Electrical and Computer Engineering 1975 - 1978
Professor and Chair, Department of Electrical Engineering 1974 - 1975
Associate Professor and Chair, Department of Electrical Engineering 1970 - 1974
Associate Professor (Tenure awarded 7/1/68), Department of Electrical Engineering 1968 - 1970
Assistant Professor, Department of Electrical Engineering 1966 - 1968
Assistant Professor, Department of Engineering 1962 - 1966

Non-academic Experience
• Cryptology Officer, United States Naval Reserve, ENS – CAPT 1957 – 1996, Retired 1996 – present

Certifications or Professional Registrations
• Registered Professional Engineer, California, Electrical, 1966-present

Current Membership in Professional Organizations
• IEEE, Life Senior Member
• IEEE Computer Society
• Illumination Engineering Society of North America
• Member; Tau Beta Pi; Sigma Xi; Eta Kappa Nu

Honors and Awards
• Awarded the National Reconnaissance Office Medal of Distinguished Performance by Director, National Reconnaissance Office, 6 July 2017
• Awarded title of Distinguished Professor, September 2010
• Richard W. Hamming “Excellence in Teaching Award” from the Naval Postgraduate School in September 2007.

• ACM "Recognition of Service Award" for work as Member and Director of ACM Special Interest Group on Design Automation, Responsible for Graduate Scholarship program, September 1987.


Significant Recent Publications (students underlined)


Carson C McAbee

Education
Control System Engineering (BS) – United States Naval Academy – USA – 2005
Electrical Engineering (MSEE) – Naval Postgraduate School – USA – 2014

Academic Experience
Naval Postgraduate School
Research Associate, 2017- Present (full time)

Non-academic Experience
U.S. Navy, Naval Officer, 2005 – 2017 (full time)

Significant Publications and Presentations (last 5 years)
John C. McEachen II  

**Education**  
B.S.E.E. – University of Notre Dame – 1985  
M.E.E.E – University of Virginia – 1990  
M.Phil. – Yale University – 1992  
Ph.D. – Yale University – 1995  

**Academic Experience**  
Naval Postgraduate School  
Professor, 2008- Present  
Associate Professor, 2002 – 2008  
Assistant Professor, 1996 – 2002  

Yale University  
NIH Postdoctoral Fellow, 1995 – 1996  
NIH NLM Informatics Fellow, 1991 – 1994  

University of Virginia.  
Teaching and Research Assistant, 1990.  

**Non-academic Experience**  
June 1994 – October 1996: Advanced Information Technology Consultant  

**Certifications or Professional Registrations**  
Basic Russian Linguist, Defense Language Institute, 1986  

**Current Membership in Professional Organizations**  
IEEE member  

**Honors and Awards**  
2010 Graduate School of Engineering and Applied Science (GSEAS) Entrepreneurship Award for identification and support from new sponsors.  
2005 NPS Carl E. and Jesse W. Menneken faculty award for excellence in scientific research.  
2003 NPS Richard W. Hamming faculty award for excellence in interdisciplinary teaching.  

**Service Activities**  
Internal Activities  
2011 – 2015: Director, Center for Cyber Warfare  
2007 Chair, Hamming Award Committee.  
2002 - 2003: Member, NPS Dean of Research Search Committee.  
1998 – present: ECE Ph.D. and research committees  
1998 – present: ECE alternate representative to the NPS Academic Council
External Activities
2012 – present: Co-founder, NATO-NPS Cyber Security Programme
2012 – 2015: DARPA Source Selection Board Member
2011 – present: Founding member, Steering Committee, NSA Centers for Academic Excellence in Cyber Operations (CAE-CO)
2010 – present: Technical Program Committee, Organizing Committee, IEEE International Conference on Signal Processing and Communications Systems
2006 – 2010: Senior Program Committee, International Conference on Global e-Security

Significant Publications and Presentations (last 5 years) (students underlined)

Patents

Journal Papers
James Bret Michael  
Education  
Postdoctoral studies certificate in National Security Law - University of Virginia, June 2004  
Ph.D. in Information Technology (Computer Science) - George Mason University, May 1993  
M.S. in Information Systems (Software Engineering) - George Mason University, May 1987  
M.B.A. - George Mason University, Jan. 1985  
B.S. Business Administration (Finance) - West Virginia University, May 1983  
Academic Experience  
May 1998-present: Professor (with tenure), departments of Computer Science and Electrical & Computer Engineering, Naval Postgraduate School, Monterey, Calif. (stationed in Northern Virginia from May 2011 to present) – Full-time: Trustworthy systems, with an emphasis on security, reliability, and safety engineering: Advance the theory and practice of engineering of trustworthy systems. My research has been highly impactful, enabling the public and private sectors to improve both the trustworthiness of their mission-critical systems and the effectiveness and efficiency of conducting verification and validation on those systems. My research has also informed law, policy, and standards pertaining to lowering the risk associated with acquisition and use of trustworthy systems to protect society from a wide array of vulnerabilities and threats such as those posed by cyber warfare and introduction of counterfeit components and systems into the supply chain. Graduate-level education in science and engineering education: In addition to teaching courses I participate in Naval Postgraduate School, national, and international initiatives to improve the quality of graduate-level education in science and engineering, such as the formulation of reference curricula and leveraging of distributed learning technologies.  
Jan. 1994-May 1998: Assistant Research Engineer, University of California, Berkeley  
Sept. 1993-Dec. 1993: Visiting Assistant Professor, Illinois Institute of Technology, Chicago, Ill. – Part-time: Language processing: Taught a course in the evening on compiler theory and practice. Developed a capstone project for the course for the students to demonstrate their understanding and ability to apply the principles and mechanics of compiler design and code generation.  
Non-academic Experience  
April 2012-present: Cofounder and Chief Innovation Officer, KoVirt Data Systems LLC (formerly Unified Data Solutions), Ashburn, Va. – Part-time: Secure network communications and storage: Enable the company to innovate by getting the members of the engineering team to collaborate, generate ideas, implement ideas, and create value for the company’s customers. The company is developing secure on-demand provisioning of infrastructure to empower customers to retain control over their stored data and securely access that data from anywhere.  
Nov. 1992-Dec. 1993: Formal Methods Engineer, Argonne National Laboratory, Argonne, Ill. – Full-time: Theorem proving and lightweight formal methods: Conducted research on the
development of processes, techniques, and tools to enable the industrial application of formal methods for high-assurance systems.

June 1987-Sept. 1992: Research Staff Member, Institute for Defense Analyses, Alexandria, Va. – Full-time: Software engineering: Performed research on the integrating modern software engineering methodologies and tools into the systems engineering of large-scale distributed systems acquired and used by the U.S. Department of Defense. Developed processes, techniques, and tools to improve the successful implementation, adoption, and sustainment of software-intensive systems.

Current Membership in Professional Organizations
Senior member, IEEE

Honors and Awards
Lump-sum cash awards, Naval Postgraduate School, Sept. 2016 and 2017
National Intelligence Exceptional Achievement Medal, June 2017
Commendation from the Director of the Technology Directorate, National Security Agency, Mar. 2014
Department of the Navy Meritorious Civilian Service Medal, Sept. 2013
2010 Engineer of the Year Award, Reliability Society of the Institute of Electrical and Electronics Engineers, Jan. 2011
Commendation from the Assistant Secretary of the Navy, Research Development and Acquisition, Chief Systems Engineer, Aug. 2008

Service activities (within and outside of the institution)
Government Advisory Committee, Rapid Analysis of Various Emerging Nanoelectronics (RAVEN) program, Intelligence Advanced Research Projects Agency
Associate Editor, IEEE Systems Journal

Most Important Publications and Presentations (past five years)

Recent Professional Development Activities
Online studies in Acquisition and Leadership - Defense Acquisition University, 2012 – present: completed eighteen Harvard Business School online courses on leadership and management
Sherif Michael

Education
B. S. E. E. Electrical Engineering, Cairo University, 1974.
M. S. I. E. Industrial Engineering, West Virginia University, 1980.
Ph.D. Electrical Engineering, West Virginia University, 1983.

Academic Experience
Naval Postgraduate School, Professor, 2005- Present (full time)
Joined the naval Postgraduate School on 1983, serving as Assistant/Associate Professor.

Certifications or Professional Registrations
Registered as a Professional Engineer in the State of West Virginia.

Current Membership in Professional Organizations
Senior member of IEEE. Member of the following IEEE societies: Circuits & Systems Society, Nuclear & Plasma Sciences Society, Solid-State Circuits Society. Member of the AIAA

Honors and Awards
Member: ETA KAPPA NU, TAU BETA PI, ALPHA PI MU and SIGMA XI. Awarded more than 70 research Projects and contracts.

Service Activities

Internal Activities
Serving as Chairman of ECE's Circuits and Devices Technical Activity Group - Member of the Space Systems Academic Group, SSAG - Member of the Energy Academic Group, EAG - Member of the Center for Material Research, CMR -Serving as the IEEE Student Counselor.

External Activities:
Technical Program Chairman of the 60th IEEE Midwest Symposium on Circuits and Systems, Boston, MA; Past member of the Board of Governors of the CAS Society; Publicity Chairman of the 1999 IEEE International Symposium on Circuits and Systems, Orlando FL; General Chairman and organizer of the 1998 IEEE International Symposium on Circuits and Systems, Monterey CA, ISCAS’98; Technical Program Chairman of the 40th Midwest Symposium on Circuits and Systems, Davis, CA; General Chairman and organizer of the 34th Midwest Symposium on Circuits and Systems, Monterey CA; Served at different capacities at the Asilomar Conference on Signals, Systems and Computers, 1983-present. Currently serving as the Secretary of the Asilomar CSSC.

Frequent reviewer of technical papers submitted to the following: IEEE Transactions on Circuits and Systems, IEEE International Symposium on Circuits & systems, the Midwest Symposium on Circuits & systems, the International Conference on Electronics, Circuits & systems, the Asilomar conference, the International Conference on Electronics, Circuits & systems. National Science Foundation, Energy Research Center research proposals.

Significant Publications and Presentations (last 5 years)

vol. 5, no. 1, pp. 54-60, 2017.


[More than 125 Publication over his career ]

**Intellectual Property, Patents:**

- **Michael, S. N., O’Connor, J. E., ”AlGaAs/GaAs Solar Cell with Back-Surface Alternating Contacts,” 15-207-128, 2016. Patent was awarded December 2017.**


**Professional Development Activities (last 5 years)**

Attended more than 7 short courses.
Participated in more than 27 technical conferences and meetings.
Giovanna M Orii

Education
Laurea degree EE (BSEE + MSEE equivalent) - University of Catania – Italy – 1993
Ph.D. EE - University of Catania – Italy – 1997

Academic Experience
Naval Postgraduate School
Associate Professor, 2011- Present (full time)
Research Assistant Professor, 2008—2011 (part time)
Contract Instructor, 2007 (part time)

Non-academic Experience
Self Employed, Power Engineering Consultant, 2000 to 2007 (full time)
United Technologies Research Center, Associate Research Engineer, 1998 -1999 (full time)
University of Wisconsin- Madison, Research Intern/Associate, 1995-1997 (full time)

Certifications or Professional Registrations
Certified Engineer in Catania, Italy

Current Membership in Professional Organizations
IEEE Senior member

Honors and Awards
2017 IEEE IAS Renewable and Sustainable Energy Conversion Systems Committee Third Prize Paper Award.
2017 ECE Department Special Act Award for her energy management system research "in recognition of her substantial contribution to the US Navy’s goal of energy efficiency and energy conservation”.
2016 ECE Department Special Act Award for her research on power electronics-based energy management systems.
2012 ECE Special Act Award for contributions to the development of the new NPS Energy curricula and, in particular, the Electrical Engineering Energy curriculum and new course.
2002 IEEE IAS Outstanding Young Member Award.
1993 Graduation Award ($650 US) from the Professional Association of Engineers of Catania as valedictorian of her class.
1993 Graduation Award ($1300 US) from the Catania Association of Industries for Research.

Service Activities
Internal Activities
2017 Chair of the Nomination Committee of the NPS Faculty Council.
2011 to present: Member of the NPS Energy Academic Group.
Elected Member of the Nomination Committee of the NPS Faculty Council in Nov. 2015.
External Activities

Lead Technical Program co-Chair, IEEE Energy Conversion Congress and Expo 2018.
Women in Engineering co-Chair, Energy Conversion Congress and Expo 2018 and 2017.
Associate Editor, IEEE Transactions on Power Electronics. (March 8, 2016 - Present).
Special Activities Chair, IEEE IAS Industrial Power Converter Committee (IPCC) (2017).
Technical Program co-Chair, IEEE Energy Conversion Congress and Expo 2013.
Member, IEEE IAS Executive Board. (January 2010 - December 2011).
Department Chair, IEEE IAS Industrial Power Conversion Systems. (2010-2011). IPCSD is the largest department within the Industry Application Society.
Vice Chair, IEEE IAS IPCSD. (January 2008 - December 2009).
Chair (‘06-’07), Vice-Chair (‘04-’05), Secretary (‘02-’03) of the Industrial Power Converter Committee of the IEEE Industry Application Society.
Category Judge, Monterey County Science Fair (2011-2012).
Category Judge, California State Science Fair, Los Angeles, CA. (April 2017).
2016- 2018, Judge for Special Awards, Monterey County Science Fair, Monterey, CA.

Significant Publications and Presentations (last 5 years) (students underlined)


Professional Development Activities (last 5 years)

Phillip E. Pace
Education

BSEE (1983), MSEE(1985) - Ohio University, Athens Ohio
PhD(EE) – University of Cincinnati, Cincinnati Ohio

Industrial Experience

HUGHES AIRCRAFT COMPANY, 1983--1987
Radar Systems Group, El Segundo, CA.
GENERAL DYNAMICS CORPORATION, 1990-1992
Air Defense Systems, Division, Pomona, CA.

Academic Experience

Naval Postgraduate School
Assistant Professor
Promotion to Associate Professor (July 1995)
Tenured (July 1, 1997)
Promotion to Professor (July 2000)
Department of Electrical and Computer Engineering.

Current Memberships

Institute of Electrical and Electronic Engineers (IEEE)
Association of Old Crows (AOC)

Honors and Awards

Electronic Warfare Academic Training Award, Association of Old Crows, September 1995.
Elevated to Fellow Member, Institute of Electrical and Electronic Engineers, 2017.
Internal Activities

Director, Center for Joint Service Electronic Warfare

External Activities

Associate Editor, *IEEE Transactions on Aerospace and Electronic Systems*

Significant Publications:


Andrew A. Parker

Education
Bachelor of Mechanical Engineering - Georgia Institute of Technology – 1979
Master of Science Engineering Science (EE option in Electromagnetics) – Naval Postgraduate School – 1992
Master of Science Engineering Management – University of Maryland University College – 1994

Academic Experience
U.S. Naval Academy
Instructor, Physics Department, 1992 – 1994
Instructor, Electrical and Computer Engineering Department, 1993 – 1995
Anne Arundel Community College, Arnold, MD
Hartnell Community College, Salinas, CA
Contract Instructor, Physics and Electrical Engineering, 1996 – 2000
Naval Postgraduate School
Faculty Associate, Electrical and Computer Engineering Department, 1997 – Present

Non-academic Experience
U.S. Naval Officer, Nuclear Submarine Service, Electrical Officer, Radiological Controls Assistant, Assistant Engineer, Chief Engineer, 1979 – 1990
Trident Engineering, Annapolis, MD, Forensic Engineering, 1992 – 1995 (part time)
Self Employed, Engineering Consultant, Electrical and Mechanical, 1996 – present (part time)

Certifications or Professional Registrations
Professional Engineer, Mechanical Engineering, CT, CA
Professional Engineer, Electrical Engineering, CA

Honors and Awards
Master Instructor, 1993

Service Activities
Internal Activities
Assistant Radiation Safety Officer, 2017 – Present
Member of the NPS Energy Academic Group, 2018 – Present
Military Affiliate Radio System Custodian, 1997 – Present
External Activities
Amateur Radio Emergency Services, 1997 – Present
Carmel Red Cross, Communications Officer, 1995 – 2005
Monterey Bay Aquarium, Guide, 2005 – Present
Matthew A. Porter

Education
BSEE – United States Naval Academy – 2010
MSEE – Naval Postgraduate School – 2011

Academic Experience
Naval Postgraduate School
Research Associate, 2011-Present

Non-academic Experience
Officer, USN, 2006-2011

Certifications or Professional Registrations

Current Membership in Professional Organizations
Member, IEEE

Honors and Awards

Service Activities

Internal Activities

External Activities

Significant Publications and Presentations (last 5 years)


Professional Development Activities (last 5 years)

Attended the following conferences: 2015-2016 Hardened Electronics and Radiation Technologies (HEART) Technical Interchange Meetings, 2017 Workshop on Compound Semiconductor Materials and Devices (WOCSEMMAD), 2016 GOMACTECH Meeting
(Ralph) Clark Robertson

Education
BSEE – Texas Tech University – 1973
MSEE – University of Texas at Austin – 1980
Ph.D. – University of Texas at Austin – 1983

Academic Experience
Naval Postgraduate School
ECE Chair, 2010—March 2019
Cyber Academic Chair, 2015—2017
Professor, 1996—Present
Associate Professor, 1989—1996

Virginia Polytechnic Institute & State University
Assistant Professor, 1983—1989

Non-academic Experience
IBM Corp., 1973—1979

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
None

Honors and Awards
2007 IEEE Military Communications Technical Achievement Award
2008 Hamming Teaching Award

Service Activities
Internal Activities
1997—2009: Associate Chair, Instruction, Department of Electrical and Computer Engineering
September 2002—December 2009: Director of the NPS ECE Cryptologic Research Laboratory
1992—1997: Associate Chair, Students, Department of Electrical and Computer Engineering

External Activities
Editor for Spread Spectrum Systems, IEEE Transactions on Communications, April 1, 1996 to 2002
Unclassified Technical Program Chair, IEEE Military Communications Conf. 2000
General Chairman 1999 IEEE Communication Theory Workshop
General Chairman 1997 IEEE Communication Theory Workshop
General Chairman 1995 IEEE Communication Theory Workshop
Technical Program Committee member, IEEE Military Communications Conf., 2011—2012

**Significant Publications and Presentations (last 5 years)**

None

**Professional Development Activities (last 5 years)**

None
Ric Romero

Education
BSEE – Purdue University – 1999
MSEE– University of Southern California – 2004
Ph.D. EE - University of Arizona – 2010

Academic Experience
Naval Postgraduate School
Associate Professor, 2016- Present
Assistant Professor, 2010- 2016
Graduate Research Assistant, 2007—2010 (part time)

Non-academic Experience
Raytheon Missile Systems, Tucson, AZ
Multidisciplined Senior Engineer II, 1999-2010
Rockwell Collins, Cedar Rapids, IA
Co-op Engineer (4 semesters), 1996-1998

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
IEEE Senior Member

Honors and Awards
2004 Excellence in Technology Award, Raytheon Company, Corporate Award
1999 McDonnel Douglas Endowment, Purdue University

Service Activities
Internal Activities
2014-2017, ECE Representative NPS Faculty Council
2011-2014, ECE Representative Alternate NPS Faculty Council
2011-Present, Laboratory Director, Cognitive Sensing, Radio, & Radar Lab

External Activities
Committee Member, Tri-service Radar Symposium, 2018-present
Reviewer, IEEE International Radar Conference, Brisbane, Australia, 2018
Reviewer, IEEE Radar Conference, Oklahoma City, OK, 2018
Reviewer, IEEE Radar Conference, Seattle, WA, 2017
Reviewer, IEEE International Conference on Signal Processing and Communications Systems, 2012
Reviewer, IEEE European Signal Processing Conference, 2012
Reviewer, IEEE Transactions on Aerospace and Electronics Systems (past and present)
Reviewer, IEEE Transactions on Signal Processing (past and present)
Reviewer, IEEE Transactions of Vehicular Technology (past and present)
Reviewer, Elsevier Signal Processing Journal (past and present)
Reviewer, various other journals (past and present)

Significant Journal and Conference Publications (last 5 years) (students underlined)


Professional Development Activities (last 5 years)

Attended various IEEE conferences related to radar, communications, and signal processing
John Roth
Education
Ph.D. ECE – NPS - 2016

Academic experience
NPS, Assistant Professor, 2017-present, (full-time)
USNA, Assistant Professor, 2016-2017, (full-time)
USNA, Instructor, 2013-2016, (full-time)

Non-academic experience
USMC, 2004-2012, (full-time)

Certifications or professional registrations
n/a

Current membership in professional organizations
IEEE Member

Honors and awards
2015 Best Paper Award, Software Track, Hawaii International Conference on System Sciences
2012 HKN/IEEE Award in Engineering Excellence

Service activities
Internal Activities
ECE Department Representative to the NPS Faculty Council
Nominating Committee Member, NPS Faculty Council

External Activities
Minitrack Co-Chair, Hawaii International Conference on System Sciences - 2018
Treasurer, Asilomar Conference on Signals, Systems, and Computers – 2018

Significant Publications and Presentations


J.D. Roth, “The role of wireless in cyber education,” keynote speaker, NI Week, Austin, TX, May, 2017.


**Professional Development Activities**
Attended the conferences listed in the above sections
James W. Scrofani

Education
- Ph.D., Electrical Engineering; Naval Postgraduate School (NPS), Monterey, CA, 2005, Dissertation: Theory of Multirate Signal Processing with Application to Signal and Image Reconstruction
- Master of Business Administration; Brenau University, Gainesville, GA, 1994
- B.S., Chemical Engineering; University of Florida, Gainesville, FL, 1987

Academic Experience
Associate Professor (Full-time), NPS, Dept. of Electrical and Computer Engineering
Director, Center for Multi-INT Studies (CMIS) (Full-time), NPS

Non-academic Experience
Served in the United States Navy (1987-2011)
- Navy Captain (O-6), retired, with over 24 years of leadership experience in the Intelligence/Department of Defense Acquisition, R&D and Submarine Warfare Communities.
- Extensive Program Management Experience: Technical Director for the Advanced Systems and Technologies (AS&T) Directorate, National Reconnaissance Office (NRO), responsible for the operation of a large, complex, federal organization and program management of a multimillion-dollar R&D portfolio; Various Submarine-Launched Ballistic Missile (SLBM) System program management positions at headquarters and field levels
- Experienced Leader -- numerous key leadership positions, including the supervision of military, government, and contractor personnel

Certifications or Professional Registrations
Professional Engineer, Department of Professional and Occupational Regulations, Commonwealth of Virginia. (July 9, 2001 – July 31, 2019).

Membership in Professional Organizations
- Institute of Electrical and Electronics Engineers (IEEE), Senior Member, 2011 – Present
- IEEE, Member, 1995 – 2011
- IEEE, Signal Processing Society, 1996 – Present
- IEEE Aerospace and Electronic Systems Society Membership, 2011 – Present
- IEEE Robotics and Automation Society Membership, 2011 – Present
- IEEE Computer Society Technical Committee on Intelligent Informatics, 2013 – Present
- International Society of Information Fusion (ISIF), 2011 – Present

Honors and Awards
2018 Hamming Faculty Award for Interdisciplinary Achievement
Special Act Award (01 Oct 2011 – 31 Jul 2012)
Tau Beta Pi Engineering Honor Society, 1987

Service Activities

- Program Committee Member, National Symposium on Sensor and Data Fusion (NSSDF), 2018.
- Faculty Council Representative to the NPS Research Board
- National Capital Region Liaison

Important publications and presentations

- Presentation, Office of the Director of National Intelligence, Chief, Intelligence Community Strategic Studies Group, Rich O’Lear, Maj. Gen, USAF (ret), CMIS Overview, 2013
- Presentation, National Reconnaissance Office, Director of Advanced Systems and Technologies Directorate, CMIS Overview, 2013

Recent professional development activities

- Cognitive Computing and Cognitive Systems, Tutorial, Hawai’i International Conference on System Sciences, 2018
- Smart Data, a Pathway to the Future, Tutorial, Hawai’i International Conference on System Sciences, 2018
- Overview of High-Level Information Fusion Theory, Models, and Representations, Tutorial, 19th International Conference on Information Fusion, 2016
- Introduction to Recommender Systems, on-line course, Coursera, 2016
Terry E. Smith
Education
MSEE – Air Force Institute of Technology (AFIT), WPAFB, OH, Electronic Warfare - 1984
BSEE – Calif. Polytechnic State Univ., San Luis Obispo, CA, Microwave & RF Studies - 1982

Academic Experience
Naval Postgraduate School
Lecturer, 2016- Present (non-tenure track, seasonal part-time)
Contract Lecturer, 2015-2016 (part-time), Digital Consulting Services (DCS)
Military Faculty, 2006-2012 (full-time), GSOIS/Information Sciences Dept.

Pt. Mugu and Patuxent River
Lecturer, 2009-2011 (part-time) Instructor for annual EW101 short course. Supporting NAVAIR, I taught introductory radar system principles, as well as common electronic warfare (EW) concepts/practices to Navy field engineers at several operating locations.

Non-academic Experience
Retired Military Officer (USAF) & Industry (ITT, MRC, Sperry-Univac, & Hughes):
AFOTEC OL-KT - Cyber Engineer & Operating Location Chief (2 years)
NPS/GSOIS/IS – Information & Electronic Warfare Program Officer (6 years)
AFOTEC Detachment 5 - Assistant Director of Operations (3 years)
NASIC - Senior MASINT Data Exploitation Manager (8 years)
ITT Systems & Sciences – Dep. Manager for High-Power Microwave Sources (6 years)
DTRA - Chief Scientist & Facility Chief, Electromagnetics Branch (2 years)
Mission Research Corporation (MRC) EMP Program Manager (6 years)
Air Force Research Lab - Section Chief, Aircraft/Missiles Division (3 years)
Sperry-Univac Company Microwave Engineering – RF Components Engineer (1 year)
Hughes Aircraft Company - Radar Systems Manufacturing Group - Co-op Student (3 years)
US Air Force - Radio Relay Equipment Repairman (4 years)

Honors and Awards
2009 Northrop Grumman Teaching Award based on NPS/GSEAS systems engineering analysis curriculum scholastic and teaching excellence
2015- 2018, Judge for Monterey County Science Fair, Monterey, CA.

Significant Publications and Presentations (last 5 years)
Weilian Su
Education
MS ECE – Georgia Institute of Technology – Atlanta, GA - 2001
Ph.D. ECE - Georgia Institute of Technology – Atlanta, GA - 2004
Academic Experience
Naval Postgraduate School
Associate Professor, 2010- Present
Assistant Professor, 2004—2010
Non-academic Experience
IBM, ASIC Application Engineer, 1997-1999
Current Membership in Professional Organizations
IEEE Senior member
Honors and Awards
2017 Best Paper Award: Control Systems and Applications Track, IEEE CCWC
2017 Best Paper Award: Wireless & Satellite Communication Track, IEEE CCWC
2003 Best Tutorial Paper Award, IEEE Communications Society.
1997 Lockheed Martin Capstone Design Award, Rensselaer Polytechnic Institute.
Service Activities
Internal Activities
Committee Member, GSEAS Dean Reappointment Committee, March - May 2017.
Faculty Council Member (Alternate) for Dept. of ECE, NPS, 2007-2010
External Activities
Editor, Associate Editor, Elsevier AdHoc Networks. (January 2009 - Present).
Editor, Associate Editor, Hindawi Journal of Sensors. (January 2009 - Present).
Editor, Associate Editor, IARIA International Journal On Advances in Intelligent Systems. (January 2009 - Present).
Editor, Associate Editor, IARIA International Journal On Advances in Networks and Services. (January 2009 - Present).
Member, IARIA Work Group on Advances on Networking Convergence. (January 2009 - Present).
Member, IEEE ComSoc Radio Communications Committee. (January 2009 - Present).
Member, WSEAS Working Group on COMPUTERS. (January 2009 - Present).
Officer, President/Elect/Past, Monterey Bay Subsection of the IEEE Santa Clara Valley Section. (January 2014 - December 2017).

**Significant Publications and Presentations (last 5 years) (students underlined)**


**Professional Development Activities (last 5 years)**

Preetha Thulasiraman  

Education  
PhD, Electrical Engineering, University of Waterloo, Waterloo, Canada, 2010  
MSc, Electrical Engineering, University of Arizona, Tucson, AZ, 2006  
BSc, Electrical Engineering, University of Urbana-Champaign, Urbana, IL, 2004  

Academic Experience  
Naval Postgraduate School  
Assistant Professor, 2011-2017  
Associate Professor, 2017- Present (full time)  

Non-academic Experience  
None  

Certifications or Professional Registrations  
None  

Current Membership in Professional Organizations  
IEEE Member, 2006-Present  
Association for Computing Machinery (ACM) Member, 2012-Present  

Honors and Awards  
Rear Admiral John Jay Schieffelin Award for Teaching Excellence, Ranked top 5% of Faculty, 2014  
Rear Admiral John Jay Schieffelin Award for Teaching Excellence, Ranked top 5% of Faculty, 2015  
ECE Special Act Award for Teaching, 2012  
ECE Special Act Award for Teaching, 2016  

Service Activities  
Internal Activities  
ECE Academic Associate for International and Civilian Students, Oct. 2014-Present  
Cyber Academic Group Academic Associate for Engineering Track, Oct. 2015-Present  
GSEAS Dean Re-appointment Committee, Spring 2014  
GSEAS Dean Search Committee, Summer 2014  
Faculty Council Representative for ECE, Jan. 2012-Dec. 2014  
Faculty Council Alternate Representative for ECE, Jan. 2015-Dec. 2017  

External Activities  
Conference Session Chair, IEEE Globecom 2012-2013  
Guest Editor, Spring Peer to Peer Networking Applications, Special Issue, 2016  
Guest Editor, IEEE Internet of Things, Special Issue, 2017  
Proposal Reviewer for NASA Edison Small Satellite Flights Demonstrations, 2013  
Technical Program Committee (TPC) Member and Reviewer for various IEEE conferences  

Reviewer for various IEEE Transactions Journals
Reviewer for various non-IEEE Journals, including Elsevier and Springer

**Significant Publications and Presentations (last 5 years) (students underlined)**


**Professional Development Activities (last 5 years)**


Attended Cyber Summer Seminar on Reverse Engineering, 2013
Murali Tummala

Education
Ph.D. in EE, Indian Institute of Technology, Bombay, India, 1984
MSEE, Indian Institute of Technology, Bombay, India, 1981
BSEE, Institution of Engineers, Calcutta, India, 1979

Academic Experience
Naval Postgraduate School
Assistant Professor, 1986-1990 (full time)
Associate Professor, 1990-1997 (full time)
Professor, 1997-present (full time)

Non-academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
IEEE Senior member

Honors and Awards
1991 Admiral John J. Scheiffelin Award for Excellence in Teaching
2001 Naval Postgraduate School Research Recognition Award

Service Activities
Internal Activities
ECE Associate Chair for Research, 1998—2010
Chair, ECE Ph.D. Program Committee (2006 – present)
Faculty Director, ECE Network Engineering Laboratory, 1997-present
Academic Council Representative, 1990-1996

External Activities
Publicity Chair, Asilomar Conference on Signals, Systems, and Computers (1997 to 2010)
IEEE Monterey Bay Subsection, elected officer positions, 1987-1998
Manuscript reviewer for IEEE journals and conferences
IEEE conference organizing committees and session chairmanships

Significant Publications and Presentations (last 5 years) (students underlined)


**Professional Development Activities (last 5 years)**

WILLIAM WILLIAMSON III

EDUCATION
PhD, Physics, 1996 University of Toledo, Toledo OH
MS, Physics, 1992 University of Toledo, Toledo OH
BA, International Relations, 1983 University of Toledo, Toledo OH

ACADEMIC EXPERIENCE
US Naval Postgraduate School (National Capitol Region)
Associate Research Professor (10/2017 – Present)

Patrick Henry College
Adjunct Professor (01/2018 – Present)
Guest Lecturer (06/2017 – 11/2017)

NON-ACADEMIC EXPERIENCE
MITRE Corporation
Chief Engineer Sentient Capstone Demonstration 11/2014-09/2017
Acting Department Head, Sensor and Signal Processing Dept 01/2015 – 05/2015
Group Leader, Signal Processing Engineer 07/2011-10/2015
Department/Project Chief Engineer, Domestic Security Division 06/2009-07/2011
Portfolio and Project Lead, Domestic Security Division 03/2009-10/2010
Department Chief Engineer, Joint Service Intelligence Programs Dept 04/2007-03/2009

Logos Technologies
Senior Scientific Analyst (08/2003 – 03/2007)

Institute for Defense Analysis
Research Staff Member (1999 - 2003)

Center for Naval Analyses
Research Staff Member (1996 - 1998)

Mayo Foundation

SIGNIFICANT PUBLICATIONS AND PRESENTATIONS (last 5 years)


Xiaoping Yun  
**Education**  
BS in EE, Northeastern University (China), 1982  
MS in Systems Science and Mathematics, Washington University in St. Louis, 1984  
D.Sc. in Systems Science and Mathematics, Washington University in St. Louis, 1987  

**Academic Experience**  
Distinguished Professor, Naval Postgraduate School, 2011 – present (full time)  
Professor, Naval Postgraduate School, 2000 – 2011 (full time)  
Associate Professor, Naval Postgraduate School, 1994 – 2000 (full time)  
Assistant Professor, University of Pennsylvania, 1987 – 1994 (full time)  
Research Assistant, Washington University in St. Louis, 1982 – 1987 (part time)  

**Current Membership in Professional Organizations**  
IEEE Fellow  
Member of IEEE Robotics and Automation Society  

**Honors and Awards**  
IEEE Robotics and Automation Society Distinguished Service Award, 2009  
NPS Outstanding Research Achievement Award, 1999  

**Service Activities**  

**Internal Activities**  
Committee Chair, Controls TAG, 2001 – present  
Faculty Director, Controls/Robotics Lab, 2010 – present  
Committee Member, ECE Curriculum Committee, 2014 – present  
Course Coordinator for EC2300, EC2320, EC3320, EC4310, and EC4350  
ECE Chair of Department Lab and Facility Committee, 2001 – 2007  
ECE Distinguished Professor Nomination Committee, 2008, 2009, 2014, 2015, 2018  
Co-Chair of Joint ECE/MAE Controls Committee for finalizing the recommendation on jointly offering EC2300 and ME2801 and sharing lab equipment between ECE and MAE departments, 2010  

**External Activities**  
Member of Constitution and Bylaws Committee, IEEE Robotics and Automation Society, 2012
Vice President of Publications, IEEE Nanotechnology Council, 2010
Member of Executive Committee (ExCom), IEEE Nanotechnology Council, 2004 – 2006, 2011 – 2014
Member of IEEE Fellow Evaluation Committee, IEEE Nanotechnology Council, 2005 – 2007
Member of Administrative Committee (AdCom), IEEE Robotics and Automation Society, 2004 – 2012
Member of Executive Committee (ExCom), IEEE Robotics and Automation Society, 2004 – 2011
Member of Conference Activities Board, IEEE Robotics and Automation Society, 1999 – 2007
Associate Editor of IEEE Transactions on Robotics and Automation, 1993 – 1996
Co-Editor of the Special Issue on Mobile Robots, IEEE Robotics and Automation Society Magazine, 1995
General Chair of 2010 IEEE Nanotechnology Materials and Devices Conference (NMDC 2010), Monterey, CA, October 2010

**Significant Publications and Presentations**


Todd R. Weatherford, PhD
Professor, ECE Department
Naval Postgraduate School
Phone: 831 656-3044
trweathe@nps.edu

EDUCATION
Ph.D., Electrical and Computer Engineering, NC State Univ. 1993
M.S., Electrical Engineering, NC State Univ. 1989
B.S., Electrical Engineering, Rutgers University, 1983

EXPERIENCE
Professor (June 2016 – present), Associate Professor (July 2002 – June 2016) TS/SCI
• Naval Postgraduate School, Electrical and Computer Engineering Department, Monterey, CA
• Director - Center for Rad Hard Electronics, Microelectronics Lab, NPS FXR & LINAC
• Research Interests: Microelectronics Reliability, Radiation Effects, Semiconductors
• Advising:
  o PhD students graduated: 8 (1 as Advisor, 1 as Co-advisor, 6 as Committee members)
  o MS students graduated: 84 (47 as Advisor, 6 as Co-Advisor, 31 as Second reader)
    (2 Co-Ad @ CP-CSU SLO)
• External projects funded (PI/Co-PI): Total $6.4M
  o 30+ projects as PI: ($1.09M in CY15, $1.05M in CY14, $558K in CY13, $485K in CY12)

Assistant Professor NPS (1995-2002)
Research Engineer (1990-1995)
  • Naval Research Laboratory, Condensed Matter, SFA contractor
Graduate Research Assistant, NCSU (1985-89)
  • NC State Solid State Laboratory, President NCSU Graduate Student Assoc (1989)
Electronics Engineer – RCA Corporation (1981-85) RCA Adv. Technology Laboratories and RCA Broadcast

PUBLICATIONS
• 36 journal papers (13 1st author, 11 with NPS students)
• 37 conference papers (17 1st author, 30 refereed, 11 with NPS students)
• Hirsch Index - 14

PATENTS
• 2 U.S. issued patents
AWARDS and HONORS

• 2015 GOMAC Best Paper
• 2015 Electronic Materials Symposium - Best Student Poster (M. Wade) NPS Alan Krause Award
Lawrence James Ziomek

Education
BE - Major: Electrical Engineering - Villanova University (1971)
MSEE The University of Rhode Island (1974)

Academic Experience
Naval Postgraduate School
Professor 1995-present (full time)
Associate Professor 1986-1995 (full time)
Assistant Professor 1982-1986 (full time)

Non-academic Experience
Applied Research Laboratory, Department of Ocean Technology, The Pennsylvania State University, State College, PA, Research Assistant, 1976-1982 (full time)

TRW Systems Group, Redondo Beach, CA, Member of Technical Staff, 1973-1976 (full time)

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
None

Honors and Awards
Naval Postgraduate School
Certificate of Recognition for Outstanding Instructional Performance in 1993

Villanova University
College of Engineering Professional Achievement Award (1988)

The Pennsylvania State University
Graduate Program in Acoustics
Kenneth T. Simowitz Memorial Award for outstanding effort in publishing research results (1982)

Eta Kappa Nu
Tau Beta Pi
Sigma Xi
Phi Kappa Phi

Illinois State Scholarship
Service Activities
Internal

ABET Coordinator for the ECE Department, AY2016-present.

Member of the Executive Committee of the Undersea Warfare Academic Group (USWAG), 2009-present.

ECE Department Faculty Mentor, January 2008-December 2016.


Interim Chairman of the Undersea Warfare Academic Group (USWAG) for both the Winter and Spring Quarters of AY2015.

Publications (Last 5 Years)
Note: My book is scheduled to be translated and published in Chinese (Simplified Characters).

Presentations (Last 5 Years)
None

Professional Development Activities
Regular attendance at the Menneken Lecture where guest speakers from academia, private corporations, DOD, and active-duty military present lectures on various topics regarding undersea warfare.
Appendix C – Equipment

Please list the major pieces of equipment used by the master’s level program in support of instruction and attainment of educational goals.

As discussed in Section FACILITIES, II. Laboratories, the ECE Department has 22 laboratories that support the teaching and research mission of the MSEE Program. All of the equipment in all 22 laboratories is described in detail in Section FACILITIES, II. Laboratories. A list of major pieces of equipment is given below:

- semiconductor parameterization equipment, capacitance-voltage measurement equipment, semi-automatic probing station, high speed sampling scopes, logic analyzers, printed circuit assembly tools, Unix and PC workstations, semiconductor parameterization equipment (high power capability), manual probing stations (2+), wire-bonding equipment, and PC workstations
- lasers (including a fiber sigma laser), fiber optics instrumentation including an OTDR, optical spectrum analyzer, connector application equipment, an optical fiber amplifier, optical autocorrelator for pulse-width measurement, various diode laser controllers, RF and microwave instrumentation (signal synthesizer, microwave spectrum analyzer), and general purpose test instrumentation
- scalar and vector microwave network analyzers, spectrum analyzers
- a fully automated anechoic chamber for antenna pattern measurements, as well as a tabletop antenna measurement system
- instrumented radar and electronic warfare equipment
- servo control stations and associated computers that are used to conduct simulations and physical experiments, modeling, analysis, and design of control systems, and multiple mobile robots
- measurement devices and power converter and electric machine modules to assess component operation, develop feedback controls, and study evolving power system challenges
- routers, LAN switches, video processing equipment, ATM switches, a channel simulator, wireless LAN infrastructure, and Windows and Linux workstations
- the NPS Flash X-ray Facility
- cluster computers, GPU systems, FPGA systems, sensor networks, signal analyzers and signal generators
- a solar simulator for bench testing of solar cells and panels
Appendix D

Institutional Summary

Graduate School of Engineering and Applied Sciences
Suite 537, Spanagel Hall
Naval Postgraduate School
Monterey, CA 93943-5117
July 1, 2019

for

Engineering Accreditation Commission
ABET
415 N. Charles Street
Baltimore, Maryland 21201
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1. The Institution

1.1 Name and address of the institution:
Naval Postgraduate School, 1 University Circle, Monterey, CA 93943

1.2 Name and title of the chief executive officer of the institution:
VADM Ann Rondeau, USN (Ret.) President

1.3 Name and title of the person submitting the self-study report:
VADM Ann Rondeau, USN (Ret.) President

1.4 Name the organizations by which the institution is now accredited and the dates of the initial and most recent accreditation evaluations.

NPS is currently accredited by one regional organization and three programmatic organizations. The list of organizations and initial/renewal dates are as follows:

<table>
<thead>
<tr>
<th>Accreditor</th>
<th>Initial Accreditation</th>
<th>Most Recent Renewal</th>
<th>Next Review</th>
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<tbody>
<tr>
<td>WSCUC</td>
<td>1955</td>
<td>2010</td>
<td>Review Fall 2020</td>
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<tr>
<td>ABET</td>
<td></td>
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<tr>
<td>Astronautical</td>
<td>1996</td>
<td>2014</td>
<td>2019</td>
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<td></td>
<td>Engineering</td>
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<tr>
<td>Electrical</td>
<td>1973</td>
<td>2014</td>
<td>2019</td>
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<td></td>
<td>Engineering</td>
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<tr>
<td>Mechanical</td>
<td>1973</td>
<td>2014</td>
<td>2019</td>
</tr>
<tr>
<td></td>
<td>Engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systems</td>
<td>2010</td>
<td>2014</td>
<td>2019</td>
</tr>
<tr>
<td></td>
<td>Engineering</td>
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<td>Systems</td>
<td>2010</td>
<td>2014</td>
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<td></td>
<td>Engineering (DL)</td>
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<td>AACSB</td>
<td>2000</td>
<td>2015</td>
<td>2020</td>
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<tr>
<td>NASPAA</td>
<td>1980</td>
<td>2015</td>
<td>2022</td>
</tr>
</tbody>
</table>

2. Type of Control

NPS Description of the type of managerial control of the institution, e.g., private-non-profit, private-other, denominational, state, federal, public-other, etc.

NPS is a federally funded institution within the Department of the Navy. The President of the Naval Postgraduate School is the academic coordinator for all graduate education programs in the Navy. The President administers fully-funded graduate educational programs at NPS, other service graduate schools and civilian universities.

NPS is assisted and advised by a Board of Advisors, a federal advisory committee, composed of not more than ten members who are eminent authorities in the field of academia, business, national defense and the defense industry, management, leadership,
and research and analysis. All Board members are appointed by the Secretary of Defense, and are appointed to provide advice on behalf of the government on the basis of their best judgment without representing any particular point of view and in a manner that is free from conflict of interest. Those members who are not full-time or permanent part-time federal employees are appointed as experts and consultants under the authority of 5 U.S.C. § 3109, and these individuals serve as special government employees.

The purpose of the Board, under the provisions of the Federal Advisory Committee Act (FACA) of 1972, as amended, shall provide the Secretary of the Navy, through the Chief of Naval Operations and the Presidents of the Naval Postgraduate School (NPS) and the Naval War College (NWC) independent advice and recommendations on matters pertaining to the educational, doctrinal, and research policies and activities of the NPS and the NWC. The Secretary of the Navy or designated representative, on behalf of the Secretary of Defense, may act upon the Board's advice and recommendations.

The board meets at least once a year (fall) in the Washington, DC metro area. The board presents a written report with its advice and recommendations to the Secretary of the Navy, via the Chief of Naval Operations and the Presidents of the NPS and NWC. The Committee Chairperson may present its report in person to the Secretary of the Navy. Website for the Board is at https://my.nps.edu/web/board-of-advisors.

One of the Board’s two subcommittees focusses on matters concerning the Naval Postgraduate School and is comprised of no more than 15 members. This subcommittee meets a minimum of twice annually. The spring meeting shall be held at the campus of the NPS and the fall meeting shall be held in the Washington, DC metro area concurrent with the main committee meeting.

The Chief of Naval Operations ensures that NPS is provided the appropriate resources and policy guidance to accomplish its mission.

3. Educational Unit

Describe the educational unit in which the program is located including the administrative chain of responsibility from the individual responsible for the program to the chief executive officer of the institution. Include names and titles. An organization chart may be included.

The President of the Naval Postgraduate School is the academic coordinator for all graduate education programs in the Navy. The President administers fully-funded graduate educational programs at the Naval Postgraduate School, other service graduate schools and civilian universities.

Reporting to the President on the academic side is the Provost and Academic Dean, who is in turn the supervisor for all four school deans (Graduate School of Engineering and Applied Science, Graduate School of Operational and Information Sciences, School of International Graduate Studies, and the Graduate School of Business and Public Policy) as well as the Vice Provost of Academic Affairs, the Dean of Research, the Dean of
Students, and the University Librarian. Among the administrative staff are: Associate Provost for Faculty Management and Administration, Associate Provost for Graduate Education, Associate Provost for Educational Effectiveness, Director of Academic Administration and Registrar, Director the Center for Educational Design, Development, and Distribution. An organization chart for upper level administration within the school is shown below in Figure 1.
3.1 Overview

The engineering educational unit at NPS is the Graduate School of Engineering and Applied Sciences (GSEAS). GSEAS consists of seven academic departments (Applied Mathematics, Electrical and Computer Engineering, Mechanical and Aerospace Engineering, Meteorology, Oceanography, Physics and Systems Engineering) and three Academic Groups (Space Systems Academic Group, Undersea Warfare Academic Group, and the Energy Academic Group). The chart showing the internal organization of the engineering educational unit (GSEAS) is shown in Figure 2 below.

Figure 2. GSEAS Org Chart (October 29, 2018)
Within the Naval Postgraduate School, GSEAS supports the Navy and DoD by educating future leaders to lead, innovate and manage in a rapidly changing, highly technological world, and by conducting research recognized internationally for its relevance to national defense and academic quality. More specifically, and in support of the mission of NPS and the strategic needs of the Department of the Navy, GSEAS provides advanced technical and scientific knowledge and understanding so graduates:

- understand the capabilities and limitations of current and future technologies in battle space environments;
- understand and apply emerging and advanced technologies to enhanced war fighting capabilities;
- are able to learn, anticipate, respond and lead in future, complex and rapidly changing technological environments;
- are able to represent their organization's technical needs and interests with and within myriad constituencies, to include DoD, the Joint Staff, and industry.

3.2 Traditional Academic Degrees

GSEAS accomplishes the above by offering high quality, traditional academic degrees that include:

- Science and engineering curricula tailored to the needs of naval communities and other DoD constituents;
- Research programs funded by the defense community, aligned to future capabilities--integrated into curricula and courses;
- Education linked to real-world experiences in laboratories, experiments, testing--frequently classified;
- Blending current operational experience of students, emerging technologies, and cutting-edge faculty in both joint and international cultures;
- Life changing education--transforming officers into circumspect technical generalists, sub-specialists and war fighters.

Sustaining cutting edge faculty supported by laboratories aligned to future naval capabilities and enabling technologies that result in up-to-date curricula and programs is essential to assure that graduates are capable of leading and managing future assignments in support of enhanced war fighting and national security.

The Department of Applied Mathematics and the Department of Physics teach mathematics and physics courses in support of engineering programs and perform considerable basic and applied research. The Department of Electrical and Computer Engineering, the Department of Mechanical and Aerospace Engineering, the Department of Systems Engineering, and the Space Systems Engineering Academic Group teach engineering subjects and conduct engineering research.

Clyde Scandrett, Professor and Dean, is the administrative head of the principal education unit for engineering education, GSEAS. There are no additional administrative units within GSEAS.
3.3 Additional Engineering Programs
Within GSEAS there are several engineering programs that are not ABET accredited:

- Master of Engineering (Computer Engineering) and MS in Computer Engineering offered by the Electrical & Computer Engineering Department.
- MS in Electronic Warfare Systems Engineering offered by the Electrical & Computer Engineering Department.
- MS in Engineering Acoustics offered by the Physics Department.
- MS in Systems Engineering Management offered by the Systems Engineering Department.
- MS in Engineering Systems offered by the Systems Engineering Department.
- MS in Engineering Science offered by many departments.

Other engineering programs at NPS not offered within GSEAS that have also not been reviewed by ABET are:

- MS Information Warfare Systems Engineering offered by the Department of Information Sciences, Graduate School of Operational and Information Sciences.
- MS Electronic Warfare Systems Engineering offered by the Department of Information Sciences, Graduate School of Operational and Information Sciences.
- MS Software Engineering offered by the Department of Computer Science, Graduate School of Operational and Information Sciences.
- MS in Systems Engineering Analysis offered in collaboration between the Operations Research and Systems Engineering Departments.

3.4 Engineering Enrollment and Degree Data
Enrollment and degree statistics for the engineering educational unit as a whole and for each program being evaluated for the current and preceding five (5) academic years are shown in Table D-1 (Parts 1-6).

3.5 Engineering Personnel
The number of personnel, both full-time and part-time, for the Departments of Electrical and Computer Engineering, Mechanical and Aerospace Engineering, and the Systems Engineering Program is shown in Table D-2 (Parts 1-3).

3.6 Admission of Students
The general criteria and procedures for admitting students to engineering programs:

i. The NPS Admissions Office evaluates applicants based on three criteria. The result is the assignment of an Academic Profile Code (APC). This is a three-digit code, which summarizes pertinent portions of a student's prior college performance. The three independent digits reflect an individual's cumulative Grade-point Average (GPA), referred to as Quality Point Rating (QPR); exposure to and performance in calculus-related mathematics courses; and exposure to and performance in selected science/engineering areas.
**First Digit:**
The first digit indicates overall academic performance based on a recalculated* GPA from all previous college transcripts. The first digit is derived from the following table:

<table>
<thead>
<tr>
<th>Code</th>
<th>QPR Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.60-4.00</td>
</tr>
<tr>
<td>1</td>
<td>3.20-3.59</td>
</tr>
<tr>
<td>2</td>
<td>2.60-3.19</td>
</tr>
<tr>
<td>3</td>
<td>2.20-2.59</td>
</tr>
<tr>
<td>4</td>
<td>1.90-2.19</td>
</tr>
<tr>
<td>5</td>
<td>0.00-1.89</td>
</tr>
</tbody>
</table>

*Failures and repeated courses are included in the QPA calculation.

**Second Digit:**
The second digit represents mathematical background according to the following criteria and is described in the table below:

<table>
<thead>
<tr>
<th>Code</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Math Major/Minor, Quantitative Economics Degree with B or better average; math taken less than or equal to 7 years ago.*</td>
</tr>
<tr>
<td>1</td>
<td>Lower Level, Upper level, Linear Algebra with a GPA of at least a 3.5; math taken less than or equal to 5 years ago.</td>
</tr>
<tr>
<td>2</td>
<td>Lower Level, Upper Level with average between C+ and B+; math taken less than or equal to 5 years ago. No Linear Algebra</td>
</tr>
<tr>
<td>3</td>
<td>Lower Level Calculus Sequence with a C or better; or if math taken greater than 5 years ago.</td>
</tr>
<tr>
<td>4</td>
<td>Calculus for Business/Social Sciences with a C or better. 1 Lower Level Calculus Course with at least a C-. Two Pre-Calculus with a B or better.</td>
</tr>
<tr>
<td>5</td>
<td>One pre-Calculus with C- or better grade.</td>
</tr>
<tr>
<td>6</td>
<td>No pertinent college-level math with C- or better grade.</td>
</tr>
</tbody>
</table>

*All math courses from calculus through post-calculus are considered when evaluating the transcripts for the second digit. A minimum calculus sequence is Calculus I and II.

**Third Digit:**
The third digit represents previous course coverage in science and technical fields according to the following criteria:

<table>
<thead>
<tr>
<th>Code</th>
<th>Eng/Tech GPA</th>
<th>Meaning</th>
</tr>
</thead>
</table>

302
<table>
<thead>
<tr>
<th>Code</th>
<th>Requirement</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.00 - 4.00 ABET EAC accredited, BS Eng Degree (regardless of time passed)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>&gt;= 2.30 Non-ABET EAC accredited, Eng Degree (regardless of time passed)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>&gt;= 2.30 Any BS Tech degree (regardless of time passed)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>&gt;= 3.00 Completed calculus-based physics sequence with a B average or above</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>&gt;= 2.00 One calculus-based physics course with at least a C</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>&lt;= 1.99 No pertinent technical courses.</td>
<td></td>
</tr>
</tbody>
</table>

**Engineering Degrees include:** Aero/Astro, Computer/Electrical, Mechanical, Materials, Marine, Naval, Ocean, Systems, Industrial, Chemical, and Bioengineering and Naval Architecture. **This list is not exhaustive.**

**Technical degree to include:** Applied Physics, Engineering Physics, Physics

**Engineering/Technical GPA is based upon a 4.0 scale.**

General Engineering and EE/ME Technology degrees are not counted as engineering degrees/technical degrees for purposes of calculating an APC.

When calculating the APC, if the record cannot meet all the requirements to obtain Code 0 (i.e., GPA is 2.75 but all other requirements are met) the Code drops to a 1 automatically but no further.

A first digit code of 0, 1, 2 or 3 (as appropriate) will be assigned only if transcripts provided exhibit at least 75 semester-hours or 112 quarter-hours of actual graded classroom instruction. Grades of Pass/Fail, Credit/No Credit will not count toward the 75/112 hour requirement.

A technical code of 1 or 0 ordinarily is assigned only to an Officer whose undergraduate major was Physics, Aeronautical, Electrical, Mechanical or Naval Engineering, or whose undergraduate technical major is consistent with the Officer's designated occupational specialty. General Engineering degrees and Engineering Technology degrees are specifically excluded from this list of engineering degrees.

If a waiver of the APC is requested, the appropriate Academic Department makes the acceptance decision through the Program Officer and Academic Associate, and the Dean if ultimately required.

ii. There is no history of admission standards for freshmen -- NPS does not enroll students directly from high school.

iii. Advanced placement credits are not utilized by Admissions for evaluating undergraduate transcripts. If there is an inordinate amount of AP credits, the Director of Admissions annotates such on the academic record evaluation.

iv. There are no special admission requirements for entry into the upper division or professional programs in the engineering educational unit, since all NPS
students are admitted into Master’s programs.

v. Policies regarding admission of transfer students from other institutions to the engineering programs are as follows:

The admissions process for all transfer students to NPS, to include engineering programs, is the same process used for all students. An Academic Profile Code is established and the Department reviews the applicant’s package for acceptance or denial. Since the process is the same for both transfer students and all others, the fact that a student is transferring into NPS is transparent to the Admissions Office.

Upon entry to the Naval Postgraduate School, each student's academic record will be evaluated for possible transfer of credit or for exemption from portions of the curricular program by validation of course work previously completed. Twelve hours of graduate-level courses previously completed may be accepted for transfer credit. These include graduate-level courses taken after completion of the baccalaureate degree and those taken in the last term before award of the baccalaureate and certified to be in excess of degree requirements.

NPS generally allows a maximum of 12 graduate-level quarter-credits to be transferred for purposes of earning a graduate degree. However, an additional 12 quarter-credits may be transferred from the Air Force Institute of Technology (AFIT) in Dayton, Ohio. This is in addition to the normal transfer allowed (12), bringing the total to a maximum of 24 quarter-credits transferable from AFIT to NPS.

Permission to transfer a specific course to serve as a substitute for a degree requirement will be determined by the Department Chairman or equivalent person responsible for nominating candidates for degrees at NPS and must be pre-approved in a coherent plan of study for the student. Regardless of transfer credits allowed, all NPS master's degrees still require at least 20 quarter-credits be earned directly from NPS.

vi. There is no history of transfer engineering student statistics -- NPS does not generally categorize students as transfer students. All students are admitted into graduate degree programs. Some credits may be transferred as described above.

3.7 Programs Offered for Accreditation and Degrees Granted

The five programs to be evaluated and the focus of this accreditation process are the following:

1. MS in Astronautical Engineering
2. MS in Electrical Engineering
3. MS in Mechanical Engineering
4. MS in Systems Engineering
5. MS in Systems Engineering, DL

3.8 Requirements for Graduation

The processes used to certify that graduation requirements complying with Engineering Accreditation Commission (EAC) criteria have been met by each graduate are within the engineering departments, not at the college and/or university level. Samples of work
sheets or check-off sheets used for this purpose are available in each engineering department. Meeting EAC criteria is beyond scope of the general Registrar processes at NPS.

3.9 Information Regarding Administrators

Current summary curriculum vitae for the administrative head of the engineering educational unit and associates or assistants who have faculty status or are in responsible charge of a major service unit are provided below.
President Ann E. Rondeau, Ed. D.
Vice Admiral, U. S. Navy, Retired
Naval Postgraduate School
Monterey, California

Retired Vice Adm. Ann E. Rondeau will be appointed as President, Naval Postgraduate School on January 29, 2019. She brings to the assignment an unparalleled record of leadership and achievement within the military and academia in the areas of education, training, research, executive development, change management, and strategic planning. Prior to her appointment, Adm. Rondeau served as the sixth president of the College of DuPage. Her most recent military position was as the President of the National Defense University, a consortium of five colleges and nine research centers in Washington, DC.

Rondeau has extensive leadership experience in significant military and educational roles. In 1985, she was selected and served as a White House Fellow in the Reagan Administration and went on to serve as the Deputy Commander of the U.S. Transportation Command in Illinois, Pentagon Director/Chief of Staff for the U.S. Navy Staff, Commander of the Navy Personnel Development Command in Virginia, Commander of the Naval Service Training Command at Great Lakes, Ill., Pacific Fleet Staff Chief of Staff in Hawaii, Commanding Officer of Naval Support Activity in Tennessee and other staff and commanding responsibilities with policy, support and student service. Rondeau retired from the U.S. Navy as a three-star admiral in 2012 and was the second woman to have achieved that rank in the Navy. She then served as a partner and later an independent consultant with the IBM Watson group.

Rondeau holds a B.A. from Eisenhower College (NY), an M.A. from Georgetown University (DC) and an Ed.D. from the College of Education at Northern Illinois University in DeKalb. She also holds an honorary Doctorate in Public Service from Carthage College (Kenosha, WI) and an honorary Doctorate in Humane Letters from Rosalind Franklin University of Medicine and Science (Chicago, IL).

She is proud member of the Arizona State University Flag Officer Advisory Council, the National Museum of the American Sailor Foundation Board of Directors, the Military Advisory Board (under the aegis of Center for Naval Analysis), the Dwight D. Eisenhower Memorial Commission, the Chicago Regional Growth Corporation Board, Choose DuPage Board of Directors, and the Council for Higher Education Accreditation. Additionally, Dr. Rondeau serves on the Executive Board of the U.S. Navy “Education for Seapower Study” —a clean-sheet review of naval learning.
Dr. Steven R. Lerman
Provost, Naval Postgraduate School
Naval Postgraduate School
Monterey, California

Dr. Steven R. Lerman assumed the position of Provost and Academic Dean of the Naval Postgraduate School on August 29, 2016.

Dr. Lerman comes to the Naval Postgraduate School following more than 40 years of experience in higher education, most recently serving as Provost and Executive Vice President of Academic Affairs at The George Washington (GW) University (2010-2015) and A. James Clark Professor of Civil and Environmental Engineering (2010-2016). As Provost, Dr. Lerman was responsible for GW’s 10 schools and colleges, athletics (24 Division I varsity sports, club sports and intramurals), the Division of Student Affairs and the University Library. Approximately 4,900 full and part-time faculty and staff report up through these units with a combined budget of $580 million. Dr. Lerman was also responsible for all academic and student life aspects for three GW campuses (Foggy Bottom, Mt. Vernon and the Virginia Science and Technology Campus) as well as at the university’s three learning centers.

Prior to GW, Dr. Lerman served as Dean for Graduate Education (2007-2010) and Vice Chancellor (2008-2010), at his alma mater, the Massachusetts Institute of Technology (MIT). In this capacity, Dr. served as the chief deputy to the Chancellor who has responsibility for student affairs, undergraduate education and graduate education.

Dr. Lerman has served as Director of the Center for Educational Computing Initiatives, the research unit of an MIT-wide research center devoted to studying the application of computational and communication technologies on education. He held the Class of 1922 Professorship at MIT, chaired the Faculty Advisory Boards of the MIT OpenCourseWare initiative and Academic Media Production Services, and was Deputy Director of the Singapore-MIT Alliance, MIT’s largest distance education program. He served as the Chair of the MIT faculty from 1998 to 2001 and as Associate Chair of the Faculty from 1996 to 1998.

Dr. Lerman is a past Lilly Teaching Fellow, and the recipient of several teaching awards during his time at MIT, including the Maseeh Teaching Award, as well as the Advisor of the Year award through the National Association of Graduate and Professional Students. He has both chaired and served as a member of countless academic, industry and government advisory boards, and has broadly published in his field of transportation systems analysis.

Dr. Lerman received his Bachelor of Science and Master of Science degrees in Civil Engineering, and his Doctorate in Transportation Systems Analysis, from the Massachusetts Institute of Technology.
Dr. Clyde Scandrett was appointed Dean of the Graduate School of Engineering and Applied Science in December 2014. He is a former chair of the Department of Applied Mathematics (2002-2008) and twice Chair of the Undersea Warfare Academic Group (2000-2002 and 2011-2014).

Dr. Scandrett received his undergraduate degree from the California Institute of Technology in 1976, and received his doctorate in Engineering Sciences and Applied Mathematics from Northwestern University in 1985. His research interests are primarily in the field of wave propagation having several publications in the Journal of the Acoustical Society of America, Wave Motion, and the Journal of Computational Physics. Dr. Scandrett continues his support of the Mine Warfare Community in his involvement with biennial symposia focused on the Mine problem and in editing past proceedings. Prior to his arrival at the Naval Postgraduate School in 1987, Dr. Scandrett also worked for two years as an assistant research scientist at the Supercomputer Computations Research Center at Florida State University.
Colonel Timothy Sands is the Associate Dean of the Graduate School of Engineering and Applied Sciences with a faculty appointment at the rank of Associate Professor. The Associate Dean serves the graduate education of more than nine-hundred students in resident & distance-learning programs; managing daily operations of more than two-hundred fifty faculty and staff in seven academic departments; and ensuring safe operations of ninety scientific laboratories including planning and execution of the school's $20M+ annual mission-budget, overseeing externally funded research programs exceeding $35M; and furthermore serving as the senior Air Force officer & liaison on the Navy installation, advising the university President on air force collaboration and students.

Colonel Sands entered active military service in 1993 as program manager for the acquisition of space systems. He later became a career electronic warfare officer and flew combat missions in the B-52 heavy bomber in Serbia, Kosovo, Afghanistan, and Iraq. Dr. Sands served as a weapons officer, an instructor, an evaluator, a professor and researcher, and research center director, associate provost, chief academic officer, and dean. He earned the bachelors, masters, and professional degrees in mechanical engineering from NC State University, Stanford University, and Columbia University respectfultly, and the doctorate in astronautical engineering from the Naval Postgraduate School.
Dr. Hobson is a professor and chair in the Department of Mechanical and Aerospace Engineering specializing in experimental and computational turbomachinery problems. He has more than 60 journal and refereed conference publications in this field. His current research interests are in transonic fan and compressor aerodynamics, stall precursors, inlet distortion, cross flow fan propulsion, mini gas turbines for UAV propulsion, transitional flows in compressor cascades, erosion of compressor blades due to sand ingestion, high cycle fatigue and signature suppression. He has been the director of the Turbopropulsion Laboratory since 2005 and had managed a yearly budget of more than $1.0M. He joined the Naval Postgraduate School in 1990 as an associate professor in the Department of Aeronautical and Astronautical Engineering. This after his PhD in Aerospace Engineering at the Pennsylvania State University in 1989. His thesis was on the Fully Elliptic Calculation of Turbomachinery Flows. Prior to that he worked at the National Institute for Aeronautics and Systems Technology as head of the Aerothermodynamics Group. He oversaw the design of the turbine, or hot section, of a small gas turbine. Prior to that he worked on modification of aircraft exhaust systems for passive countermeasures against heat-seeking missiles. His design using transpiration cooling earned him the Directors award for Innovative Engineering. He received his MSc in Mechanical Engineering (1983) and BSc in Aeronautical Engineering (1979) both from the University of the Witwatersrand, Johannesburg. His Masters thesis was on transpiration cooled boundary layers. Dr Hobson has been a consultant to DENA (Duke Energy).
Dr. Ronald E. Giachetti, is the Chair and Professor of Systems Engineering at the Naval Postgraduate School (NPS) in Monterey, California. He teaches and conducts research in the design of enterprise systems, systems modeling, and system architecture. He has published over 50 technical articles on these topics including a textbook on the *Design of Enterprise Systems: Theory, Methods, and Architecture*.

At the Naval Postgraduate School he leads the systems engineering department consisting of 45 faculty and staff serving 450 students in resident and distance learning programs. In addition to managing the department, he teaches courses in system of systems engineering and system architecture.

He is internationally known for his work in enterprise systems, having lectured in Colombia, Peru, Mexico and other countries, participating in the National Research Foundation of Chile, and as a member of IFAC’s technical committee on enterprise integration. Prior to joining NPS, he was an Associate Professor of Industrial and Systems Engineering at Florida International University in Miami, FL. At FIU he developed and led the MS in Information Systems program and actively taught in external programs in Jamaica, Mexico, Colombia, and Peru. He has conducted $1M in externally funded research for the Navy, NSF, US Army, US Air Force, Royal Caribbean Cruise Lines, Carnival Cruise Lines, and other Florida companies. He was a National Research Council postdoctoral researcher in the Manufacturing Systems Integration Division at the National Institute of Standards and Technology (NIST) in Gaithersburg, MD. He earned a Ph.D. in Industrial Engineering from North Carolina State University in Raleigh, NC in 1996; a MS in Manufacturing Engineering from Polytechnic University in Brooklyn, NY in 1993; and a BS in Mechanical Engineering from Rensselaer Polytechnic Institute in Troy, NY in 1990.
Douglas J. Fouts
Professor and Chairman
Department of Electrical and Computer Engineering Naval Postgraduate School
Monterey, CA

Douglas J. Fouts has been the Chair of the Department of Electrical and Computer Engineering since April 1, 2019. Prior to that he served the ECE department as the Associate Chair for Research from September 2017 until April 2019 and as the Associate Chair for Instruction from July 2015 until September 2017. He has been a Professor in the department since 2003, was an Associate Professor from 1996 until 2003, an Assistant Professor from 1990 until 1996, and he has held a secondary appointment in the Space Systems Academic Group since 1991. He has also served as the Naval Postgraduate School Interim Vice President and Dean of Research from January 2012 until Jul 2012 and as the Associate Dean of Research from July 2006 until January 2012. He also worked in industry as a design engineer at Burroughs Corporation (now Unisys) from 1980 to 1983 and at The Aerospace Corporation in 1979. Prof. Fouts received his PhD and MS in Electrical and Computer Engineering from the University of California at Santa Barbara in 1990 and 1984, respectively, and his bachelor’s degree in Computer Science from the University of California at Berkeley in 1980. The primary area of teaching and research for Prof. Fouts is Computer Engineering, although he also teaches courses in electronics. Over the years he has been successful at keeping the Computer Engineering courses offered by the department current with rapidly-developing new technology by developing courses in Fault Tolerant Computing (EC4810), VLSI Design (EC4870), Advanced Computer Architecture (EC4820), FPGA Design (EC4830), Embedded Computer Systems (EC3800), and Spacecraft Computing (SS3035). Prof. Fouts has had a very active research program over the years that includes both unclassified and classified work. His current research interests include reconfigurable computing, FPGA design, embedded computer systems, and reverse engineering. His unclassified research has resulted in the publication of over 45 papers in scholarly journals and refereed conferences and he holds 6 US patents. He has advised or co-advised over 100 MSEE theses and PhD dissertations at the NPS. Prof. Fouts received the Menneken Award for Excellence in Scientific Research in 2002, the Outstanding Research Achievement Award for the Department of Electrical and Computer Engineering in 1997, the Outstanding Instructional Performance Award for the Space Systems Academic Group in 1996, and the Outstanding Research Achievement Award for the Space Systems Academic Group in 1993. He is a member of the Institute of Electrical and Electronics Engineers, the American Radio Relay League, and he is a registered professional Electrical Engineer in the state of California. He is also an accomplished trombonist and the Scoutmaster for Boy Scout troop 93.
4. Academic Supporting Units

Supporting academic departments that provide required portions of the instruction for engineering students in the programs being evaluated are the Department of Operations Research in the Graduate School of Operational & Information Sciences, the Space Systems Academic Group, the Department of Physics, and the Department of Applied Mathematics, the latter three in GSEAS.

5. Non-Academic Support Units

There are no non-academic support units at NPS that support only the engineering academic programs. All non-academic support units that support academic programs at NPS are consolidated at NPS level.

5.1 Dudley Knox Library (DKL)

5.1.1 Mission:

*Dudley Knox Library contributes to learning, research and teaching—anytime, anywhere—through relevant and evolving collections, tools, services, and spaces designed for NPS patrons of today and tomorrow.*

5.1.2 Vision:

*The Dudley Knox Library is a dynamic and collaborative partner with members of the NPS community that is dedicated to advancing knowledge through integrated resources, responsive services, library instruction, and research assistance. We work together to promote NPS’s position as a top-tier graduate-level teaching and research institution that fosters lifelong learning. DKL is a flexible, agile organization that measures and continually assesses our quality, relevance and effectiveness as we support the NPS strategic plan.*

5.1.3 Leadership:

Edward M. Corrado is the chief administrative officer and Director of the Dudley Knox Library. His responsibilities include providing vision and leadership for the Library and campus in accordance with and in support of the NPS mission and strategic plan, managing a budget of approximately $5.5 million. Mr. Corrado joined NPS in 2017. Prior to joining the Naval Postgraduate School he was the Associate Dean of Library Technology Planning and Policy and Interim Dean of Special Collections at the University of Alabama. He was also the Director of Library Technology at Binghamton University. His research interests include digital preservation, data management, cloud computing, and reproducibility of library and information science research. He is the co-author of Digital Preservation for Libraries, Archives, and Museums, which is now in its second edition. He has a Masters of Library Service from Rutgers University and a Bachelor of Arts in Mathematics from Caldwell University.
5.1.4 Scholarly Content:

The Library provides access to a robust suite of eBooks, eJournals and databases plus a core print collection that supports NPS graduate instruction and research needs. DKL provides access to ~86% of the top-ranked engineering and applied science journals based upon InCites Journal Citation Reports dataset (updated September 9, 2017). We also provide access to thousands of additional scientific journals covering many disciplines (search here: https://nps.primo.exlibrisgroup.com).

Like other academic libraries, DKL continues to experience high annual subscription price increases for our scholarly content (11.3% annual price increase over 2015-2017 alone). Such increases, coupled with similar increases in databases, software, and personnel costs, makes it increasingly difficult for us to maintain current levels of subscription spending to as many resources as our faculty and students require. In this environment of escalating costs we regularly engage our stakeholders and monitor usage statistics to best leverage our limited resources to support the NPS mission.

We facilitate discovery of engineering and applied science information through subscriptions to a range of specialized and interdisciplinary databases (with and without full-text) including: Aerospace Research Central (AIAA), American Society of Mechanical Engineers (ASME), IEEE Explore, INSPEC, Janes’, JSTOR, Meteorological and Geoastrophysical Abstracts, ProQuest, Web of Knowledge, and many more.

Because no library is an island we routinely provide “just in time” document delivery and interlibrary loan services that rapidly obtain materials for our students and faculty from other academic and federal libraries.

5.1.5 Seamless Access:

The library website (https://library.nps.edu) provides the portal to our information resources as well as a wide range of student- and faculty-academic support services. Over recent years library staff reviewed web analytics, conducted usability studies, and created “personas” of our three key users – resident students, distributed learning (DL) students, and faculty to help us understand our patrons. Armed with this information we comprehensively redesigned our website with a focus on making it “user-centric.” The resulting site emphasizes patrons’ top activities to simplify their access to information and associated services. We continue to gather feedback and make continuous improvements to the site. Other libraries as well as the team behind the redesign of the NPS institutional website have adapted many of our process and best practices.

In 2017 we launched a cutting-edge, cloud-based, access and discovery system that gives our patrons a more “Google/Google Scholar-like” search experience. A single search box on the library homepage enables users to quickly search across both resources and disciplines to retrieve results from print, online and data sources at the journal or book title level down to the journal article or book chapter level. Putting more resources into the hands of our patrons through this consolidated search helps users rapidly locate appropriate resources and know which sources are available for more advanced search protocols.

A team of four reference librarians provide the primary reference assistance and instruction services to campus. An additional four librarians also support individual departments and
disciplines. We offer drop-in research-related workshops: Research Quick Start I & II and Thesis Quick Start, as well as visits to classrooms to provide discipline-specific information modules.

5.1.6 Institutional Memory:

Named for NPS’s first faculty member, Calhoun, the NPS institutional archive ([https://calhoun.nps.edu](https://calhoun.nps.edu)) is a highly searched and centralized archive of NPS-authored works. Built on open-source software, Calhoun provides worldwide access to more than 55K items including theses and dissertations (dating from the early 1920’s); faculty-authored journal articles, book chapters, and technical reports; and institutional publications. Resources have permanent handle-style URLs that are discoverable from Google, Google Scholar and other locations and used for many purposes at and beyond NPS.

In a parallel effort to promote and provide access to NPS-authored works that are “restricted through classified,” we created an internal online portal to provide access to NPS restricted theses, dissertations and technical reports from 2001 to present. We also created and continue to curate NPS’ presence on classified networks to raise awareness of NPS research efforts.

Both Calhoun and our restricted resources have proven to be extremely well utilized centralized repositories for public access to NPS-authored and institutional content. Ongoing collaborations with the Defense Technical Information Center (DTIC) ([http://www.dtic.mil](http://www.dtic.mil)) enriches their databases and provides broader access to NPS-authored scholarly works and associated data.

5.1.7 Peer Comparisons:

Dudley Knox Library provides annual statistical inputs to the Integrated Postsecondary Data System (IPEDS) and the Association of College and Research Libraries (ACRL). This enables us to benchmark our staffing and spending against two groups of peer academic libraries (peer groups defined by NPS: NPS Research Peer Institutions and NPS Peer Institutions). While our library is currently understaffed as compared to peer libraries, our total spending (labor, content and operations) is comparable. Despite our staff vacancies (exacerbated by hiring freezes, recent retirements, and the climbing cost of serials pressuring our relatively level budget), DKL has excellent service to our community as demonstrated through faculty feedback and graduating student surveys.
5.2 Graduate Writing Center (GWC)

5.2.1 Mission:

To develop the writing and critical thinking skills of NPS students for success in graduate school and as military and civilian leaders.

5.2.2 Leadership:

Dr. Sandra Leavitt has been the Director of the Graduate Writing Center and Thesis Processing Office at the Naval Postgraduate School since 2012. With a budget of approximately $1.5 million, she supervises writing coaches and language instructors while providing tutorials and hands-on workshops for resident and distance learning masters and doctoral degree thesis students. She holds the title of research assistant professor with a 2007 doctorate in Comparative Politics and International Relations from Georgetown University.

The GWC provides all new students with an overview of expectations for graduate-level research and writing through its Foundations of Academic Writing seminar.

The Graduate Writing Center offers individualized, one-to-one coaching to help NPS students develop the critical thinking, writing, and communication skills necessary for success at NPS and in their future assignments.

Additional GWC services include a rich variety of hands-on workshops, tutorials, online resources, and learning tools to help students advance their critical thinking and develop their academic communication, research, and writing skills.

Workshops are offered in person and many are recorded to provide just-in-time refreshers.

5.3 Thesis Processing Office (TPO)

5.3.1 Mission:

Publish high-quality theses, dissertations, and capstone reports that reflect NPS’s commitment to quality, service, academic integrity, and expansion of knowledge.

Thesis processors provide tutorials for using NPS-specific Word and LaTeX templates for the preparation and publication of theses and dissertations. TPO staff work closely with students and their advisors on applying DoD distribution markings, proper attribution, and copy editing to their capstone reports. International students have free editing available to them. Thesis
processors prepare for publication public release as well as restricted through Top Secret theses and dissertations. Thesis Processing also produces *Compilations of Abstracts (COAs)* covering all of NPS and specific academic groups, such as undersea warfare, cybersecurity, and energy. Public release theses and COAs are accessible via the Library’s Calhoun repository as well as the Defense Technical Information Center (DTIC), while access to restricted through classified publications is provided through other avenues (including DTIC) for access by authorized individuals.

### 5.4 Information Technology and Communications Services (ITACS)

#### 5.4.1 Mission:

*The Information Technology and Communications Services (ITACS) department provides technological and communications support for the entire voice, video and data infrastructure of NPS. This support encompasses national and international students enrolled in both residential and Distance Learning (DL) programs, all requiring robust and flexible educational delivery systems and research capabilities.*

#### 5.4.2 Leadership and organization:

The ITACS department is led by Mr. Joe LoPiccolo, Director, Information Technology and Communications Services and Chief Information Officer, and is comprised of 52 civilian staff, organized as below.

#### 5.4.3 Operations:

**5.4.3.1 Client Services:** Client Services is made up of Educational Technologies, the Technology Assistance Center, and Classified Computing Programs.

a. The **Educational Technologies** team provides campus-wide support of the technology in all NPS’ shared learning spaces and audio-visual (AV) systems used in teaching both resident and non-resident students. This includes oversight of 12 computer labs, 8 VTC/Video Tele-Education (VTE) systems, 86 smart classrooms, 21 technology smart conference facilities, 135 software packages and several virtual environments with over 300 virtual machines. Educational Technologies also maintains the Sakai Collaborative Learning Environment (CLE), web-based collaboration, streaming and on-demand video systems, on-campus podcasting, and the robust video tele-education infrastructure including a 60-port Video Bridge.

b. The **Technology Assistance Center (TAC)** is the primary means of IT support for students and faculty. The TAC handles the level one, two and three support calls, including hardware support for faculty, staff, resident students, and DL students. In a typical month the TAC will respond to approximately 1,400 phone calls, 300 walk-ins, and 1,000 emails.

c. The **Classified Computing Program (CCP)** provides staff and infrastructure to support the operations of the University’s three classified networks. Leveraging the expertise found in ITACS’ other functional areas, CCP supports classrooms, computer labs, secure video teleconferencing, distance learning, conferences, and seminars in the Sensitive Compartmented Information Facility (SCIF), Systems
Technology Battle Lab (STBL), the Dudley Knox Library, Watkins Hall, and in various auditoria and lecture halls around campus, as needed.

5.4.3.2 Research Computing: Research Computing provides support for High Performance Computing (or HPC, also known as Supercomputing), Linux computing, Machine Learning/Artificial Intelligence, and Big Data/Data Analytics (Hadoop). The HPC Data Center was established in 2009, and currently hosts approximately 400 users (students, faculty, staff, and their collaborators) that are using the computers for teaching and research. As of May 2018, the systems in the HPC datacenter have approximately 5,570 CPU "cores" across 124 servers, and over 3 Petabytes of disk storage. The users of the systems typically are running models and codes that require immense amounts of computing power and storage that would otherwise require them to obtain resources on systems outside of NPS. Several new faculty members have come to NPS in part because of the availability of the NPS Research Computing resources.

5.4.3.3 Resources Management: This includes IT Asset Management; Contract Administration; Financial Management; Facilities Management; and Human Resources.

The Development Operations (DevOps) team consists of three primary groups including Application Development, Cyberinfrastructure and Unified Communications:

a. The Application Development team provides integrated, comprehensive technology solutions that enable NPS to streamline and improve its business processes and practices. This includes the technical implementation of the NPS public web site (www.nps.edu), the NPS Intranet web site, maintenance and administration of over 50 locally developed and commercial web applications, development of new web applications, administration of approximately 310 relational databases on more than 30 instances of database servers (Microsoft SQL Server, Oracle, and MySQL), implementation and maintenance of an academic information data warehouse, implementation and maintenance of a web-based issue tracking and project management system, and implementation and maintenance of web-based collaboration tools, such as an Enterprise Wiki and SharePoint. Examples of major applications that the team supports include the NPS student management system (known as “Python”) and an open source financial management system, Kuali Financial System (KFS). Additionally, the team provides assistance to researchers in the areas of database administration, application administration, and application development.

b. Cyberinfrastructure (CI) operates five distinct physical networks connecting more than 7,500 wired and wireless edge devices. The largest is the EDU network with a 100 Gigabit per second (Gb/s) connection to the Corporation for Education Network Initiative in California’s (CENIC) Digital California (DC) network backbone for commercial Internet and the High-Performance Research (HPR) networks for Internet2, U.S. Department of Energy’s Energy Sciences Network (ESnet), National Lambdarail (NLR) and other research capabilities. The datacenter houses 335 physical and virtual servers. CI manages the enterprise backup system and is also responsible for the infrastructure for telephone and
network cabling and the physical plant, including construction/remodeling projects across campus.

c. The **Unified Communications** team supports all of the e-mail, telephone, VoIP, cell phone, Blackberry and video tele-conferencing communications at NPS.

**5.4.3.4 Cybersecurity:** The Cybersecurity (CS) team is responsible for securing the networks and data on campus including computer network defense and monitoring, anti-virus and vulnerability management, operating system and application patch management, certification and accreditation of networks and applications, and provides the tools and technologies to find, protect, and react to the unauthorized disclosure of sensitive privacy data on NPS networks. CS provides measures that protect and defend information and information systems by ensuring their confidentiality, integrity, availability, non-repudiation and authentication. This includes Computer Network Defense for intrusion detection, network monitoring, and restoration of information systems.

The team liaises with third parties throughout DoD, DON, the greater academic community, as well as state and local government organizations to maintain currency with the latest cybersecurity and privacy policies, guidelines, threats, and vulnerabilities. Additionally, the team delivers relevant and timely Cybersecurity and Privacy training to the campus user population as well as collaborates with faculty and students on Cybersecurity-relevant Research topics. Recently, the team established an EDU Cybersecurity Operations Center (CSOC) that provides around the clock CS support to the campus and other DoD educational partners including the US Naval Academy, the US Naval War College, and the Defense Language Institute-Foreign Language Center.

**5.4.4 Communications Services, Partnerships and Outreach**

The IT Strategic Plan, *Enabling the Mission*, informs planning and policy decisions for the department. The Information Technology Council, comprised of representatives from every major academic area as well as a number of administrative departments, acts as the advisory group for planning and implementation of initiatives while under the strategic direction of the IT Executive Council led by the NPS Provost.

Information Technology and Communications Services provides the following campus-wide services, which also support all areas of engineering at NPS:

1. Accounts: 6,054
2. Active Phone Lines: 989 digital; 728 VoIP; 2,059 analog
3. Audio-Conferencing Ports: 24
4. ISDN Video-Conferencing Circuits: 60
5. Video-Conferencing Facilities: 49
6. Video Tele-Education Systems: 8
7. Sixty Port Multipoint Control Unit (MCU)/Video Bridge: 1
8. Multimedia Presentation Systems: 130
9. Backup Data combined: 442.8 terabytes
10. E-Mail Stored: 29.6 terabytes
11. Client E-Mail Quotas—unlimited
Client Storage Quotas—unlimited
External E-Mail Received: 29,503,038 per year
Internet Traffic: 3.1 terabytes per day
Network Attached Systems: 5,451
Campus Wireless bandwidth—1 gigabytes
Campus Wireless traffic—2.6 terabytes per day
Campus Wired Network—Software Defined Network (1st in DoD)
Campus Internet Connection—100 Gigabits—(1st in DoD)
Networks: 5
User Data: 595.2 terabytes
Web Services:
  Extranet: page views: 6,850,655 per year
  Intranet: page views 1,641,144 per year

Additionally, the Monterey Peninsula Department of Defense Net (DoDNet) provides fiber-optic connectivity from NPS to local DoD assets including the Defense Language Institute-Foreign Language Center and Presidio of Monterey, the Defense Manpower Data Center, Fleet Numerical Meteorology and Oceanography Center, the Naval Research Laboratory Monterey detachment, and the National Weather Service, enabling these properties to abandon commercial leased services and save resultant costs.

5.4.5 Facilities
The following facilities offer support to engineering programs:

- Twenty-nine classrooms, equipped with multimedia projection systems and instructor computers
- Eight video-tele-education classrooms augmented with videoconferencing technology, specialized video display systems, instructor computer, document camera, live streaming and capture technology, microphones, speakers and digital audio-visual routing consoles.
- Fifteen Learning Resource Centers (some specifically used by engineering), which includes secure labs that maintain circuit layout and design software, programming and simulation software; and some with thirty-four computer workstations, a multi-function device, and multi-media system used for classroom-level instruction.

5.4.6 High-Performance computing (HPC)
HPC includes supercomputer systems, storage and archiving systems, Linux-based scientific workstations, visualization systems, high-speed networks, special purpose and experimental systems, and application and systems software needed to make these systems useful. The HPC resources at NPS include the following:

5.4.6.1 Hamming
Hamming is a general-purpose heterogeneous supercomputer. First installed in 2009 and refreshed several times since, the cluster's name commemorates the internationally renowned mathematician Richard Hamming, who was a Professor of Mathematics at NPS from 1976 until his passing in 1998. With 4270 cores and over 18 Terabytes of available
memory, the Hamming supercomputer is a formidable resource for research needs and classroom use alike. Ten of Hamming's 81 compute nodes also feature GPUs for appropriate applications, and a large curated collection of proprietary and open-source software is available.

5.4.6.2 Grace
Grace is a cluster for "big data" research using the Hadoop distributed filesystem and Spark in-memory processing system. First installed in 2015, this subsystem is named after RDML Grace Hopper, a pioneer in computer science and information theory whose significance to the US Navy and her field will be remembered for generations. Whereas Hamming is suited for simulations, where code on multiple machines can "pull in" data as needed, Grace's model is the opposite: the code is deployed to the data, which is stored across multiple compute nodes, for processing "in place." These intermediate results can then be combined incrementally to give research insights. This model makes Grace suited for real-world data sets that are too large for processing directly.

5.4.6.3 Maserati
Maserati is a fast data transfer point, connected directly to the CENIC research network. Maserati is a data transfer node (DTN) connected via a 100Gb/s link, and participates in the Pacific Research Platform. This network is especially useful for researchers who want to share data with colleagues at other institutions along the west coast, including California universities, Department of Defense research laboratories, and Department of Energy computing facilities.

5.4.6.4 Bowditch
Bowditch is a platform for "cloud-native" computing applications. The system is named after the mathematician Nathaniel Bowditch, whose work in navigation is still important to navies and sailors today over 200 years after his death. Bowditch is a generic "container" platform, using some of the same tools that power the likes of Google and Amazon. Resources already developed on Hamming or Grace can be accessed from Bowditch using the unified high-speed cluster network or deployed to cloud services such as Amazon Web Services (AWS) when more scalability is needed. Still under development, Bowditch will be used for applications such as neural network training, artificial intelligence, and machine learning.

5.4.6.5 Existing Use
The current user base consists of over 400 users from over a dozen departments, institutes and academic groups, and includes NPS faculty, students, distance learning students, and partner institutions (e.g. Naval Academy, NRL, AFRL). Workloads include weather forecasting, arctic ice prediction, turbo-propulsion modeling, digital forensics, image recognition, and many other topics related to the DoD mission.

5.4.6.6 Classified HPC
Although this is currently outside the scope of the current use of HPC resources, our users have expressed a strong desire to have similar HPC resources available on the classified side. This is an important area for further investigation and consideration.
6. Credit Unit
NPS courses are listed with two numbers in parentheses separated by a hyphen, which indicate the hours of instruction per week in the classroom and in the laboratory respectively. When calculating quarter-hours for the credit value of the course, laboratory hours are assigned half the value shown. Thus, a (3-2) course, having three hours of lecture and two hours of laboratory, will be assigned a credit of four quarter hours.
NPS operates year round, with four twelve-week quarters. Included in each quarter are final examinations and an enrichment week.

6.1 Course Credit for Master's Thesis Work
Credit hours of 0 lectures, 8 laboratories (0-8) will be granted for each thesis slot registered for provided it is on the student's course matrix. Thesis credit shall be graded pass/fail, thus it is not used in computation of the student's QPRs.

6.2 Credit Hour Policy
A credit hour is an amount of work represented in intended learning outcomes and verified by evidence of student achievement that reasonably approximates not less than:

6.2.1 One hour of classroom or direct faculty instruction and a minimum of two hours of out-of-class student work each week for approximately ten to twelve weeks for one quarter hour of credit, or the equivalent amount of work over a different amount of time; or
6.2.2 At least an equivalent amount of work as required in paragraph (1) of this definition for other academic activities as established by NPS, including laboratory work, internships, practica, and other academic work leading to the award of credit hours.

7. Tables
<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Enrollment Year</th>
<th>Total Undergrad</th>
<th>Total Grad</th>
<th>Degrees Awarded</th>
</tr>
</thead>
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Note:
Shaded areas are not applicable.
All enrollment data is from the fall term of each academic year.

(Return to Educational Unit Overview)
Table D-1 (Part 2). Program Enrollment and Degree Data
Astronautical Engineering

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Enrollment Year</th>
<th>Total Undergrad</th>
<th>Total Grad</th>
<th>Degrees Awarded</th>
</tr>
</thead>
<tbody>
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<td>2nd</td>
<td>3rd</td>
<td>4th</td>
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Shaded areas are not applicable.
All enrollment data is from the fall term of each academic year.
Table D-1 (Part 3). Program Enrollment and Degree Data

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Note:
Shaded areas are not applicable.
All enrollment data is from the fall term of each academic year.
Table D-1 (Part 4). Program Enrollment and Degree Data

Mechanical Engineering

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<tr>
<th>Academic Year</th>
<th>Enrollment Year</th>
<th>Total Undergrad</th>
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<td>1st 2nd 3rd 4th 5th</td>
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Note:

Shaded areas are not applicable.
All enrollment data is from the fall term of each academic year.
Table D-1 (Part 5). Program Enrollment and Degree Data
Systems Engineering (Resident)

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<th>Academic Year</th>
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Note:
Shaded areas are not applicable.
All enrollment data is from the fall term of each academic year.
Table D-1 (Part 6). Program Enrollment and Degree Data
Systems Engineering (DL)

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<th>Academic Year</th>
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</table>

Shaded areas are not applicable.
All enrollment data is from the fall term of each academic year.

(Return to Education Unit d. Program Enrollment and Degree Data)
## Table D-2 (Part 1). Personnel

Department of Electrical and Computer Engineering

Year: 2019

<table>
<thead>
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<th></th>
<th>HEAD COUNT</th>
<th>FTE</th>
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<tbody>
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<tr>
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<tr>
<td>Lecturers, Sr. Lecturers, &amp; Prof. of Practice</td>
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<tr>
<td>Technicians/Specialists</td>
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<tr>
<td>Office/Clerical Employees</td>
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</tr>
<tr>
<td>Faculty Associates – Research</td>
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¹Department Chair, 0.25 FTE for Associate Chair Fargues, 0.25 FTE for Associate Chair Kragh, and 0.25 for Associate Chair (Fouts)

²Excludes Department Chair and 0.75 FTE each for tenured Professor Fargues, Kragh, and Fouts
## Table D-2 (Part 2). Personnel

Department of Mechanical and Aerospace Engineering

Year: 2019

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<tr>
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<tr>
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<sup>1</sup>Department Chair

<sup>2</sup>Excludes Department Chair

<sup>3</sup>Learning Support Systems
### Table D-2 (Part 3). Personnel

Department of Systems Engineering

Year: 2019

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</thead>
<tbody>
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<tr>
<td>Administrative(^1)</td>
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<tr>
<td>Faculty (tenure-track)(^2)</td>
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<tr>
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<tr>
<td>Lecturers, Sr. Lecturers, &amp; Prof. of Practice(^3)</td>
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<tr>
<td>Technicians/Specialists</td>
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<tr>
<td>Office/Clerical Employees</td>
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<tr>
<td>Faculty Associates – Research or Education</td>
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</tbody>
</table>

\(^1\)Includes Department Chair & Associate Chair for Distributed Programs & Outreach - Owen.
\(^2\)Excludes Department Chair
\(^3\)Excludes Associate Chair for Distributed Programs & Outreach - Owen.

Return to Educational Unit in Main Document