# ECEE Department Strategic Plan 2021

## Executive Summary

The Electrical, Computer, and Energy Engineering (ECEE) Department at the University of Colorado Boulder is a community of faculty and staff committed to providing world-class education and research opportunities for our undergraduate and graduate students. Our goal is to prepare them for a lifetime of innovation and leadership in Colorado, the nation, and the world in response to the grand challenges of our time and the changing needs of society.

We aim to be among the leading electrical and computer engineering departments in the world. In a vibrant and inclusive environment, we strive towards the creation of a smarter, healthier, better connected, more secure, and sustainable world. The objectives and the strategies around the five pillars essential to this aim - **community and climate**, **academic programs**, **research and creative work**, **infrastructure**, and **external engagement and outreach** - are the focus of this Strategic Plan.

### 1. Community and Climate

In our August 2020 Retreat, the Department formulated a central thematic goal which is to adapt department structures/behaviors to foster an inclusive, cooperative, and happy team focused on student education and growth. Central to this thematic goal are the urgent need and the steps required to improve the climate, inclusivity, and diversity in the department. The Strategic Plan specifies our objectives, strategies, and metrics to create and maintain a healthy and positive social and technical environment for all members of our community in order to improve retention of faculty, staff and students, and to improve transparency and processes, including code of conduct, hiring, and faculty and staff evaluation that follow more holistic and humane principles.

### 2. Academic Programs

***Undergraduate degree programs*:** The ECEE Department offers two ABET accredited undergraduate degrees in Electrical Engineering (EE), and Electrical and Computer Engineering (ECE). Stagnating or decreasing undergraduate enrollments is an indication of a significant strategic weakness, which we plan to address by stronger outreach and recruitment efforts, especially in Colorado. In outreach and recruitment efforts, we will involve our alumni and our External Advisory Board (EAB) members, and we will feature successes of our diverse graduates in their careers in industry, start-up companies, and graduate schools. We will modernize and promote our curriculum and learning environments and, based on the introduction of *Cross-cutting Research Themes* (CRT), we will rebrand our department as the most preferred destination for motivated and curious students interested in contributing to the creation of a smarter, healthier, better connected, and sustainable world. We aim to increase the undergraduate enrollment per tenured or tenure-track (TTT) faculty from 12 to 15 over the next

five years, and to 20 over the next ten years, while increasing the participation of female and underrepresented minority students. Our goals are to match or exceed the per-TTT faculty enrollment metric in comparison to other College of Engineering and Applied Sciences (CEAS) departments. Furthermore, we will maintain the current minors and introduce additional ones to meet the demand for education in the department's core areas of expertise, and in emerging areas pursued in our *Cross-cutting Research Themes*.

***On-campus Masters degree programs*****:** In addition to Bachelor's/Accelerated Master's (BAM) degree, traditional MS and ME degrees in Electrical Engineering, the ECEE department offers Professional MS degree programs (PMP) in Embedded Systems, Photonics, Power Electronics, and Next Generation of Power and Energy Systems. By highlighting the unique strengths and successes of our graduates in these programs, and by rebranding the programs for marketing to both international and domestic audiences, one of our goals is to at least maintain the traditional MS enrollment, and at least double PMP enrollments over the next five years. Furthermore, among our goals is the introduction of additional PMP's in cutting-edge areas pursued in *Cross-cutting Research Themes,* where the demand for our graduates is growing.

***Online MS-EE on Coursera degree program:*** the online Master of Science in Electrical Engineering (MS-EE), hosted on the Coursera platform, offers stackable graduate-level courses, graduate certificates, and a fully accredited degree. The MS-EE on Coursera is the first MOOC-based MS EE degree program in the world, featuring a number of radical innovations in terms of curricular structure, admission policy, and pedagogy. This has enabled our entrance and expansion into education for *distance professionals*, an entirely new market with a format that addresses the needs of that community. Our goals are to accelerate development of MS-EE on Coursera offerings to at least 100 credit hours over the next 5 years, and to achieve at least a 20% year-over-year increase in MS-EE enrollment.

***Ph.D. degree program***: Ph.D. students are the key contributors to our research program. Over the past ten years, our Ph.D. student enrollment has decreased by 20% in spite of the fact that our research expenditures have increased by more than 50%. To address this strategic weakness, we aim to secure robust and sustainable recruitment and support models, improve success rates in the recruitment of top Ph.D. candidates, and improve experiences for our Ph.D. students. Our objectives are to increase the number of Ph.D. students per TTT faculty from 3.1 now to at least 4 over the next five years, and to at least 5 over the next ten years. It is envisioned that reorganizing our research directions into *Cross-cutting Research Themes* (CRT) will serve as a catalyst towards achieving these goals.

### 3. Research and Creative Work

Our department has strong researchers and research groups in several core expertise areas including optics, photonics, nanostructures, and quantum engineering, electromagnetics, RF and microwaves, remote sensing, communications, data, information, and network sciences, computer engineering, systems and controls, power electronics, and power and energy systems. We are uniquely positioned in the vicinity of major national labs (NIST, NOAA, NREL) and joint institutes (JILA, RASEI), and our faculty have strong records of collaborations with researchers in these institutions and are participating in research initiatives across CEAS,

across the CU-Boulder campus, and beyond. The strengths of our core research areas, especially in optics, RF/microwaves, and power electronics, are internationally recognized. Additionally, recent faculty hirings have added substantial strengths to our systems and controls, quantum engineering, and computer engineering groups. Our research expenditures have increased from around $9M in 2010 to around $14M in 2020.

We however recognize that our abilities to follow or define cutting-edge research trends has been somewhat limited by the long-entrenched research-group organization with faculty artificially separated into disjoint groups. Furthermore, our processes in defining the department's growth priorities, particularly as relates to hiring and other resource allocation, have been haphazard. To address these strategic weaknesses, while building upon our core strengths and our uniquely favorable location and research environment, the Strategic Plan introduces *Cross-cutting Research Themes* (CRT) as a way to improve the impact and visibility of our research. Importantly, the proposed introduction of CRTs is accompanied by the introduction of CRT proposal, evaluation and prioritization processes that are well defined and inclusive across the entire department. Our goals are to be *recognized as the leaders in the Cross-cutting Research Themes*. Furthermore, it is envisioned that CRTs will foster teamwork and collaboration, and serve as catalysts to achieve other key objectives, including modernization of our curriculum and degree programs, and improved undergraduate and graduate enrollments. We aim to increase research funding by 25% in 5 years and 60% in 10 years.

**4. Infrastructure**

Overall, while some modest improvements have been made, the infrastructure and the facilities available to the ECEE Department have neither changed substantially nor have seen any major renovations over the past several decades. Aggravating the limited and depreciated space and infrastructure are other severe Engineering Center building limitations, including accessibility issues, scarcity of windows and naturally lit open-space areas conducive to gathering, interacting, discussing, and collaborating, scarcity of restroom facilities, as well as subpar electrical and networking services, contaminated dry compressed air, limited closed-cycle cooling water for high power equipment, limitations on fume hood capacity, and building services such as piping and air ducts invading into labs and offices with little notice or mitigation of the disruption to experiments or livability. Abilities to expand or upgrade laboratories or offices are very limited. Most important, it is clear that the inadequate space and infrastructure are presenting roadblocks to the department's mission and our ambitious vision especially as it affects recruiting of students and new faculty.

Our goals are to have modern, world-class infrastructure and facilities representative of a leading electrical, computer and energy engineering department, with state of the art teaching and research laboratories, modern, naturally lit offices, meeting areas, and classrooms, open-space areas that encourage interactions and collaborations, collaborative multi-user facilities, state of the art electrical, water, compressed air, fumehoods, networking and HVAC services, sustainability features, resulting in high energy and water efficiency, as well as healthy and productive working environments, with room to grow.

## 5. External Engagement and Outreach

Our department has maintained ties with local industry through an Industrial Advisory Board (IAB), and has sought IAB inputs on matters related to curriculum, degree plans, advancement plans, and strategies. However, we recognize that our outreach activities have been relatively modest and somewhat ineffective. Realizing that external engagement and outreach are critical to our mission and the vision of being a leading electrical and computer engineering department, a Marketing and Outreach Committee has been formed in 2020. The committee has broadened IAB to an External Advisory Board (EAB), has initiated a department's newsletter, and has started formulating plans for much more vigorous marketing and outreach activities moving forward. The department's newsletter has been introduced, and a new department website featuring a new look and easier to access information for our students and constituencies has been launched in early 2021. Looking ahead, the department website will be reorganized to prominently feature our research strengths including individual faculty, core areas of expertise, as well as our *Cross-cutting Research Themes* as they get introduced.

## 6. Strategic Plan as a living document

We consider the Strategic Plan a living document that will be maintained and updated by the department's Strategic Planning Committee based on our success in meeting our objectives, as well as further advancements and inputs from the department's committees, and our community, including our faculty, staff, students, and constituencies. As we progress towards our stated objectives we plan to grade and evaluate our progress towards meeting these goals.

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# ECEE Department Strategic Plan 2021

# Introduction

The lack of a Strategic Plan was highlighted as a major weakness in the 2018 ARPAC report. Upon initiative by the new department Chair, a Strategic Planning Committee (SPC) was formed in summer 2020 and tasked with collecting inputs and preparing a draft Strategic Plan. Inputs to the draft included outcomes from the department's retreat in August 2020, the 2018 ARPA report, results of faculty, staff and student surveys collected in the 2018-2020 period, an overview of CEAS and campus-level strategic plans, inputs from department's committees, and a review of research areas at more than 15 higher-ranked and peer EE/ECE departments.

Throughout the process, the draft has been kept open in a work-in-progress form, to enable department members to review the draft and provide comments, edits and inputs.

# Mission and Vision Statements

**Mission statement:** *We provide world-class education and research in electrical and computer engineering to prepare our students in Colorado, the nation, and the world for a lifetime of innovation and leadership in response to the grand challenges of our time and the changing needs of society.*

***Vision statement:*** *We aim to be among the leading electrical and computer engineering departments in the world. In an inclusive and vibrant environment, we strive towards the creation of a smarter, healthier, better connected, more secure, and sustainable world.*

The objectives and the strategies around the five pillars essential to this aim expressed in our vision statement - community and climate, academic programs, research and creative work, infrastructure, and external engagement and outreach - are the focus of this Strategic Plan.

# 1. Community and Climate

In the August 2020 Retreat, the Department formulated a central thematic goal to:

*Adapt department structures/behaviors to be an inclusive, cooperative, and happy team focused on student education and growth.*

Central to this thematic goal and the department's mission and vision statements are the urgent need and the steps required to improve the climate, inclusive excellence, and diversity in the department. The climate concerns are also highlighted in the ARPAC 2018 report. In response, the department has formed a Climate Committee staffed by faculty, staff, and student representatives tasked with formulating objectives and suggesting strategic steps and metrics needed to address the climate, inclusive excellence, and diversity issues in all aspects of the Department's mission. This section of the Strategic Plan includes defined objectives, standard operating objectives, strategies, and metrics to:

1. Create and maintain an inclusive community,
2. Increase diversity,
3. Improve retention of faculty, staff and students, and
4. Improve transparency and processes.

**Responsibilities:**

In charge of formulating and implementing the Community and Climate strategies, monitoring and reporting on the metrics are:

- Climate Committee
- Faculty Search Oversight Committee
- Associate Chair for Faculty Affairs
- Staff Operations Manager
- Executive Committee
- Chair

## 1.1. Create an Inclusive Community

**Defined objectives:** Adapt the Department's structures and behaviors to be an overall inclusive, cooperative, and happy team focussed on student education and growth.

**Standard operating objectives**: the Department is committed to fostering inclusive excellence, increasing the diversity of our faculty, staff, and student voices, and providing a positive, equitable, and welcoming departmental community.

- ECEE students must adhere to the University's Student Code of Conduct and abide by the Honor Code.
- Faculty must adhere to the Professional Rights and Duties of Faculty members.

- All members of the Department (faculty, staff, and students) must adhere to the University's Code of Conduct.

**Strategies:**

- Create, adopt and promote an explicit Inclusive Excellence statement.
- Create, adopt and promote an explicit Conduct Code for faculty, staff and students to ensure that we provide a safe and inclusive learning and work environment.
- Include staff and student representatives on all Department's committees.
- Perform internal climate, inclusiveness, and diversity surveys among faculty, staff, and students.
- Provide means for anonymous feedback related to department culture, leadership, and policy, and act upon the reported issues.
- Engage external campus resources to conduct climate, inclusiveness, and diversity assessments, including surveys among faculty, staff, and students.
- Include contributions to professionalism and inclusive excellence in annual merit evaluations of faculty and staff members
- Create opportunities for faculty, staff, and students to get to know each other.
- Maintain the Climate Committee staffed by faculty, staff, and student representatives.

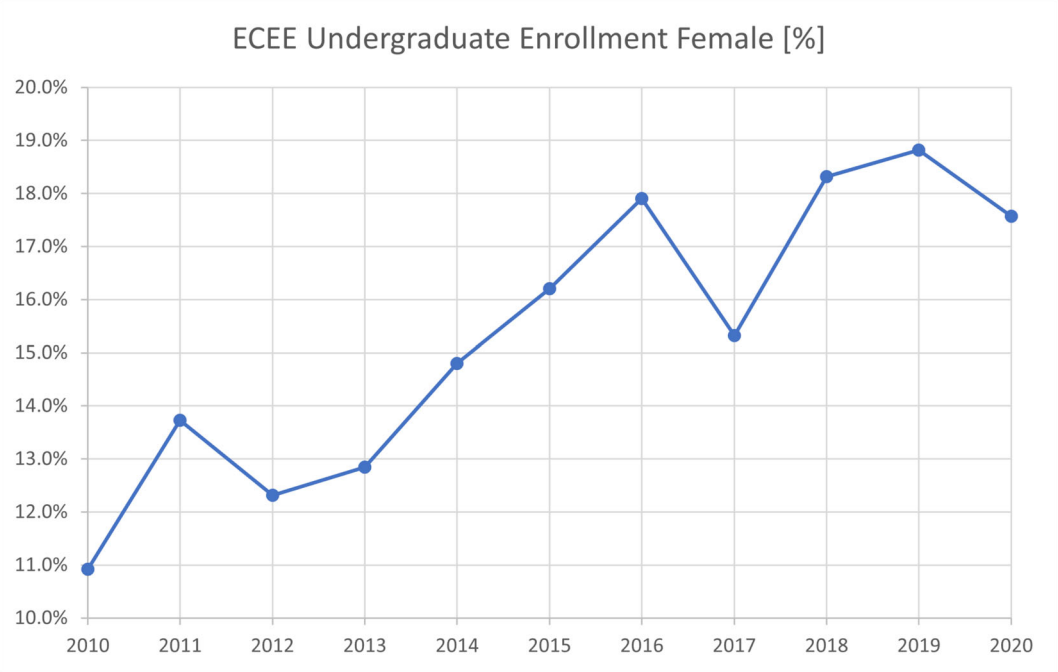
**Metrics:**

- Inclusive Excellence statement created and adopted by the Department.
- Conduct Code created and adopted by the Department.
- Means created for anonymous feedback to report issues related to department culture and policies. The feedback is monitored by the Climate Committee and acted upon.
- Composition of committees: numbers of faculty, staff, and student representatives. All committees include staff and student representatives.
- Results from internal and external assessments and surveys; longitudinal survey results show improvements over baseline.
- Opportunities created for the faculty/staff/students to get to know each other.
- The Climate Committee continues to formulate and implement inclusive excellence strategies, monitors, and reports metrics towards achieving defined and standard operating objectives towards inclusive excellence.

## 1.2. Increase Diversity

**Status:** The department has made improvements in diversity of faculty, students and staff over the past 10 years. In 2020, among tenured and tenure-track (TTT) faculty, 21% were female, which is an increase from 13% in 2011, still somewhat lower compared to the CEAS 25%. Female TTT faculty are at 25% among Assistant Professors, 22% among Associate Professors, and 7% among Professors. In 2020, 24% of the TTT faculty in our department are minority (BIPOC), which represents an increase from 11% in 2010, and is comparable to CEAS at 24%.

As shown below, the department has made steady progress in increasing the representation of female undergraduate students, from around 11% in 2010 to around 18% in 2020, still below 29% for the CEAS..




Among 194 enrolled Masters students in 2018, 26% were BIPOC, 18% female, and 15% underrepresented minority (URM). Among 119 enrolled Ph.D. students in 2018, 15% were BIPOC, 24% female, and 8% URM. The URM representation, which is comparable to the CEAS demographics, is still well below the national demographics.

**Defined objectives:** compared to the College of Engineering, match or exceed participation of women and underrepresented minorities among faculty, staff, and students.

**Standard operating objectives:**

- Create a diverse and inclusive community that reflects the diversity of the State of Colorado population.
- Achieve retention and graduation rates among women and underrepresented minorities comparable to overall retention and graduation rates.

**Strategies:**

- Create, adopt and promote an explicit Conduct Code for faculty, staff and students to ensure that we provide a safe and inclusive learning and work environment.
- Follow college and campus-level best practices and leverage college and campus-level diversity initiatives.
- Achieve a more diverse faculty and staff by pro-actively advertising future faculty or staff positions and by proactive recruitment of outstanding faculty or staff candidates among women and underrepresented minorities.

- Achieve a more diverse faculty by taking advantage of the current and future campus and CEAS diversity-hire opportunities, the Faculty Diversity Action Plan, and the CU Boulder Inclusion, Diversity and Excellence in Academics (IDEA) Plan.
- Achieve a more diverse and inclusive student population by
    a. engaging diverse CU students, including building relationships with student groups, and professional societies, as well as development networks.
    b. engaging teachers at high schools and community colleges serving minority students to recruit undergraduate students
    c. participating in recruiting events for graduate students from minority-serving institutions and marginalized STEM organizations, and networks
    d. facilitate access for students from underserved backgrounds (low-socioeconomic status, first-generation students, underrepresented racial/ethnic minorities, LGBTQIA+) by offering scholarships provided by businesses or alumni.
- Create a student advising plan specifically tailored to improve retention and graduation rates of women and underrepresented minority students. The advising plan may include peer mentoring.
- Require a diversity statement in applications to faculty positions and include this statement among the candidate evaluation criteria
- Value faculty and staff service toward diversity goals
- Develop a detailed diversity plan with input from our faculty, staff, and students, our Climate Committee, our Marketing and Outreach Committee, and our Undergraduate and Graduate Curriculum Committees.
- Engage external campus resources to evaluate diversity and inclusion plans and follow-up on required, recommended, or suggested improvements.

**Metrics:**

- Breakdown of demographics (undergraduate, graduate, faculty, staff) shows diversity improvements over the baseline.
- Results from internal and external climate, inclusiveness and diversity assessments and surveys; longitudinal results show improvements over the baseline.
- Retention and graduation rates among women and underrepresented minority students are at least as high as among the overall student population/
- The number of outreach events to minority and underrepresented groups, along with an evaluation of the results of these efforts.
- Faculty and staff service toward diversity goals are explicitly rewarded

## 1.3. Improve Recruiting and Retention of Faculty and Staff

In the 2018 ARPAC Report, the external reviewers linked the department's difficulties retaining junior faculty with climate issues, lack of transparency, and structure in the evaluation of teaching, research, and service contributions. The 2018 ARPAC Report also pointed to numerous challenges related to staffing, including high advisor turnover, which adversely affected student experiences, and climate issues between faculty and staff. This section of the Strategic Plan is focused on objectives, strategies, and metrics aimed at securing successful

recruiting and retention of faculty, staff, and students, which are central to the Department's mission and vision.

### 1.3.1 Improve Recruiting and Retention of Faculty

**Defined objectives:**

- Establish clear and transparent faculty hiring processes
- Establish clear, transparent, and holistic faculty and instructor merit evaluation and promotion processes cognizant of individual and collaborative contributions in teaching, research, and service.
- Create a supportive and transparent environment and mentoring infrastructure to support the promotion and recognition of junior and mid-career faculty and instructors.

**Standard operating objectives:**

- Maintain a supportive and collaborative environment necessary to support faculty and instructors in transparent and holistic merit evaluation and promotion processes.

**Strategies**

**Recruiting**

- Create a clear and transparent faculty hiring process plan open to participation by the entire faculty.
- Improve our competitiveness in recruiting top faculty candidates
    - Direct faculty hiring into prioritized Cross-cutting Research Themes (CRT, see Section 3.1)
    - Use CRTs to increase the visibility of our research programs and strengthen advertising, including social media presence, and outreach in the US and abroad
    - Improve diversity recruiting using the CU Boulder Inclusion, Diversity and Excellence in Academics (IDEA) Plan.

**Retention**

- Develop an annual faculty merit review process that is clear and transparent and which considers faculty contributions in teaching, research, and service in a more humane, fair, and holistic manner.
- Develop an improved infrastructure to support junior and mid-career faculty in teaching, research, and service activities, in annual merit evaluations, and in promotion and tenure cases:
    - Institute a robust mentorship program with clearly defined rules and expectations: at least two senior faculty members (one in the area, one outside the area), selected based on inputs from the mentored junior and mid-career faculty, are tasked with assisting in teaching, research and service, and in preparation of promotion and tenure cases.

    - Recognize diversity and culture of inclusion in the mentorship plan and in mentorship assignments
    - Create means for junior mid-career faculty to report on the effectiveness of the mentorship program on a continuous basis
    - Institute regular (at least yearly) one-on-one meetings between junior and mid-career faculty and the Associate Chair for Faculty Affairs or the Chair to discuss expectations, strategies, support, and mentoring.
    - Make sure that the mentorship load is equitably distributed
    - Recognize mentorship as a service contribution
- Extend the mentorship infrastructure to support instructors in teaching and in their promotion cases.
- Institute “stay” interviews with faculty to identify concerns and follow-up with actions to address issues
- Review and update the grievance policy regarding annual merit evaluations
- Establish a clear and transparent multi-year teaching plan that ensures equitable and fair teaching load cognizant of the needs and preferences of junior and mid-career faculty.
- Involve instructors in the Department’s curricular development and governance.
- Establish a regular ongoing process to nominate faculty for internal and external awards and recognitions.

**Metrics:**

- Hiring process plan created and adopted by the Department [include a copy in an Appendix]
- Annual merit review process formulated and adopted by the Department
- Mentoring infrastructure developed to support promotion and tenure cases
- Mentoring infrastructure developed to support instructors in their teaching mission and in promotion cases
- Results from one-on-one meetings between faculty and the Chair and actions taken to address the issues raised.
- Results from "stay” interviews and actions taken to address the issues raised
- Measurement of outcomes in promotion and tenure cases
- Measurement of the comfort of junior faculty members with their mentors.
- Measurements of the retention of faculty
- Equitable teaching plan established and adopted by the Department
- The number of faculty and instructors nominated for internal and external awards.

### 1.3.2. Improve Recruiting and Retention of Staff

**Status:** By strategic hiring and subsequent reorganization, the staff composition and organization have markedly stabilized and improved since the challenges and issues were noted in the 2018 ARPAC report. The Department staff have created and published a set of objectives and principles stating that the staff:

- Embraces professional excellence, diversity and inclusion, accountability, teamwork, and collaboration

- Commits to treating our community and customers with respect, trust, fairness, compassion, and encouragement
- Continues to mentor, learn, develop and grow professionally and as teammates
- Has fun and works with humor and creativity.

An improved infrastructure has been developed to support onboarding and mentoring of staff members. Onboarding completion has to be signed by the employee and supervisor and submitted to college HR within 30 days of hire. Furthermore, a Recognition and Rewards plan has been created, and is in the approval process by the college and campus.

**Standard operating objectives:**

- Ensure that the staff continue to operate according to the stated principles
- Keep staff roles and responsibilities clear and well defined with respect to interactions with students and faculty
- Ensure that every staff member/position has backup and duties are well documented.
- Provide onboarding and mentoring infrastructure for staff
- Provide means, including anonymous, for staff members to communicate concerns and issues.
- Perform a thorough review of current staffing, requested, and future staffing needs on a yearly basis.

**Strategies**

**Recruiting:**

- Follow the University hiring processes and merit review processes
- Improve diversity recruiting using the CU Boulder Inclusion, Diversity and Excellence in Academics (IDEA) Plan.

**Retention:**

- Maintain infrastructure to support onboarding and mentoring of staff members.
- Institute regular meetings between staff, the Chair, and the Executive Committee to review organization, roles, and responsibilities, as well as any issues identified in interactions with students and faculty.
- Involve staff representatives in all Department committees.
- Institute “stay” interviews with staff to identify concerns; follow-up with actions to address issues raised.
- Provide means for staff (including anonymous) to communicate issues to the Staff Operations Manager or to the Chair on an ongoing basis
- Establish a regular ongoing process to nominate staff for internal and external awards and recognitions.
- Establish a growth plan, e.g. leveraging the credits benefit, that explicitly promotes acquisitions of new skills and abilities to take on career-fulfilling tasks.

**Metrics:**

- Mentoring and onboarding infrastructure developed to support staff development and retention. Onboarding completion has to be signed by the employee and supervisor and submitted to college HR within 30 days of hire.
- Results from meetings between staff and the Chair/Executive Committee, and actions taken to address the issues raised.
- Results from "stay" interviews and actions taken to address the issues raised
- Measurements of the retention of staff.
- The number of staff nominations for internal and external awards.
- A thorough review of current staffing, requested, and future staffing needs undertaken within a year..

## 1.4. Improve Transparency

**Standard operating objective:** Transparency is the key principle necessary to ensure that all members of our community, faculty, including instructors, staff, and students have trust in our self-governance, and feel comfortable in all aspects of the Department's operations. Transparency principles should apply broadly but should in all cases respect the privacy of our community members as dictated by the University operating principles and procedures.

**Strategies:**

- Develop a field guide for operation of all committees.
- Revise by-laws as needed to codify transparency and processes.
- Open all committee and faculty meetings to all members of the community. Publish meeting times on a calendar maintained by the Department.
- Make all meeting materials accessible to the members of the Department.
- Create mechanisms for reporting concern, including a way to report issues or concerns anonymously
- Updates to the Department, including departmental hires, changes, and processes, are provided by the Chair and the committee leadership on a regular basis, with time available for Q&A.
- Increase attendance and participation at committee and Departmental meetings.

**Metrics:**

- A field guide for operation of all committees is created and adopted by the Department.
- By-laws are revised to codify transparency and updated processes.
- All committee and faculty meetings are open to all members of the community. Meetings times are published on a calendar maintained by the Department. Committee materials are maintained in a location maintained by the Department, and accessible to all members of the Department
- Measures of attendance and participation at Departmental meetings.

# 2. Academic Programs

## 2.1. Undergraduate Degree Programs

**Vision:** *We will develop and continuously modernize our cutting-edge curriculum and learning environments with the goals of enabling our diverse students to gain knowledge, skills and experience necessary to successfully pursue diverse careers in industry, entrepreneurship, or graduate schools, and to contribute to the creation of a smarter, healthier, better connected, and sustainable world.*

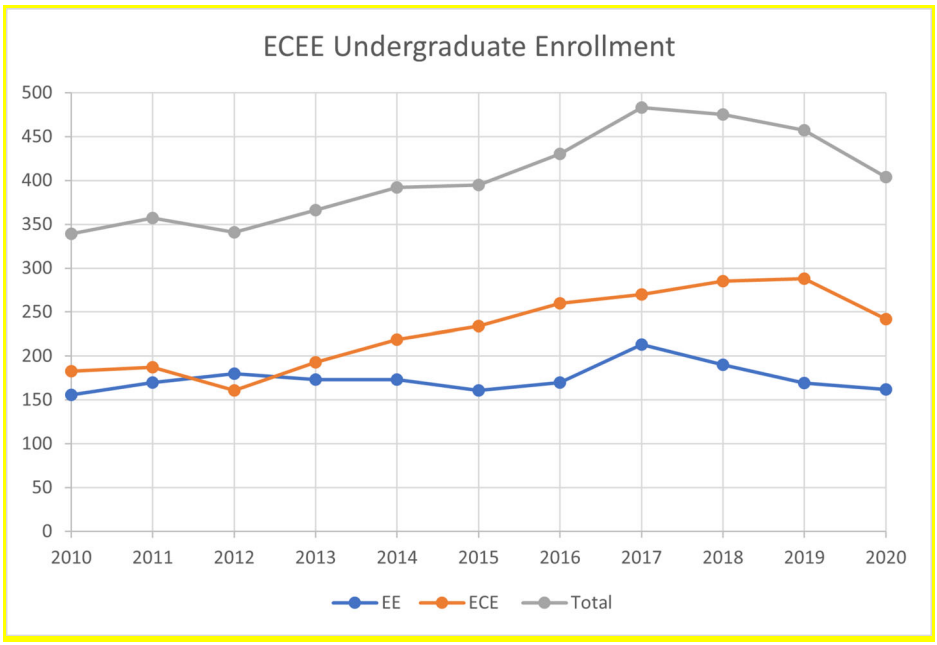
**Status:** The ECEE offers two undergraduate degrees that are accredited by the Engineering Accreditation Commission of ABET:

- Bachelor of Science in Electrical Engineering, which provides a foundation in the core areas of electrical engineering, their underlying science and mathematics, and their application to real-world problems.
- Bachelor of Science in Electrical and Computer Engineering, which covers many of the same foundational areas as in the electrical engineering degree with added emphasis on computer software and hardware.

The department also offers a Bachelor's / Accelerated Master's (BAM) degree program, which allows currently enrolled CU Boulder undergraduate students the opportunity to receive a bachelor's and master's degree in a shorter period of time. Students receive the bachelor's degree first, but begin taking graduate coursework as undergraduates.

Further, the department offers Undergraduate Minors in Computer Engineering (CEMR), Electrical Engineering (EEMR), Energy Engineering (ENMR), Electrical Renewable Enrgy Sys (REMR), and Signals & Systems (SSMR).

The undergraduate enrolment in EE and ECE degree programs increased from 351 in 2010 to 443 in 2019. The enrollment in minors increased from 33 in 2010 to 66 in 2020. The enrollment trends illustrated below show an increase in ECE compared to EE, and a concerning decrease in EE enrollment over the past several years.The enrollment drop in 2019-2020 can likely be attributed to the pandemic. In 2020, the department awarded 130 BS degrees.




Considering the 2019 undergraduate majors, the department had 12 students per TTT faculty, well below the majority of other CEAS departments (ASEN: 25, CHEN: 27, CSCI: 19, MCEN: 25). This is clearly a strategic weakness of our department, which together with stagnating enrollment trends points to the importance of recruitment strategies directed towards increasing undergraduate enrollments. About 70% of our students are residents of Colorado, which is why it is important that we improve our focus on local outreach and recruitment efforts.

Over the past 10 years, the 2nd year Fall retention rate has remained relatively steady at around 90%, while the 6-year graduation rate has been 80-85%. These rates are comparable to the rates in other CEAS departments.

Undergraduate fiscal year student credit hours (SCH) increased from around 7,000 in 2010 to around 9,000 in 2020. In 2019, the department had 35 TTT faculty, 6 instructors and 18 other faculty members (lecturers, adjunct professors). The percentage of undergraduate SCH by tenured and tenure-track (TTT) faculty decreased from 73% in 2010 to 48% in 2020. In 2020, instructors contributed 20% of the undergraduate SCH, while other faculty (lecturers, adjunct professors) contributed 31% of the undergraduate SCH. The trends point to the importance of planning of teaching assignments, and involving instructors, lecturers and adjunct faculty in the Department's curricular development and governance.

According to "Career Paths of CU Boulder Undergraduate Alumni 1997 through spring 2017" study by the CU-Boulder Institutional Research, Office of Data Analytics, median salaries of both EE and ECE graduates exceed median salaries of graduates across CEAS departments.

| | Estimated Median Salary | | |
|---|---|---|---|
| Years from graduation | EE | ECE | CEAS |
| 1-5 | $91.1 | $99.6K | $85.9K |
| 6-10 | $95.1 | $108.4K | $92.0K |
| 11+ | $104.6 | $104.1K | $97.2K |

The median salaries of EE and ECE graduates are comparable to the median salaries of graduates from ASEN and CSCI, and noticeably exceed the median salaries of graduates from MCEN, CVEN, and CHEN. We note that the results may be biased due to relatively small sample sizes in the study. Nevertheless, the fact that our graduates are sought after and have successful careers is a strategic strength of our department. We see opportunities in developing a database of our graduates, maintaining stronger contacts with our alumni and employers, using feedback from our alumni and employers in our curriculum modernization process, and promoting successes of our alumni in our recruiting, outreach and fund-rasiing efforts.

**Defined objectives:**

- Improve recruiting and increase enrollments to increase student per TTT faculty ratio from 3.1 to 5 over the next 5 years, and 10 over the next 10 years, which will match or exceed this metric in comparison to other CEAS departments.
- Improve recruiting of female students and students from underrepresented minorities.
- Modernize our curriculum by introducing new courses on emerging topics in engineering and revisiting the course sequencing.
- Review and update degree requirements.
- Improve the offering of undergraduate research opportunities (for example, in the spirit of the discovery Apprenticeship Program).
- Collaborate with EAB to facilitate summer internship opportunities.
- Further improve retention of students to exceed the retention rates in the College of Engineering and Applied Science.

**Standard operating objectives:**

- Enable our diverse students to successfully pursue diverse careers in industry, entrepreneurship, or graduate schools.
- Prepare students to contribute to the creation of a smarter, healthier, better connected, and sustainable world.
- Perform continuous evaluation and improvements in our curriculum and undergraduate degree programs, and secure ongoing ABET accreditation.

## Strategies

### Recruiting

- Through our Cross-cutting Research Themes (see Section 3), promote our department's research and education strengths and it's image as the most attractive and exciting destination for students interested in pursuing engineering.
- Institute recruiting events, including mixers for undecided majors, open house events involving faculty, advising staff, and students, industry mixers, and social media advertising campaigns for freshmen.
- Institute recruiting events at high schools throughout Colorado.
- Improve advertising of our undergraduate programs, highlighting our modernized curriculum, and successes our diverse graduates have in pursuit of diverse careers.
- Incentivise participation and involvement of current students, alumni and EAB members in recruiting events

### Curriculum modernization

- Establish ownership groups for core courses to ensure continuity, and implement improvements.
- Revise the curriculum and the degree requirements to:
    - Enable introductions of tracks and/or certificates
    - Make it easier to introduce new courses or minors in emerging areas consistent with the needs defined by Cross-cutting Research Themes (CRT, see Section 3.1)
    - Revisit sequence of courses to best prepare students that would like to pursue graduate studies.
- Involve instructors, lecturers and adjunct faculty in the Department's curricular development and governance.
- Institute processes to ensure teaching laboratories are functional and well equipped. This may include creating an additional laboratory manager staff position specifically tasked with maintenance of laboratory facilities, equipment and tools and providing technical and logistical support to students and faculty.
- Organize the department's store and processes to ensure that laboratory kits are available to students in a timely manner.
- Institute a common parts/tools kit available to all ECEE students.
- Based on our learning from the MS-EE program (see Section 2.3) and the remote teaching practices developed during the COVID-19 pandemic, modernize the delivery and structure of both theory and laboratory courses to enhance remote learning scenarios and improve the learning experience for our undergraduate students. For example, the common parts/tools kit can enable developing competence and experience with simple experiments included as homework assignments in core theory courses.

**Mentoring and advising**

- Institute robust student mentoring and advising program that involves both staff and faculty to improve academic performance and retention rates.
- Proactively take advantage of College and Campus career services to assist students with internships and job placement.

**Continuous evaluation and improvements**

- Complement FCQ data with surveys seeking focus-group student feedback on curriculum changes and improvements, including accessibility and inclusiveness aspects.
- Perform exit surveys of graduating/transferring students about their experiences.
- Perform surveys of alumni 5 years after graduation and seek feedback about the quality and relevance of the education received and seek improvement suggestions.
- Seek inputs from IAB and employers about the curriculum, why they hire our students, and why they hire students from other institutions.
- Compare the structure of the curriculum and the overall offering with top-tier engineering departments in the nation
- Perform continuous metrics-based evaluation and improvements in the curriculum

**Metrics:**

- Curriculum revisions and updates: courses introduced or updated, minors introduced or updated, degree programs introduced or updated
- Course enrollments
- Number of last-minute canceled classes
- FCQ data and internal surveys to measure the effectiveness of the curriculum and the student experience
- Results of external surveys about the effectiveness of the curriculum
- Measurements of the retention of different student populations.
- Actions based on internal metrics or external recommendations including IAB/employer surveys and ABET reviews.

**Responsibilities:**

In charge of formulating and implementing the Undergraduate Degree Program strategies, monitoring and reporting on the metrics are:

- Undergraduate Curriculum Committee
- Laboratory Committee
- Marketing and Outreach Committee
- Associate Chair for Education
- Department Chair

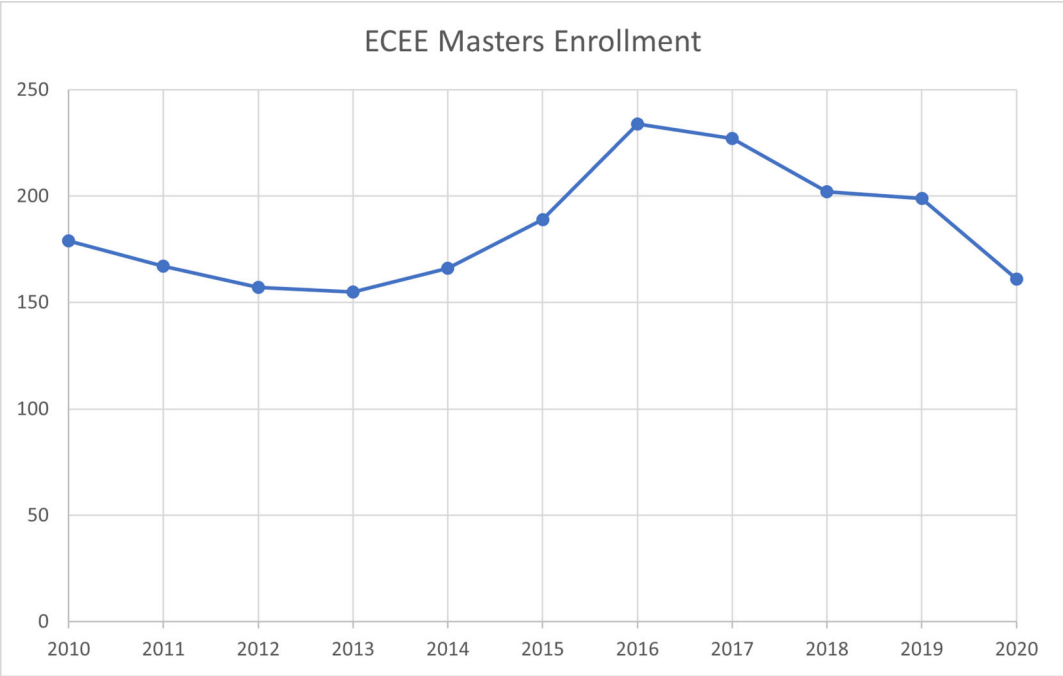
## 2.2. On-Campus MS Degree Programs

**Vision:** *Our department will be internationally recognized for its top-ranked Masters programs, including current and new Professional Masters Programs in cutting-edge areas where the demand for our uniquely qualified graduates is growing.*

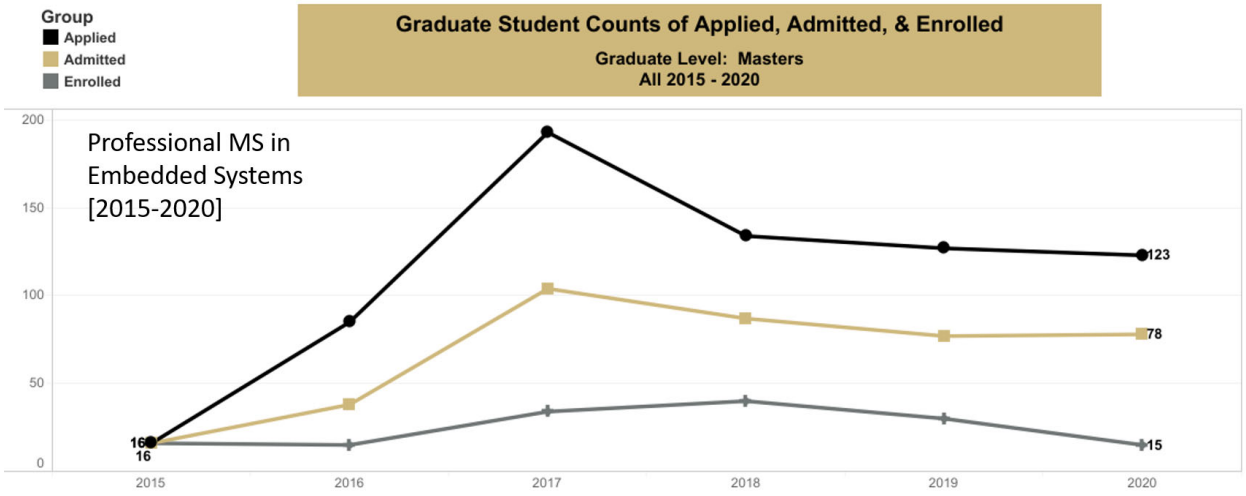
**Status:** The department offers two traditional Masters degrees, Master of Science (MS) and Master of Engineering (ME) in Electrical Engineering. The department also offers the Bachelor's / Accelerated Master's (BAM) degree program summarized in Section 2.1. In 2015, the department introduced a new degree option, Professional Master in Embedded Systems Engineering (PMP-ESE), followed by another three Professional Master programs: Power Electronics (PMP-PE) in 2016, Photonics (PMP-PHO) in 2018, and Next Generation Power and Energy Systems (PMP-NGPES) in 2020. The professional master's programs are focused on highly employable disciplines that provide skills based on industry needs. The tuition distribution model in professional masters programs has allowed us to hire additional instructors and adjunct faculty, and to expand the graduate curriculum, especially in PMP-ESE, PMP-PE, and PMP-NGPES.

In 2019, 64% of Masters students were international and the majority of students are self supported in all masters degree programs. In 2020, the department awarded 102 Masters degrees. Among Masters students, 18% were female, 29% were minority, and 19% were underrepresented minority.

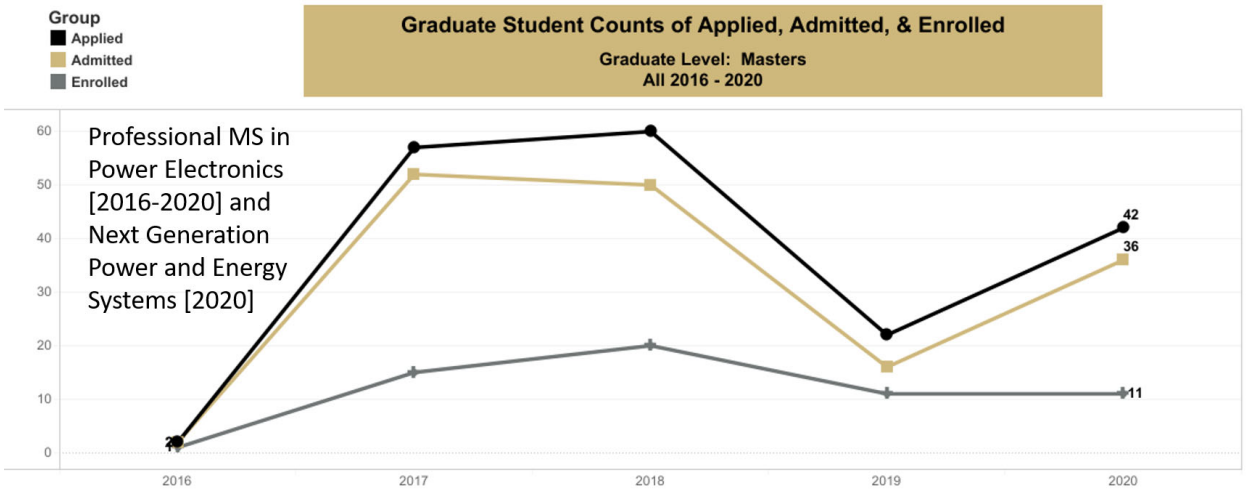
As shown below, the overall Masters enrollment over the past 10 years reached a peak of around 234 students in 2016 followed by a concerning decline over the past several years to 161 in 2020. While the 2019-2020 decline can be attributed to the pandemic, the trend over the past several years points to the need to reexamine the ways Masters programs are organized and marketed.




To better understand the overall Master enrollment trends, it is instructive to examine enrollments in the two largest PMP programs, embedded systems engineering (PMP-ESE) and power electronics (PMP-PE). Upon introduction in 2015, the PMP-ESE applications, admitted and enrolled students peaked in 2017 followed by a decline over the past several years, which a sharper drop in 2020 due to the pandemic and the fact that most of the PMP-ESE students are international.



The PMP-PE application, admission and enrollment trends follow a similar pattern shown below as most of the students in the PMP-PE program are international. The uptick in 2020 is due to the introduction of the PMP-NGPES program, which is unique in the sense that domestic students constitute a significant portion of the applicants and the enrollment.




While the initial success in PMP programs has been encouraging, the declining trends are concerning, threatening longer-term sustainability of these programs, especially in cases, such as PMP-ESE and PMP-NGPES, where the majority of the curriculum is supported by non-TTT faculty. In response to these challenges, we will need to reexamine the ways our masters programs are positioned and marketed to international and domestic students, and to institute a more rigorous oversight of the PMP curricula and operation.

**Defined objectives:**

- Develop top-rated MS degree programs, including traditional MS, Professional MS programs (PMP), and Graduate Certificates.
- Over the next five years, at least maintain the enrollment in the traditional MS/ME programs, and at least double PMP, and Graduate Certificate enrollments to ensure long-term sustainability of these degree programs.
- Address solvency threats to the existing PMPs due to COVID-19 pandemic.
- Develop new PMPs to meet the demands in emerging areas pursed in our Cross-cutting Research Themes (CRT, see Section 3).
- Improve experiences for MS and PMP students.

**Standard operating objectives:**

- Maintain top ratings of the MS and PMP degree programs
- Maintain PMP enrollments at the levels that ensure the long-term sustainability of these degree programs

**Strategies:**

- Institute faculty ownership and oversight models for PMP programs, in coordination with PMP instructors.
- Conduct surveys of MS and PMP about reasons for degree choices
- Update descriptions of MS and PMP degree programs to minimize confusion and improve guidance for incoming applicants
- Develop new PMP degree programs in areas with high enrollment prospects
- Identify target audiences for MS and PMP degree options and tailor website presentation and advertising accordingly
- Coordinate advertising of PMP and MS-EE degree options. Make use of our CRTs (see Section 3.1) in advertising and promotion of PMP and MS-EE degree options
- Develop and maintain a database of MS and PMP alumni
- Seek feedback from MS/PMP alumni about the quality, the relevance and the career impact of MS and PMP degree programs
- Seek feedback from IAB and employers about the quality and the relevance of MS and PMP degree programs

**Metrics:**

- Enrollments in MS, PMP, and Certificate programs
- Results of FCQ's and student surveys
- Results of surveys among MS/PMP alumni
- Results of IAB and employer surveys

**Responsibilities:**

In charge of formulating and implementing the online and professional master's Degree Program strategies, monitoring and reporting on the metrics are:

- MSEE Internal Workgroup
- Graduate Studies Committee
- Professional/Online Graduate Programs Committee
- Associate Chair for Education
- Chair

## 2.3. Online MS-EE on Coursera

**Vision:** *We will maintain leadership and grow our top-ranked online Master of Science in Electrical Engineering (MS-EE) program hosted on the Coursera platform.*

**Status:** The online Master of Science in Electrical Engineering (MS-EE), hosted on the Coursera platform, offers stackable graduate-level courses, graduate certificates, and a fully accredited Master's Degree in Electrical Engineering. Students in the MS-EE on Coursera program earn

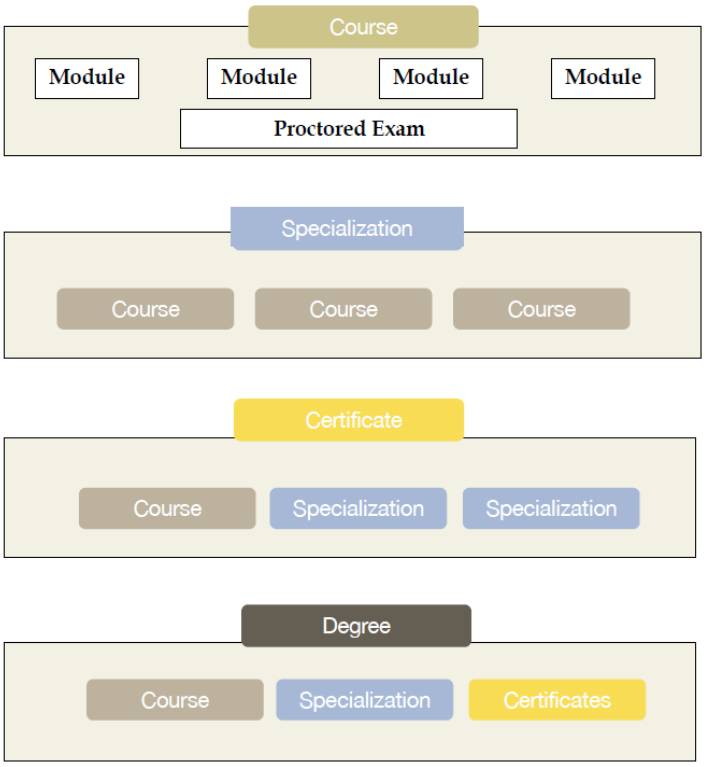
the same credentials as our on-campus students. There are no designations on official CU transcripts, diploma, or certificates, that this is an online program.

After successful experimentation with the MOOC (massive open online course) technology on the Coursera platform starting in Fall 2015, the department secured Campus approval, support, and investments necessary to pioneer the fully online MS-EE degree, which was officially launched in October 2019.

MS-EE is the first MOOC-based MS EE degree program in the world, featuring a number of radical innovations in terms of curricular structure, admission policy, and pedagogy. The program aims to deliver a level of instruction equal to on-campus Masters programs in a scalable, low-instructor-touch, high student engagement format. The program is based on a new curricular structure that clarifies learning objects and allows for continuous improvements. Each course length is based on the subject taught rather than the rigid 15-week semester. Access to the program is substantially expanded based on a radically new performance-based admission policy together with an egalitarian tuition rate. The program is fully integrated into the Campus infrastructure, and features a new enrollment management structure that innovates upon Coursera's own framework. Importantly, the MS-EE degree program has enabled our entrance and expansion into education for *distance professionals*, an entirely new market with a format that addresses the needs of that market.

The program is *not* aimed at existing on-campus students. Instead, the primary intended audience for the MS-EE program are distance professionals, 25-35 year demographics, nationwide and even worldwide.

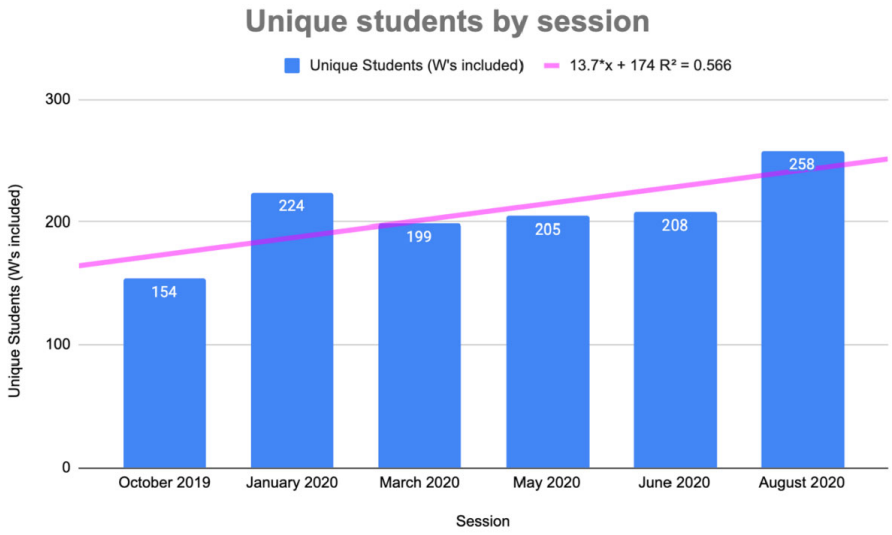
The MS-EE curricular structure shown below consists of transcripted, modularized *Courses*, with length and credit hours (0.6-1.6 credits) dependent on subject matter. A *Specialization*, which consists of 3-5 courses, is roughly equivalent to a semester-long on-campus course. Specializations are not transcripted. Admission to the degree program is via completion of Gateway Specialization. Graduate Certificates, which consist of courses and specializations contributing to 9+ credit hours, are awarded by the graduate school and transcripted. Finally the MS-EE degree is awarded to students who complete 30 credit hours with GPA greater than or equal to 3.0.




Non-credit-earning versions of courses are also available on the Coursera platform at Coursera-regulated subscription rates. This model which significantly broadens visibility of the program and the pool of students who may consider enrolling into the degree program.

The Courses and Specializations offered so far are in Embedded Systems, Power Electronics, Optical Engineering and Battery Management systems. In the first year of the program, by the end of 2020, the department had 41 Courses in 12 Specializations contributing to 34.6 credit hours, with 83 students admitted to the degree and one student already on the verge of completing the MS-EE degree.

Between October 2019 and August 2021, 708 unique students enrolled, and the enrollment growth trend exceeds projections, which is very encouraging.




79% of the enrolled students are from the US (44 states), and 90% are non-resident, defying traditional wisdom that online programs have a 50-75 mile enrollment radius from their home campus. 21% enrolled students are international, with very wide distribution across the globe.

Introduction of the MS-EE degree program, in collaboration with Coursera, has had a broader transformative impact on Campus operations, including automation of admissions, course enrollment, payments, grades and transcripts.

The MS-EE has significant potentials to impact our on-campus educational programs, including:

- Increase visibility worldwide, which can increase and improve our pool of Masters and Ph.D. candidates. We have already seen mentions of the MS-EE courses among applicants, especially in the power electronics area.
- The use of developed course materials, technology, and pedagogy approaches in on-campus course offerings. This has had a substantially important and positive impact on our preparedness during remote or hybrid campus operations due to the pandemic in 2020 and 2021.
- Teaching experience for on-campus students who have been serving as Course Facilitators, holding online office hours, answering forum and email questions, flagging and escalating any observed problems.

The MS-EE program has definitely seen a good start, but urgently needs development of additional Courses and Specializations and broader involvement of faculty across a wider range of ECEE areas. The objectives, strategies, metrics and responsibilities are formulated in this Strategic Plan to address the MS-EE needs and potentials. The most significant challenge is related to the faculty time and effort required to develop quality online materials.

**Defined objectives:**

- Maintain leadership and grow our top-ranked online MS-EE on Coursera degree program.
- Accelerate development of MS-EE on Coursera course offerings to at least 100 credit hours over the next 5 years.
- Achieve at least a 20% year-over-year increase in MS-EE enrollment.
- Secure longer-term operational framework for the MS-EE program including a Campus MOU related to revenue distribution, with 44% of the campus revenue returned to the department, and 6% paid as royalty to instructors.

**Standard operating objectives:**

- Maintain the top rating of the MS-EE degree program.
- Grow MS-EE enrollments to the level that ensures the long-term sustainability of the program.

**Strategies:**

- Develop and maintain support infrastructure, including staff and technical resources necessary to enable faculty to develop program courses, specializations, and certificates.
- Award teaching credit for MS-EE on Coursera program courses, specialization, and certificate developments.
- Make use of PMP-driven and CRT-driven (see Section 3.1) curriculum development to accelerate developments of additional MS-EE on Coursera program offerings.
- Coordinate presentation and advertising of PMP and MS-EE degree options. Make use of our CRTs (see Section 3.1) in advertising and promotion of PMP and MS-EE degree options.
- Include MS-EE student testimonials in advertising of the MS-EE on Coursera program.
- Seek feedback from IAB and employers about the quality and the relevance of the current MS-EE on Coursera program offerings, and about their continuing education needs that could be fulfilled by additional offerings.

**Metrics:**

- Number of online MS-EE on Coursera program credit hours, courses, specializations, certificates.
- MS-EE enrollment numbers.
- MS-EE course ratings and student feedback.
- Results of feedback from EAB members and employers.

**Responsibilities:**

In charge of formulating and implementing the MS-EE on Coursera degree program strategies, monitoring and reporting on the metrics are:

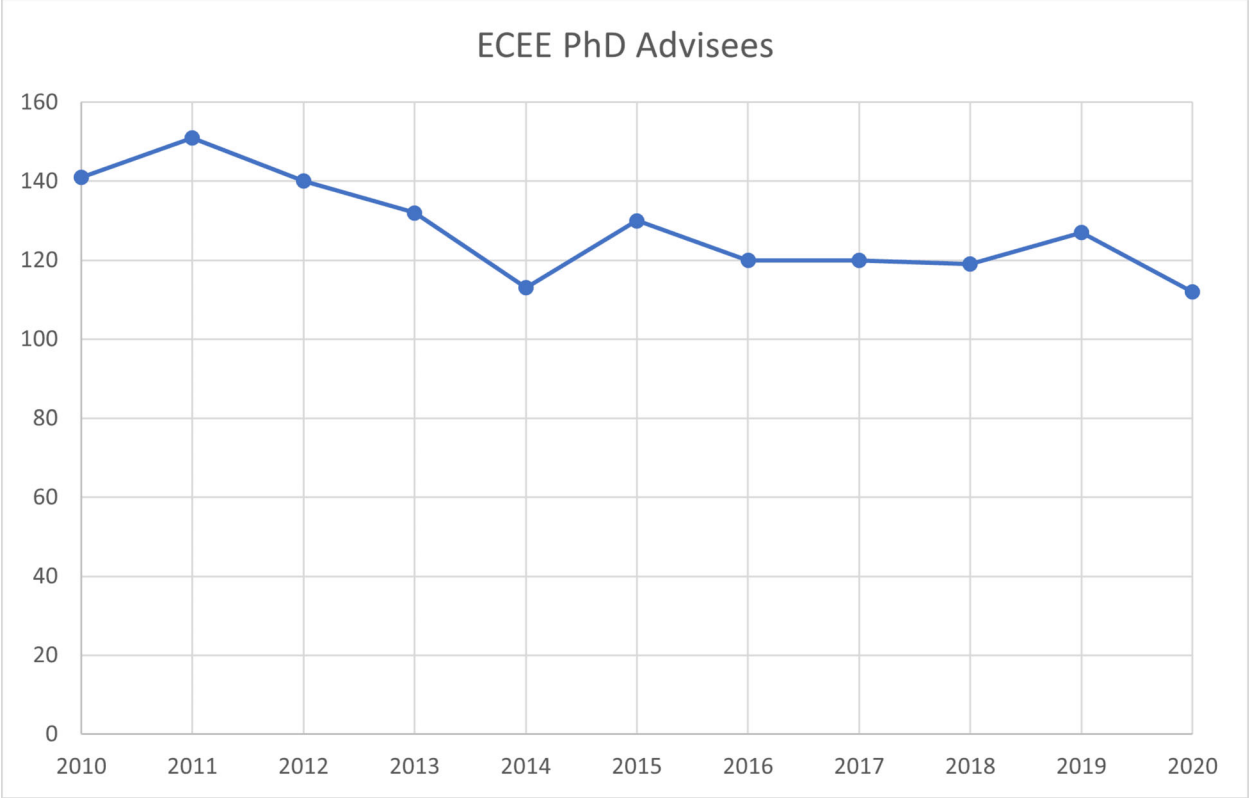
- MS-EE on Coursera Internal Workgroup
- Professional/Online Graduate Programs Committee
- Associate Chair for Education
- Chair

## 2.4. PhD Degree Program

**Vision:** *We will secure robust and sustainable recruitment and support models for our Ph.D. degree program, improve success rates in the recruitment of top Ph.D. candidates, and improve experiences for Ph.D. students who are the key contributors to the growth of our research programs.*

**Status:** In 2020, the department had a total of 109 PhD students. Of these, 93 were supported by ECEE faculty. Among 93 students supported by ECEE faculty, 74 are ECEE students, and 19 are from other departments. In 2020, the department awarded 14 Ph.D. degrees. In 2019, among Ph.D. students, 22% were female, 15% minority, and 6% were underrepresented minority. 43% of Ph.D. students were international. The demographics are similar to other CEAS departments.

The trend below shows a concerning decrease in PhD students advised by ECEE faculty, in spite of the fact that research awards and expenditures have increased over the past ten years.



In 2020, the number of PhD students advised per TTT faculty was 3.1, which is well below the two CEAS departments leading in research expenditures, ASEN (6.1) and CHEN (5.4), somewhat below MCEN (4.1) and CSCI (3.7), and ahead of CVEN (1.5).

The trend in the number of PhD students advised by ECEE faculty, and the per TTT statistics show that we have significant challenges in attracting PhD students and expanding our research program, which calls for more significant strategic actions to improve recruiting and support of our PhD students. It is envisioned that Cross-cutting Research Themes (CRT, see Section 3) will play a significant role in this process.

**Defined objectives:**

- Secure robust and sustainable recruitment and support models for Ph.D. students
- Improve success rates in the recruitment of top Ph.D. candidates
- Improve experiences for Ph.D. students
- Over the next 10 years, achieve PhD enrollment per TTT faculty comparable to the current metric in the leading CEAS departments: increase the number of Ph.D. students per TTT faculty from 3.1 now to at least 4 over the next five years, and to at least 5 over the next ten years.

**Standard operating objectives:**

- Maintain a well-funded Ph.D. program aligned with the growth of our research program.

**Strategies:**

**Recruiting**

- Improve our competitiveness in recruiting top Ph.D. candidates
    - Make use of Cross-cutting Research Themes (CRT, see Section 3.1) to increase the visibility of our research programs and strengthen advertising, including social media presence, and outreach to target schools in the US and abroad
    - Emphasize outreach to minority serving institutions (MSI)
    - Improve diversity recruiting using the CU Boulder Inclusion, Diversity and Excellence in Academics (IDEA) Plan.
    - Engage alumni in outreach activities
    - Improve timeliness of the review process and offers to the top candidates
    - Improve the effectiveness of the use of college-level and campus-level resources in recruiting
- Develop a detailed plan for the use of Department resources in recruiting and supplemental funding of Ph.D. candidates.
- Pursue proposals to programs aimed at supporting Ph.D. students (e.g. Department of Education GAANN, NSF Research Traineeship (NRT)), to enhance resources available for recruiting top candidates

**Improved Ph.D. student experience**

- Establish a Ph.D. Conduct Code to define rules and expectations between Ph.D. thesis advisors and Ph.D. students
- Develop a plan for the first-year experience of Ph.D. students, to allow and encourage rotations, enable students to participate in decision making. Make use of CRTs (Section 3.1) to facilitate rotations.
- Turn Ph.D. practicum into a better structured for-credit experience.
- Institute a department-level oversight of preliminary examination policies and implementation to achieve a more consistent preliminary exam experience.
- Organize a graduate meeting space; institute opportunities for Ph.D. students to socialize, and get to know each other across various research areas and CRTs
- Involve Ph.D. students and post-doc research associates in department-level seminars
- Perform surveys of Ph.D. students to evaluate their status and experiences on a regular basis (at least yearly)
- Perform surveys of Ph.D. program alumni to evaluate the post-graduation experience and career impact and to seek improvement recommendations

**Metrics:**

- Number of applicants and measurements of ranking (GPA, letter of recommendation scores)
- The success rate in the recruitment of top candidates
- Ranking of students recruited (GPA, letter of recommendation scores)
- Number of Ph.D. students with/without sustained funding
- Ph.D. student enrollment per TTT faculty
- Results of Ph.D. student surveys, including 1st-year experience
- Ph.D. Conduct Code created and adopted
- Ph.D. Practicum offered as a structured for-credit experience
- Dedicated graduate meeting space created, participation
- Attendance at department seminars
- Instituted department-level oversight of preliminary exams
- Results of feedback from Ph.D. alumni
- Career choices of our Ph.D. graduates; numbers of Ph.D. alumni pursuing careers in academia, industry, national labs or elsewhere.
- Proposals submitted and awarded in programs aimed at supporting Ph.D. students (e.g. Department of Education GAANN program, NSF Research Traineeship (NRT))

**Responsibilities:**

In charge of formulating and implementing the Graduate Degree Program strategies, monitoring and reporting on the metrics are:

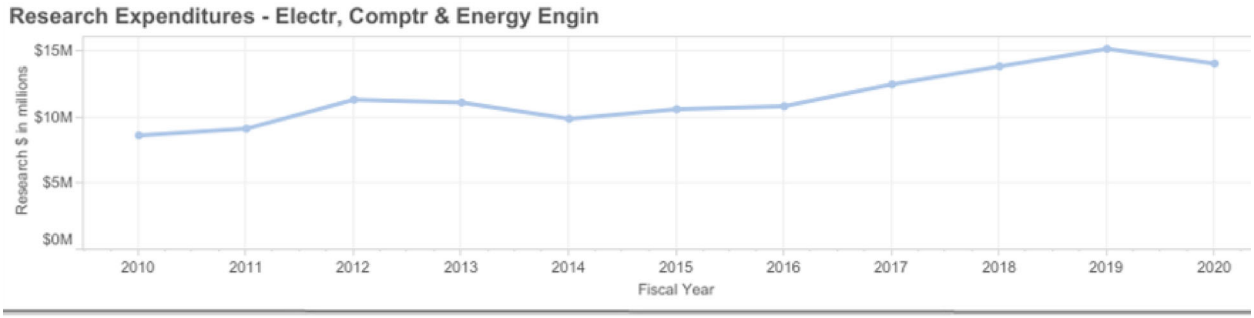
- Graduate Studies Committee
- Associate Chair for Research
- Chair

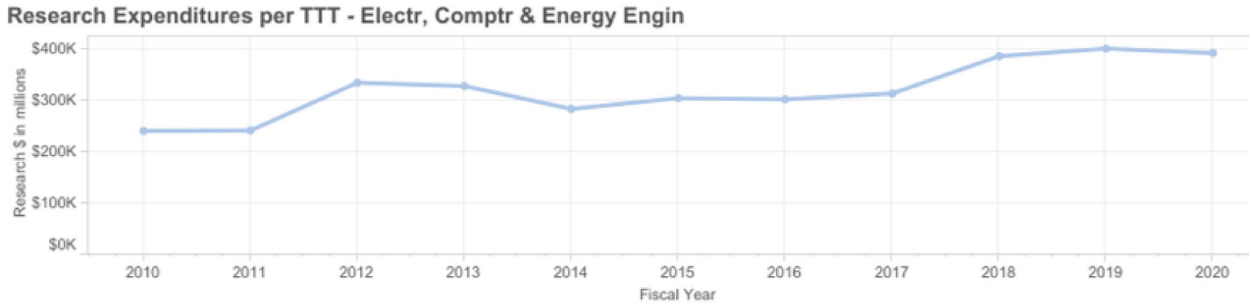
# 3. Research and Creative Work

**Vision:** *Building upon our core strengths and our uniquely favorable location and research environment, we will introduce and maintain Cross-cutting Research Themes (CRT) to improve the impact and visibility of our research, and to be recognized as the leaders in these themes. Alongside CRTs, we will introduce CRT proposal, evaluation and prioritization processes that are well defined and inclusive across the entire department. CRTs will foster teamwork and collaboration, and will serve as catalysts to accomplish other key objectives highlighted in this Plan, including improved undergraduate and graduate enrollments, and modernization of our curriculum and degree programs. Our vision is that on a longer time scale our research groups continue to define our core areas of research expertise and fundamentals in our educational programs, while CRTs will allow us to more quickly respond to and take leadership in collaborative research initiatives.*

**Status:** Our department has strong researchers and research groups in several core expertise areas including optics, photonics, nanostructures, and quantum engineering, electromagnetics, RF and microwaves, remote sensing, communications, information, data and networks, computer engineering, systems and controls, power electronics, and next generation power and energy systems. We are uniquely positioned in the vicinity of major national labs (NIST, NOAA, NREL) and joint institutes (JILA, RASEI), and our faculty have strong records of collaborations with researchers in these institutions and within research initiatives across CEAS, and across the CU-Boulder campus and beyond. The strengths of our core research areas, especially in optics, RF/microwaves, and power electronics are internationally recognized. Additionally, recent faculty hirings have added substantial strengths to our systems and controls, quantum engineering, and computer engineering groups.

As illustrated by the trends below, our research expenditures increased from around $9M in 2010 to around $14M in 2020. This corresponds to more than 60% increase per tenured and tenure-track (TTT) faculty from around $240K in 2010 to around $390K in 2020. Compared to other CEAS departments, the per-faculty expenditure in 2020 is below ASEN ($766K) and CHEN ($634K) but ahead of CSCI ($204K), and is comparable to MCEN ($373K).




While our faculty and research groups have been successful in research productivity and impact, we recognize that our abilities to follow or define cutting-edge research trends has been somewhat limited by the long-entrenched research-group organization, with faculty divided among the groups. Furthermore, our processes in defining the department's growth priorities, particularly as relates to hiring and other resource allocation, have been haphazard. To address these strategic weaknesses, while building upon our core strengths and our uniquely favorable location and research environment, the Strategic Plan introduces *Cross-cutting Research Themes* (CRT) as a way to improve the impact and visibility of our research, and to allow us to collaboratively respond to or initiate emerging research directions. Importantly, the proposed introduction of CRTs is accompanied by the introduction of CRT proposal, evaluation and prioritization processes that are well defined and inclusive across the entire department, as summarized in the Appendix of this strategic plan.

***Our goals are to be recognized as the leaders in the Cross-cutting Research Themes.*** Furthermore, it is envisioned that CRTs will foster teamwork and collaboration, and serve as catalysts to accomplish other key objectives, including improved undergraduate and graduate enrollments, and modernization of our curriculum and degree programs.

## Cross-cutting Research Themes

The strategic plan includes a proposed mechanism to formalize the prioritization of the department's research and educational areas, particularly as relates to hiring and other resource allocation.  Efforts and strategic directions shall be thematically identified as follows:

- Existing Research Areas, including Sub-Areas as appropriate, that are centered around core disciplines and strengths;
- Cross-cutting Research Themes (CRTs), which are introduced to respond to changes in internal growth, trends, initiatives, and funding opportunities.

The main differences between Research Areas and CRTs can be delineated as follows:

- Existing research areas and subareas reflect core expertise and traditional educational areas; research areas/groups may continue to follow more traditional and more stable EE/ECE core strengths.
- Research themes are initiatives centered around emerging interdisciplinary research themes that could leverage core research and educational expertise from different areas and subareas. Similar to College's Interdisciplinary Research Themes, the Department's CRTs would involve multiple faculty and research groups within the Department and across the campus. The CRT's can be formulated or redefined on a shorter time scale (e.g. 5 years or shorter) to match trends and funding opportunities.
- The CRTs, as opposed to core Research Areas, will drive department investments including faculty hiring prioritization, allowing for strategic growth of the department that relates to current and emerging initiatives that cross traditional research area boundaries, and a formalized mechanism for prioritizing growth areas with input from all faculty.

The vision is to identify and prioritize CRTs to enable our department to grow in strategic areas and make investment priorities with the goals of:

1. Prioritizing CRTs with the best growth and impact potentials in terms of:
    a. Attracting or retaining outstanding faculty;
    b. Improving the recruiting of students at both undergraduate and graduate levels;
    c. Growing collaboration opportunities;
    d. Growing funding opportunities;
    e. Identifying opportunities to support and modernize our curriculum.
2. Investing in priority CRTs based on available Department's resources such as:
    a. Faculty hiring, including start-ups and lab space.
    b. Ph.D. student hiring.
    c. Industry/alumni contributions.
    d. Curriculum adjustments to accommodate new initiatives.
3. Gaining recognition as one of the strongest programs in the identified CRTs.
4. Foster teamwork and collaboration among faculty across the Department and College.
5. Improve the visibility of our department and the national and international levels.

The visibility of our Department's strengths and research directions will also be improved by cross-listing faculty among various Research Areas, Sub-Areas, and CRTs, preferably as primary and secondary participants, as appropriate. The cross-listing should extend beyond the Department to emphasize existing strengths, collaborative work across campus and beyond, initiatives, and up-to-date research accomplishments.

Proposed defined objectives, standard operating objectives, strategies, and metrics are provided in the following.

**Defined objectives:**

- Introduce Cross-cutting Research Themes (CRTs) as a way of fostering collaborations, and improving the visibility and impact of our research and scholarly work
- Involve all faculty in at least one CRT

**Standard operating objectives:**

- Maintain CRTs representative of the Department's research strengths and emerging research directions
- Maintain average per-faculty amounts of research awards and expenditures at least equal to the averages in the College of Engineering

**Strategies:**

- Introduce CRTs
- Develop CRT proposal, selection, and prioritization, processes that involve all faculty members.
- Develop CRT evaluation processes that assess research impacts, and the impact on the department's mission in a holistic way using a diverse set of metrics.
- Direct Department-level investments to prioritized CRTs. Depending on CRT needs and Department resources available, investments may include faculty lines and start-up packages, space allocation updates, curriculum updates, etc.

**Metrics:**

- CRT proposal, selection, and prioritization processes adopted by the department.
- Developed and adopted CRT and faculty evaluation processes that evaluate research impacts, and the impact on the department's mission in a holistic way using a diverse set of metrics.
- Number of CRTs introduced and inclusiveness across all faculty
- Measurements of the impact of CRTs on Research and Creative Work
    - The number of interdisciplinary research and teaching joint initiatives.
    - The number of joint proposals between faculty for external funding opportunities.
    - The number of recognitions for successes and awards of students, staff, and faculty.
    - Number of new awards and grants based on the CRTs
    - Amount of research awards and expenditures.
- Measurements of the impact of CRTs on the Academic Programs
    - Courses introduced or updated, minors introduced or updated, PMP degree programs introduced, MS-EE credit hours developed
    - Student enrollments.

**Responsibilities:**

In charge of formulating and implementing the Research and Creative Work strategies, as well as monitoring and reporting on the metrics are:

- Strategic Planning Committee
- Graduate Studies Committee
- Associate Chair for Research
- Executive Committee
- Chair

# 4. Infrastructure

**Vision:** *Our goals are to have modern, world-class infrastructure and facilities representative of a leading electrical, computer and energy engineering department.*

**Status:** Most of the ECEE Department's offices and laboratories are currently located in the "ECEE wing" of the Engineering Center building, with some offices located in the "Office Tower" part of the building, and some new laboratories that will become available in the Aero wing in the near future. Details of the current space allocated to the ECEE Department can be found in Appendix C. Over the past several years, some improvements have been made, such as renovations of the undergraduate electronics lab, and a lecture room, and modest reconfigurations have been implemented in the main office area. The "EE wing" heating, ventilation, and air conditioning system has recently been upgraded. In particular, the two air handling units have been replaced, which provides 100% outside air to the wing, but the vents/ducts have not been upgraded, which constricts the air flow to various parts of the wing, thus severely limiting the occupancy.

Overall, the infrastructure and facilities available to the ECEE Department have neither changed substantially nor have seen any major renovations over the past several decades. Aggravating the limited and depreciated space are other severe Engineering Center building limitations, including the lack of easily accessible restrooms in the "ECEE wing", accessibility issues, scarcity of windows and naturally lit open-space areas, as well as infrastructure issues such as subpar electrical and networking services, contaminated dry compressed air, limited closed-cycle cooling water for high power equipment, limitations on fume hood capacity, and building services such as piping and air ducts invading into labs and offices with little notice or mitigation of the disruption to experiments or livability. Abilities to expand or upgrade laboratories or offices are very limited. It is clear that the inadequate space and infrastructure are presenting roadblocks to the Department's mission and our ambitious growth plans.

This section of the Strategic Plan outlines our vision, objectives and potential strategies the Department may pursue with the College and the Campus in order to address the severe space and infrastructure limitations.

**Defined objectives:**

- Formulate a plan, secure resources and means necessary to ensure that the infrastructure and facilities available to the ECEE Department allow us to fulfill our mission, and achieve our vision of being a leading program in electrical and computer engineering. Our goals are to have modern, world-class infrastructure and faculties with:
    - State of the art teaching and research laboratories
    - Modern, naturally lit offices, meeting areas, and classrooms
    - Open-space areas that encourage interactions and collaborations
    - Collaborative multi-user facilities
    - State of the art electrical, water, compressed air, fumehoods, networking and HVAC services
    - Sustainability features, resulting in high energy and water efficiency as well as healthy and productive working environments
    - Room to grow

**Standard operating objectives:**

- Continuously maintain and renovate the space, infrastructure and facilities available to the Department to allow us to most effectively fulfill our mission in healthy and productive working environments.

**Strategies:**

- Promote the Department's "space workgroup" (consisting of the Dept Chair, Assoc Chair for Education, Assoc Chair for Research, Operations Manager, and Lab & Facilities Coordinator) into a standing Infrastructure Committee with the abilities to pull in additional Department members as needed, and set short-term and long-term policies, priorities, and strategies necessary to address the standard operating objectives and the defined objectives.
- To meet the *standard operating objectives*, within present-day space, infrastructure and resource limitations, the Infrastructure Committee will:
    - Formulate a plan for office and laboratory space allocations and renovations based on transparency principles, keeping Department staff and faculty informed and involved in the process.
    - Formulate a plan for classroom renovation and maintenance (e.g., projectors, screens, cables, etc); ensure that the equipment is properly working, and maintain backup equipment to be used in case of sudden failures.
    - Serve as an interface between the College and the Department in matters related to space and infrastructure.

    - Perform a thorough evaluation and develop a Utilization Plan, which should identify laboratory and spaces utilization patterns, and formulate renovation and expansion needs and priorities.
    - Based on the Utilization Plan, work with the College to implement prioritized space and infrastructure improvements. Such improvements may include moving the main office to the 1st floor of the Engineering Center, expanding the office and laboratory spaces available to the Department within the Engineering Building, renovating and/or opening new offices, renovating and building new easily accessible restroom facilities.
    - Based on the formulated Utilization Plan, work with the College to ensure that the signage, the teaching laboratories, the lecture rooms, and the faculty and staff offices are upgraded to the standards at least comparable to other areas in the Engineering Building.
- To meet the *standard operating objectives*, the Laboratory Committee will:
    - Review the present-day status of teaching labs
    - Identify current and future teaching laboratory space and equipment needs
    - Formulate maintenance and growth plans, including prioritization of EEF proposals, and other fundraising initiatives.
- To meet the *defined objectives*, the Infrastructure Committee will work with the College and the Campus to formulate longer-term space and infrastructure strategies, and advancement options for the ECEE Department. The Infrastructure Committee will:
    - Consider options for a new building, moving the Department to an alternative location such as the East Campus, and/or implementing major renovations and expansions within the Engineering Center.
    - Poll the department faculty, staff and students to determine the tolerance and enthusiasm for a possible move to a new building located either on Main Campus or in East Campus, as well as advantages and necessities for possible collocations with other departments (CS, AMath, ME, etc)
    - Assess the potential impact on the student enrollment in both undergraduate- and graduate-level courses if a new building is in a remote location, and other departments remain on Main Campus.
    - Make a plan for future development of shared infrastructure with ECEE resulting from faculty retirements, external investments, or major collaborative equipment acquisitions. Consider nanofabrication facility, possible E-beam to be acquired, Keck laboratory facility, and upcoming retirements of faculty with major infrastructure resources.

**Metrics:**

- The Infrastructure Committee formed within 6 months.
- Teaching laboratory status report and plan completed within 6 months.
- Utilization Plan completed within 1 year
- Improvements prioritized in the Utilization Plan completed

- The signage, the teaching laboratories, the lecture rooms, and the faculty and staff offices are upgraded to the standards at least comparable to other areas in the Engineering Center building, following the campus space allocation guidelines.
- Infrastructure advancement plans formulated towards reaching the defined objective of having modern, world-class infrastructure and facilities representative of a leading electrical, computer and energy department.

**Responsibilities:**

In charge of formulating and implementing the Infrastructure strategies, as well as monitoring and reporting on the metrics are:

- Infrastructure Committee, to be formed from the existing “space workgroup”
    - Laboratory Committee
    - Associate Chair for Education
    - Associate Chair for Research
    - Operations Manager
    - Department Chair

# 5. External Engagement and Outreach

Our department has maintained ties with local industry through an Industrial Advisory Board (IAB), and have sought IAB inputs on matters related to curriculum, degree plans, advancement plans, and strategies. Our outreach activities have been modest and somewhat haphazard. Realizing that external engagement and outreach are critical to our mission and the vision of being a leading electrical and computer engineering department, a Marketing and Outreach Committee has been formed in 2020. The committee has broadened IAB to an External Advisory Board EAB), has initiated a department’s newsletter to our Alumni and EAB members, and has started formulating plans for much more vigorous marketing and outreach activities moving forward. Furthermore, a new department website has been launched, with a more modern look and easier access to information for our students and constituencies. This section of the Strategic Plans outlines objectives, strategies and metrics related to these plans, including improvements in Visibility, outreach to K-12 schools in Colorado, External Advisory Board, and Alumni.

In charge of formulating and implementing the External Engagement and Outreach strategies, monitoring and reporting on the relevant metrics are:

- Marketing and Outreach Committee
- Strategic Planning Committee
- Associate Chair for External Relations
- Chair

## 5.1. Visibility and Marketing

**Defined objectives:**

- Improve department's website and social media presence
- Improve presentation and advertising of academic and research programs, including our Cross-cutting Research Themes (see Section 3.1)
- Institute a quarterly Department's Newsletter, and distribute to our constituencies

**Standard operating objectives:**

- Promote our academic and research programs in support of our mission and vision statements

**Strategies:**

- Perform evaluation of website organization and contents on a regular basis, at least annually.
- Dedicate staff support and technical resources to keeping the website well organized, informative, and regularly updated
- Prepare and distribute a quarterly Department's Newsletter in various forms (e.g. social media, email lists) to our constituencies, including industry, other EE/ECE departments, alumni, parents
- Explicitly promote and advertise our Cross-cutting Research Themes (see Section 3.1) on the website and in the Newsletter, emphasizing major initiatives, collaborative cutting-edge research accomplishments, and cross-listing of faculty from different areas
- Implement target advertising campaigns to support recruiting into our undergraduate degree programs, PMP and MS-EE degree programs, and the Ph.D. program
- Organize and promote open-to-public seminars by faculty, students, or industry speakers
- Advertise Department events such as Capstone Expo to parents, alumni, IAB, and employers
- Support and recognize as service contributions faculty activities in social media, such as AMA (ask me anything) events, LinkedIn posts, online talks, and seminars
- Support and recognize as service contributions public talks and seminars
- Support and recognize as service contributions faculty inputs to the contents posted on the website, and in the Newsletter

**Metrics:**

- Website analytics (user testing, Google analytics, and Google AdWords, use UTM codes, number of applicants/enrollments, number of "unique" clicks, amount of RFI form requests from website).
- Measurements of Newsletter circulation and feedback
- Measurement of the impact of advertising campaigns

## 5.2. Outreach to K-12

**Defined objectives:**

- Improve our outreach to K-12 programs in Colorado

**Standard operating objectives:**

- Maintain and grow K-12 outreach activities

**Strategies:**

- Pursue social media campaigns to high-school students to improve recruiting in Colorado and beyond
- Establish working relationships with local high schools (e.g. high-school science fair projects, involve STEM faculty in seminars, courses)
- Leverage ITLL K-12 programs to enhance ECEE outreach to K-12 teachers and students; contribute to outreach events including K-12 summer camps, high school visits, and public speaking activities
- Support and recognize K-12 outreach activities as faculty service contributions

**Metrics:**

- Numbers of outreach events and participation in outreach events

## 5.3. External Advisory Board

**Defined objectives:**

- Improve IAB participation and networking with local companies
- Define needs and priorities, i.e., “asks” for contributions and fundraising campaigns targeting industry

**Standard operating objectives:**

- Maintain strong, mutually beneficial ties with industry in support of our mission and vision statements

**Strategies:**

- Improve networking with local companies, organize “Tech Mixers”
- Conduct contributions and fundraising campaigns targeting IAB members and other employers based on the following “asks:”
    - Resources needed to facilitate take-home lab experiences
    - Resources to support MS-EE course developments
    - Student mentoring
    - Internship program
    - Named student awards
    - Add-ons to Ph.D. offers
    - Named Ph.D. candidate scholarships
    - Named scholarships targeting diverse candidates among undergraduate and graduate students
    - Teaching laboratory upgrades and renovations
    - Department office upgrades and renovations
    - Naming rights to teaching laboratories
- Continuously seek EAB feedback in live strategic planning matters, including academic programs, research, and creative work, outreach and marketing
- Increase the number of proposals with EAB or other industry members in programs that encourage such collaborations, such as NSF GOALI, and funding opportunities with DOE, ARPA-E, etc.
- Establish links to industry associations (CPIA, CCIA, ASAA, PSMA)

**Metrics:**

- Measurements of EAB participation
- Measurements of “asks” fulfilled and success of fundraising campaigns
- NSF GOALI or other proposals submitted and awarded
- Measurements of links to industry associations and impact thereof

## 5.4. Alumni

**Defined objectives:**

- Define needs and priorities, i.e. “asks” for contributions and fundraising campaigns targeting alumni
    - Establish an alumni database and social media presence

**Standard operating objectives:**

- Maintain alumni database
- Maintain strong, mutually beneficial ties with alumni in support of our mission and vision statements

**Strategies:**

- Solicit Alumni inputs for the Department’s Newsletter

- Conduct contributions and fundraising campaigns targeting alumni based on the following “asks:”:
    - Student resource center
    - Dedicated graduate meeting space
    - Student mentoring
    - Undergraduate, MS/PMP, and Ph.D. student recruiting: help with outreach and advertising, presence on social media
    - Scholarships targeting STEM diversity students

**Metrics:**

- Alumni database and social media presence established
- Measurements of alumni participation in contributions to the Department’s Newsletter
- Measurements of alumni participation in contributions and fundraising campaigns

# Appendix Cross-Cutting Research Themes: Process, Proposal and Evaluation

This section includes the following guidelines for the CRTs:

1. **Process** of how CRTs are introduced, prioritized, and invested in.
2. **CRT proposal requirements**, which define expectations and contents of a CRT proposal.
3. **CRT evaluation criteria**, which define the metrics for oversight of CRT progress and impact on the Department's research and teaching missions.

## B.1. CRT Process

Below is a description of the process for the introduction of CRTs. The process is schematically summarized in Fig. 1.

**1) Introduction of CRTs**

**a) Proposals**

i) An ECEE faculty or a group of ECEE faculty submits a CRT proposal to the SPC. The CRT proposal requirements are provided in Appendix B2.
ii) The Strategic Planning Committee (SPC) reviews and evaluates the CRT proposals based on the criteria in Appendix B3, and based on consultations with the relevant committees (Undergraduate Curriculum Committee, Graduate Studies Committee, Professional/Online Graduate Programs Committee, Marketing and Outreach Committee). SPC may seek additional inputs or modifications (including merging suggestions) in the CRT proposals.
iii) SPC votes to select CRT proposals.
iv) SPC presents the selected CRT proposals to the Executive Committee (EC).
v) The EC approves the CRT proposals for presentation to the Department.
vi) The proposal is distributed to the members of the Department. In a Department meeting, the proposal is presented to the Department as a 20-min pitch followed by discussion. Feedback is solicited from the Department, including faculty, research faculty, teaching faculty, and staff.
vii) The faculty proposing the CRT, in consultation with the SPC, may update the CRT proposal based on the feedback from the Department meeting.

viii) The faculty (including research faculty) vote to select, approve and prioritize CRTs.

**b) Prioritization**

i) Among the approved CRTs, SPC presents a prioritization rationale to the EC.
ii) The EC approves the prioritization rationale and approves the CRT presentation to the Department.
iii) Faculty vote to select and approve the priority CRTs.

**c) Implementation: the Department's leadership (Chair, EC, and appropriate Committees) take the responsibilities to follow-up on investments in priority CRTs.**

i) The priority CRTs inform the investments including faculty hiring priorities, ICR/start-ups, Department's PhD candidate offers, distribution of alumni/industry gifts, space allocation, potentially seed grants.
ii) The selected CRTs, and the priority CRTs, inform actions by:
   (1) Undergraduate Curriculum Committee [e.g. curriculum development initiatives],
   (2) Graduate Studies Committee [e.g. outreach, recruitment, offers to PhD candidates],
   (3) Professional/Online Graduate Programs Committee [e.g. PMP or MS-EE development initiatives],
   (4) Marketing and Outreach Committee [e.g. website updates, news, outreach to alumni/industry, etc.]

**2) Ongoing CRT process**

**a) CRT proposals**

i) New CRT proposals may be initiated by any ECEE faculty or groups of faculty on a yearly basis according to the process described in Section 1) above.

**b) Evaluation (on yearly basis)**

i) The CRT faculty leadership submits a report to the SPC.
ii) Based on the reports and any new CRT proposals, SPC evaluates the CRTs according to the criteria listed in Appendix B3.
iii) SPC presents a CRT status summary and any priority updates to the EC. The status recommendations may include recommended **priority updates**.
iv) EC approves the status summary and the priority updates
v) SPC presents the CRT status and recommended priority updates to the Department.

vi) Faculty vote to approve the CRT status and any priority updates. In the case of non-approval, the process is re-iterated based on the feedback received.

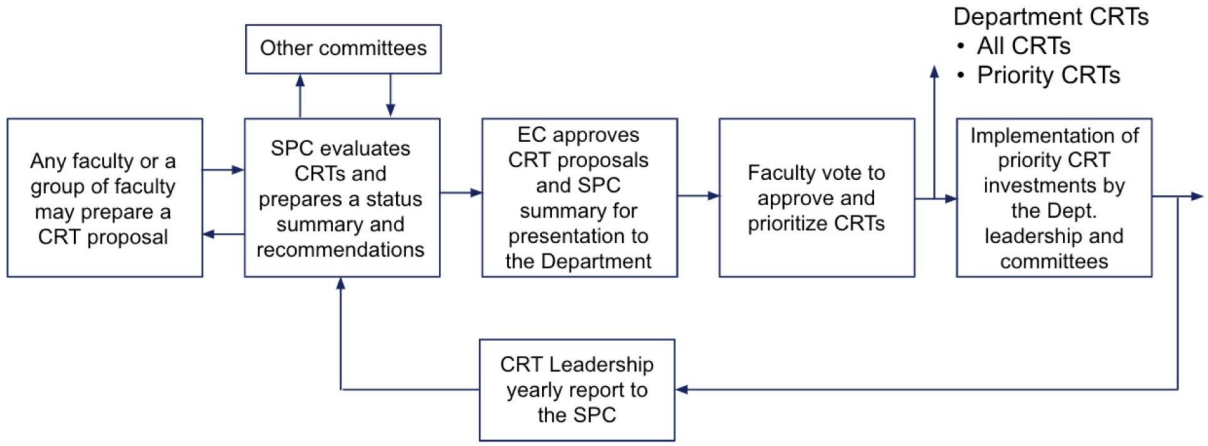



Figure 1. Process for the selection and evaluation of CRTs

(SPC = Strategic Planning Committee, EC = Executive Committee)

## B.2. CRT Proposal requirements

All ECEE faculty are eligible to propose a CRT. This section summarizes the CRT proposal requirements.

A CRT proposal shall **not exceed 5 pages**, including tables and figures, with a minimum font size of 11pt. Additional pages can be utilized for references. The proposal must contain the following information.

1. **Title and Leadership:** the proposal should identify the CRT title, and one or more faculty members who will serve as the CRT leaders and be responsible for CRT reporting.

2. **Vision**: (**up to one page long narrative)** this explains how the proposed CRT will contribute to the ECEE Department's vision in research and education. *The audience for the CRT Vision is the entire Department*. The CRT vision should address the following:
    a. How is the proposed CRT responding to emerging research areas and needs?
    b. How does the proposed CRT compare to other leading programs?
    c. How is it different or unique?
    d. How is the CRT leveraging existing strengths, and how will the CRT achieve the goals of being recognized as a leading program?

    The narrative should define success and the corresponding metrics specific to the proposed CRT.

3. **Cross-cutting ECEE collaborations**: list of the current ECEE faculty who are interested in contributing to the proposed CRT, with a one-line description of how their core expertise contributes to the CRT vision.

4. **Out-of-department collaborations**: list the faculty, research groups, centers, or institutes who are working with the ECEE faculty in the proposed CRT. Include a brief description of the existing and potential collaborations. Explain related college or campus-level initiatives.

5. **Research initiatives**: summarize current or anticipated funding opportunities and initiatives, such as multi-PI or multi-disciplinary proposal opportunities, Center-level proposal plans, initiation of a college-level IRT, etc.

6. **Curriculum development initiatives**: summarize how the CRT faculty members fill the current needs in the undergraduate/graduate/MS-EE programs. Summarize in-progress or planned curriculum developments or innovations, such as undergraduate/graduate/MS-EE course developments, or new programs such as undergraduate minor or PMP.

7. **Resources needed**: explain what are the resources and investments needed to achieve the goal of being or becoming a recognized leader in the CRT. In terms of research, the needs may include additional faculty (with related core expertise and cross-disciplinary experience), equipment, space, students, research or staff support. In terms of educational mission, the needs may include adjustments in the curriculum or degree programs, minor or PMP approvals, any additional student or staff support.

The proposal should briefly discuss: i) the worst-case scenario, assuming no investments; and, ii) the best-case scenario, assuming the resources needed are available.

8. **Success**: the CRT proposal should define success and metrics specific to the proposed CRT.

## B.3. CRT evaluation criteria

The success of a CRT depends on the impact on the research and educational mission and vision of the Department. The potential impact is evaluated at the proposal stage, and is then continuously reevaluated on a yearly basis according to the following criteria.

1. **Contribution to the Department's vision**. Specific metrics are:
    a. Number of research initiatives, including multi-PI proposals, center-level proposals, initiation of college-level IRTs.
    b. Research awards and expenditures.
    c. Publications.
    d. Faculty career advancements and recognitions.
    e. Number of undergraduate/graduate students involved in the CRT.
    f. Number of courses introduced or revised at the undergraduate and graduate level.

2. Impact on undergraduate and graduate education [evaluated in collaboration with the Curriculum Committee]
    a. Undergraduate/graduate/MS-EE course developments, curriculum and degree program developments or innovations
    b. Impact on undergraduate/graduate/MS-EE enrollments
    c. Impact on the quality of students recruited
    d. Student awards and recognitions, graduation rates and careers pursued
3. Feasibility of securing the resources required:

a. Existing strengths

b. The number of new faculty positions

c. Additional start-ups, space, or other resources required

d. Worst-case and best case scenarios

4. Number of CRT proposals, potential overlaps among CRTs, and diversity of the CRT to maximize coverage, prevent exclusion